ReadySet
Charge
Fleets

Bay Area Climate Collaborative - Metropolitan Transportation Commission
Alameda County General Services Agency

EV Fleet Deployment Strategies
Ready, Set, Charge, Fleets!

EV Fleet Deployment Strategies

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Project Partners

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The Bay Area Climate Collaborative (BACC) is a 501(c)3 public-private partnership program of Prospect Silicon Valley accelerating clean energy implementation. The BACC drives market-oriented solutions that reduce carbon, advance economic development, and accelerate penetration of climate solutions. BACC initiatives have committed nearly 150 million lbs. CO2 reduction over the next 10 years by facilitating the two largest all-battery electric vehicle fleet deployments in the country; deployment of over 150 public EV charging ports across 20 Bay Area communities; catalyzing the upgrade of over 85,000 streetlights to LED and more. Anchor partners include the Silicon Valley Leadership Group, Bank of America, PG&E, Environmental Defense Fund, major clean energy industry partners, and local governments representing over 70 percent of the Bay Area population. Prospect Silicon Valley provides a full spectrum of emerging technology support enabling next generation technologies for smart, clean and connected cities, including access to a $12 million, 23,000 sq. ft. Technology Demonstration Center in San Jose. www.baclimate.org

The Metropolitan Transportation Commission (MTC) is the transportation planning, coordinating and financing agency for the nine-county San Francisco Bay Area. MTC functions as both the regional transportation planning agency — a state designation — and, for federal purposes, as the region’s metropolitan planning organization (MPO). As such, it is responsible for regularly updating the Regional Transportation Plan, a comprehensive blueprint for the development of mass transit, highway, freight, bicycle and pedestrian facilities. The Commission also screens requests from local agencies for state and federal grants for transportation projects to determine their compatibility with the plan, known as Plan Bay Area, the most recent version of which was jointly adopted in July 2013 by MTC and the Association of Bay Area Governments.

Alameda County General Services Agency’s Motor Vehicle Division operates the County’s fleet, the main mechanism for business travel. The fleet includes shared pool vehicles that are available to employees and agency-specific vehicles that are utilized to provide social services, health inspections, and law enforcement. They continue to lead regional collaborative fleet management initiatives, including serving as lead agency on the Local Government EV Fleet Demonstration Project.
Bay Area Climate Collaborative Sponsoring Organizations

The Bay Area Climate Collaborative thanks the following sponsoring organizations for their support of this and other related projects.

ChargePoint operates the world’s largest and most open EV charging network. We also design, build, and support the technology that powers it. As our network grows, it makes driving an EV accessible to more and more people. Our mission is to get everyone behind the wheel of an EV and provide a place for them to charge wherever they go. For more, visit www.chargepoint.com.

As a global specialist in energy management with operations in more than 100 countries, Schneider Electric offers integrated solutions across multiple market segments, including leadership positions in utilities and infrastructure, industries and machines manufacturers, non-residential buildings, data centers and networks and in residential. Focused on making energy safe, reliable, efficient, productive and green, the company’s 150,000 plus employees achieved sales of $31 billion US dollars in 2013, through an active commitment to help individuals and organizations make the most of their energy. For more, visit www.schneider-electric.com.

Vision Fleet enables large-scale alternative fuel vehicle adoption by America’s fleets. The company’s Clean Miles Lease combines financing innovations from the solar and energy efficiency markets with analytic and operational support designed specifically for Alternative Fuel Vehicles (AFVs). The Clean Miles Lease enables fleets to achieve ambitious AFV objectives at low, predictable costs more quickly than previously possible. Vision Fleet’s flagship project with the City of Indianapolis is the largest to-date deployment of electric vehicles in a public fleet (425 PHEVs and BEVs). For more, visit www.visionfleet.us.
EV Fleet National Demonstration Project Participants

The Federal Highway Administration’s Congestion Management and Air Quality program funds the EV Fleet National Demonstration Project. The purpose of the project is to provide local government agency fleets in the Bay Area with battery electric vehicles and the necessary charging infrastructure to charge the vehicles. The project aimed to expose government agencies and fleet managers to electric vehicle experience and to provide lessons learned to other fleets that are considering electric vehicle adoption. Participants include:

• Alameda County
• City of Concord
• City of Fremont
• Transportation Authority of Marin
• Marin Municipal Water District
• City of Oakland

• City of San Francisco
• San Francisco Recreation and Parks Department
• City of San Jose
• City of Santa Rosa
• Sonoma County

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Mike has been involved in Electric Vehicles and Electric Vehicle fleets for over nine years. He started his EV career as VP of Customer Service and Support at Tesla Motors where he was responsible for after-sales operations for the company. Subsequent to Tesla Motors, Mike served as VP of Business Development at ChargePoint where he helped develop the ChargePoint business and distribution model. He went on to serve as VP and General Manager of NRG Energy’s eVgo division in the early conceptual stage where he guided the development of the eVgo Freedom Station. At City CarShare, Mike was the eFleet program manager introducing EVs to City CarShare members, and most recently Mike has been with the Bay Area Climate Collaborative as Senior Program Manager where he manages EV and EV-related initiatives.

David A. Head, Consultant, Head Fleet Management

Dave has been working in the automotive and equipment maintenance and management industry for over 45 years. He was the fleet manager for Sonoma County, California from December 1990 to April 2013. During his time as fleet manager he developed and implemented a number of initiatives and projects that established Sonoma County Fleet Operations as one of the most progressive
government fleets in America. In 2013, the County was recognized as the 9th best fleet in North America in the “100 Best Fleets” competition.

In 2011, Dave was Project Manager for the team that developed one of the first regional plans for deployment of electric vehicles and infrastructure in the County. The “County of Sonoma Electric Vehicle Charging Station Program and Installation Guidelines” has become a template for fleets throughout the region and earned recognition for the County as the “Most EV Ready Organization in the Bay Area” that year. Dave’s work to implement the plan by assisting cities and special service districts in Sonoma County in adoption of the plan and installation of charging stations throughout the county was recognized when the County won the award again in 2012.

After his retirement from Sonoma County in 2013, Dave has continued to stay current with the industry by serving on the board of directors for both the East Bay Clean Cities Coalition and the Sacramento Regional Clean Cities Coalition, as the Chairperson for the Northern California Chapter of the Municipal Equipment Maintenance Association (MEMA), and as an independent fleet management consultant.

DISCLAIMER

The Bay Area Climate Collaborative, Metropolitan Transportation Commission, and Alameda County General Services Agency prepared this Guide to provide fleet managers with information about Plug-in Electric Vehicles and the related infrastructure required to support them in fleet deployments.

These guidelines have been prepared at a time when PEV-related laws, regulations, and industry practices are undergoing rapid change. As a result, fleet managers must strive to continuously update their knowledge regarding industry, consumer, utility, and government expectations, as well as requirements for the deployment of PEVs and related infrastructure. These guidelines are intended to assist fleet managers to advance the adoption of PEVs in the fleets they manage. However, they do not represent a definitive legal framework for the adoption of PEVs nor the installation of charging infrastructure.

Neither the sponsoring organizations of the Ready, Set, Charge, Fleets! guide, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product or process disclosed within this document. Public and private fleets may or may not adopt similar methods of PEV and infrastructure planning, deployment, and operations. The views and opinions of authors expressed herein do not necessarily state or reflect those of the organizations that developed the document.
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Electric vehicles hold significant promise for substantially lowering fleet costs while delivering improved performance and sustainability. Leading fleets such as the City of Indianapolis, County of Alameda and County of Sonoma are demonstrating those benefits with fuel cost per mile of 3 to 5 cents, maintenance reductions of 50% or more, and tailpipe emissions reductions of up to 100% for battery electric vehicles. This shift to electrified transportation not only provides direct benefits to the fleets, but also broader economic and national security benefits – redirecting funds previously “lost” to fuel back into the local economy and reducing reliance on petroleum from volatile foreign regions.

Yet, there are a number of challenges to the adoption of plug-in electric vehicles (PEVs) in fleets including initial costs, charging infrastructure, driver acceptance, maintenance policies and use monitoring. Different duty cycles and management approaches can also add to implementation complexities.

The Bay Area Climate Collaborative (BACC) has developed this guide as part of its ongoing fleet electrification program. The purpose of this guide is to help fleet managers who would like to deploy PEVs in their fleet and realize their significant benefits. The emphasis here is on pooled light-duty fleets, but lessons learned can be broadly applied to most PEV scenarios.

Successfully realizing these benefits requires attention to a number of essential details. This guide draws on the experience of a number of successful fleets and fleet managers to cover considerations, pitfalls to avoid, and key strategies for deployment to help public and private sector fleet managers develop a successful deployment plan for their organization. We have attempted to write this as one fleet manager might discuss these concepts, ideas and issues with another fleet manager.
2. Key Findings and Summary

A number of fleets now have three or more years of experience in the adoption of PEVs into their fleets. The following are some of the key findings resulting from these early adopters.

- **Total cost of ownership savings is real**: The first studies of PEV costs are just now becoming available. Early results are showing that even though PEVs have higher initial cost than conventional vehicles, they more than make up for it in reduced operating and maintenance expenses over the life of the vehicle.

- **Drivers enjoy driving PEVs**: The benefits of driving a PEV are often overlooked. PEVs are less noisy and vibration free, making for more comfortable trips. Most have excellent performance, and there is almost never a need for a driver to refill a gasoline tank or check oil levels, which saves time and is a benefit to personal cleanliness.

- **Selecting the right vehicle for the mission is important**: It is imperative that bad PEV experiences be avoided in order to maintain the good will of the drivers. Make sure that the type of PEV, battery electric vehicle (BEV) or plug-in hybrid electric vehicle (PHEV) is matched to the mission at hand.

- **Charging infrastructure must be carefully planned in advance**: The cost, location and construction of EV charging stations can limit the success of a large-scale PEV rollout, but for small deployments or simple duty-cycles, infrastructure can be simple.

- **Electrical service must be carefully planned**: It is important to know in advance the existing electrical service in order to understand the potential cascading effects of adding EV charging infrastructure.

- **Planned charging schedules can substantially reduce electrical costs**: Many areas have time-of-use electrical rates and peak demand charges. By scheduling most charging to take place during off-peak hours, peak demand charges can be avoided or at least mitigated. Also, off-peak charging means that the lowest electric rates will apply.

- **Training the driver ensures acceptance**: Drivers are the customers of municipal fleets. If they do not like PEVs, the deployment will not be successful. A good program of driver education needs to be undertaken to cover the benefits of PEVs along with good PEV driving behavior.

- **Community relations are enhanced by the use of PEVs by city employees**: City employees who use PEVs report that the PEV is often a positive point of interest to the people they visit during their day.
3. PEV Benefits

PEVs offer substantial benefits to fleets that include tangible savings in operations and fuel costs as well as intangibles such as driver satisfaction and improved community relations.

Why should fleets consider plug-in electric vehicles (PEVs)?

There are many benefits to fleets that argue in favor of the adoption of PEVs including:

- Lower fueling costs (3-5 cents/mile for electric vs. 15-20 cents/mile for gasoline)
- Lower maintenance costs (studies show that PEVs average 1/3 less in maintenance costs)
- Lower total cost of ownership (TCO) over the life of the vehicle
- Extending vehicle longevity (fewer mechanical parts to wear out)
- Reduced emissions in community (no tailpipe emissions in electric mode)
- Cleaner roadways and parking lots for reduced contamination runoff (no oil, transmission, coolants in BEVs)
- Reduced noise in community (nearly silent in electric mode)
- Improved driver satisfaction (less noise, vibration; excellent performance)

Operating and Maintenance Costs

PEVs use electricity for fuel. Petroleum prices vary widely depending on season, as well as supply and demand. Petroleum-based fuels are produced from crude oil of which about 60% is imported from Latin America, Canada, the Mid-East and Africa. Political instability in some of these regions, combined with the cost of transporting crude oil from distant locations, contributes to the instability and continuing rise in prices.

Electricity is locally produced and not subject to wide pricing swings. It costs about 4 cents per mile to power a PEV whereas it costs 15 to 20 cents per mile to power a gasoline-powered vehicle. The increasing use of renewable energy to create electricity also means that PEVs will continuously become lower emitting in both greenhouse gases and other forms of pollutants.

Maintenance of PEVs is lower than gas powered vehicles because there are far fewer moving parts and systems to maintain. In a BEV, for example, there is no oil, no oil filter to change, no air filter and no transmission. Even PHEVs have reduced maintenance because the gasoline engine is used far less, making preventive maintenance intervals much longer. Other systems on both BEVs and PHEVs have lower maintenance costs. Brakes, for example, last much longer due to regenerative braking - the ability to use the electric motor as a brake to reduce the use of friction brakes and recharge the battery, which is a double savings.

Sustainability Initiatives

PEVs can contribute to the achievement of local sustainability goals by substantially reducing the amount of gasoline that is consumed by the fleet over a period of time. One gallon of gasoline translates directly to about 20 pounds of CO₂ released into the atmosphere. In addition to the very real savings in greenhouse gases, PEVs with municipal logos signal to residents that their city takes sustainability goals seriously and is addressing those goals with their own fleet.

In summary, a well-run EV fleet should cost less to operate and maintain than a conventional fleet. Electricity is a much less expensive transportation fuel than petroleum-based fuel on a per-mile basis. In addition, maintenance expenses are substantially reduced due to less mechanical complexity and reduced stress on braking and other drivetrain components. These reduced costs add up over the life of the vehicle and more than make up for initial purchase price differences.
There are many new terms and concepts that are associated with PEVs. It is important to understand the different types of PEVs that are available and how the different types relate to fleet operations.

- **EV** – Electric Vehicle. This can apply to any vehicle that has electricity as part of its propulsion system. In this guide we use PEV, BEV, and PHEV (see below) to indicate the type of electric vehicle, however industry often uses the term EV as a catchall phrase.

- **PEV** – Plug-in Electric Vehicle. Includes any vehicle that can recharge its battery system by plugging in to the electric grid, specifically BEVs and PHEVs (see below).

- **BEV** – Battery Electric Vehicle. A vehicle that is powered solely by electricity stored in its battery system. The battery must be charged by plugging the vehicle in to the electric grid.

- **PHEV** – Plug-in Hybrid Electric Vehicle. A vehicle that can be powered by electricity and by gasoline. Similar to a conventional hybrid except that the battery is larger and can be re-charged by plugging in to the electric grid.

- **EREV** – Extended Range Electric Vehicle. This has a larger battery than a PHEV for longer EV range, and switching between engine and electric drive functions differently. For the purpose of this document, EREVs are included as part of the PHEV family of vehicles.

- **AFV** – Alternative Fuel Vehicle. A vehicle that is powered by a fuel other than conventional gasoline or diesel fuel. Typical examples are PEVs, natural gas vehicles and fuel-cell electric vehicles.

- **LDV** – Light Duty Vehicle. A standard sedan, SUV or pickup truck is generally considered to be a LDV irrespective of power source.

- **EVSE** – Electric Vehicle Supply Equipment, also called a charging station.

- **J1772** – The SAE standard for the plug and protocol used to charge PEVs.

### Technology Overview

PEVs fall into two categories: BEVs and PHEVs. Table 1 below highlights the ideal use cases and advantages of PHEVs and BEVs in various scenarios.

BEVs run only on electricity stored in an on-board battery (typically lithium-ion) and use one or more electric motors for motive power. Most BEVs have no transmission, only a reduction gear and differential, and thus are much simpler, more reliable, and easier to maintain than gasoline powered vehicles.

PHEVs have both an electric motor and a gasoline engine. They differ from standard hybrids in that they have a larger battery that

### Table 1: EV Vehicles Available for Fleets

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>Electric Range</th>
<th>Advantages</th>
<th>Use Cases</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEV</td>
<td>60-80 miles at time of print, up to 200 miles expected by 2017</td>
<td>No tailpipe emissions, lowest fuel and maintenance costs</td>
<td>Local trips and longer trips where recharge is possible</td>
<td>Inspectors, case workers, parking enforcement, general carpool, route vehicles</td>
</tr>
<tr>
<td>PHEV</td>
<td>20-40 miles (plus gasoline range)</td>
<td>No range anxiety and more use case flexibility</td>
<td>Extended trips and local trips where re-charge is not available</td>
<td>Dedicated vehicles, general carpool, unpredictable trip distances</td>
</tr>
</tbody>
</table>
PEV Basics

can be charged by plugging the car into a source of electricity. PHEVs usually have a shorter electric-only range than a BEV, but they can switch to gasoline power when the battery is depleted which provides more overall range. Since PHEVs have a gasoline engine, they require more maintenance than a BEV. However, the gasoline engine is used less and therefore maintenance intervals can be extended beyond conventional vehicle maintenance intervals.

Which type of vehicle (BEV or PHEV) a fleet should purchase depends on several factors that will be covered in this guide.

At this time, most PEVs are light duty vehicles, so fleets are somewhat constrained in what types of conventional vehicles can be replaced by PEVs. However, there are a number of light duty trucks, SUVs, and vans that are being developed. In the meantime, this is a good opportunity for fleets to gain experience in adopting PEVs for their sedan fleets and use that experience when it comes time to consider larger vehicles.

EV Ecosystem

While it is possible, and in many cases acceptable, to charge PEV batteries using the EV charging cable that is supplied with the vehicle and plugged into a standard 120 volt outlet (see note on Table 2), our recommendation is that fleets adopting PEVs should install charging stations to fuel their vehicles.

The selection of type, location, and number of charging stations will be covered in this guide as well as the “infrastructure behind the infrastructure” – the need for sufficient electrical service at locations where PEV fleets are to be fueled. Unlike consumer PEVs that can be fueled conveniently in an owner’s garage overnight, fleets are typically parked together which may require either additional electrical service from the electric utility company, or a round robin strategy for fueling – or both. See Table 2 below for a listing of the various types of EVSEs.

<table>
<thead>
<tr>
<th>Terminology</th>
<th>Voltage</th>
<th>Amperage</th>
<th>Plug Style</th>
<th>Charging Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Level-1</td>
<td>120 VAC**</td>
<td>Up to 16A</td>
<td>Standard household outlet or SAE J1772</td>
<td>Up to 1.9kW</td>
</tr>
<tr>
<td>AC Level-2</td>
<td>208-240 VAC</td>
<td>Up to 80A</td>
<td>SAE J1772</td>
<td>Up to 19.2kW</td>
</tr>
<tr>
<td>SAE DC Level-1</td>
<td>200-500 VDC</td>
<td>Up to 80A</td>
<td>SAE J1772 Combo</td>
<td>Up to 40kW</td>
</tr>
<tr>
<td>SAE DC Level-2</td>
<td>200-500 VDC</td>
<td>Up to 200A</td>
<td>SAE J1772 Combo</td>
<td>Up to 100kW</td>
</tr>
<tr>
<td>CHAdeMO</td>
<td>Up to 500 V DC</td>
<td>Up to 125A</td>
<td>CHAdeMO</td>
<td>Up to 62.5kW</td>
</tr>
<tr>
<td>Tesla SuperCharger</td>
<td>Proprietary</td>
<td>Proprietary</td>
<td>Tesla Proprietary</td>
<td>Up to 120kW</td>
</tr>
</tbody>
</table>

** Note: If a decision is made to use a standard 120 volt outlet it should be a heavy-duty outlet with ground fault circuit interruption connected to a dedicated 20 amp circuit. Also the outlet should be located such that the weight of the vehicle charger is not supported by the plug.
5. PEV Use Cases for Fleets

Not all fleet vehicles can be replaced by PEVs, but most fleet operators will be surprised at how PEVs can be used for tasks that were previously considered as only for conventional gasoline powered vehicles. The Use Cases for PEVs is closely tied with the availability and the cost of electricity as a transportation fuel, and the charging infrastructure required to support PEVs in the fleet.

Use Cases

PEVs are ideal for many fleet vehicle missions. The typical fleet vehicle is driven on short daily round trips, often within the range of a single charge for a BEV. There are often use cases that are routine – a certain route is followed every day or a certain number of short trips are made every day. Because of the predictability in terms of frequency and distance, these scenarios are ideal for BEVs. Longer trips, or where daily mileage is not as predictable, are the purview of the PHEV, which can switch automatically to gasoline when the battery is depleted.

The current PEV products that are available on the market are in the light-duty vehicle (LDV) class. This includes mainly compact sedans and small SUVs. Focusing on the LDV sedans that are available, there are many 4-door and 5-door (hatchback) products on the market in both the BEV and PHEV configurations. These light duty vehicles (LDVs) are a good fit to replace existing compact, and in some cases, full-size sedans and SUVs that may be in the fleet.

There are also some full-size pickup trucks, vans and medium-duty trucks that are under development, but not yet available in production quantities. Many of these emerging truck technologies have larger battery packs that can support job site electrical power from the vehicle battery pack. Jobsite power on light- and medium-duty trucks is an alternative to running the engine to power on-board systems and can significantly reduce engine hours, idle time, job site noise and operating expenses. Significant progress is also being made in offering battery-powered buses, as well as other medium-duty and heavy-duty trucks for special missions such as refuse collection. While recognizing the

Electric Utility Rates

What is “Demand Charge”?
Demand Charge is a billing mechanism used by some utilities to recover the cost of providing transmission and distribution service to non-residential customers. This charge is in addition to the usage rate for customers whose consumption reaches a predetermined maximum threshold. In the case of PG&E, demand charges are assessed for loads greater than 10 kW. Typically energy use is monitored during the monthly billing period and the Demand Charge is based on the highest use during any 15-minute period. Demand Charge rates may vary based on time-of-use as well as the season. The importance of Demand Charge for EV charging is that if several EVs are charging at the same time, the Demand Charge associated with a specific electric meter can be much higher. Demand Charges should be avoided. If not effectively managed, this can increase an electric bill by several thousand dollars per year. Fleets can minimize Demand Charge through sequential timing of charging sessions.

What is Time-Of-Use Rate?
Most commercial electric utility rate schedules have time-of-use rates. Rates during partial-peak and off-peak hours of the day are lower than the rates during the peak hours of 12 - 6 p.m. on weekdays. By scheduling EV charging during off-peak and/or partial-peak periods, fleets can substantially reduce the cost of charging.

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importance of electric light-, medium- and heavy-duty trucks and buses, this Guide does not address the adoption of these vehicles. To determine which vehicles are well matched to PEV use cases and which are not, it is a good idea to assess the fleet before undertaking a project to add PEVs. Typical use cases include vehicles that are driven 50-70 miles per day. A BEV sedan is a very good fit for this use case because it can be driven throughout the day without a need to be re-charged. For vehicles traveling more than 70 miles PHEVs should be considered since they have the ability to switch to gasoline power when the battery is depleted. There are also situations where vehicles are taken out for a shorter period of time and returned to a garage (such as pool vehicles). These use cases are also ideal for either BEVs or PHEVs because the vehicles can be recharged in between uses, thus maximizing electric miles.

It is important to note that at the time of this writing (Spring 2015) a number of longer range BEVs have been announced. These longer range BEVs are projected to have ranges that exceed 200 miles and at reasonable costs that would be compatible with fleet operations. Once these vehicles are available, the trade-offs between PHEVs and BEVs for fleet operations will change.

PEV Battery Charging

Fleets, especially municipal fleets, have some distinct advantages in charging PEVs. One of the main considerations when deploying PEVs is that they need to be charged on a daily basis and sometimes during the day if usage permits. It is more advantageous to install several chargers at a single site rather than single units at several locations because it lowers the installation costs. Since many fleet vehicles are garaged in a central location, the cost of adding a group of charging stations at that location is minimized. However, there are certain offsetting considerations regarding central charging that need to be considered. These include ensuring that there is sufficient electric service to support simultaneous charging of multiple vehicles, and the potential of increasing Demand Charges (see sidebar on the previous page) during simultaneous charging of multiple vehicles. This also brings up the consideration of electric utility rates. While municipalities often have favorable electric rates, they are still subject to the Demand Charge mentioned above as well as time-of-use rates in most jurisdictions. With proper planning, charging times can be pre-planned to minimize excess Demand Charges and to take advantage of time-of-use electrical rates.
6. Fleet Challenges

There are many things that fleet managers need to know before considering PEVs for their fleet. Fleet Managers who have been given the task of developing an alternative fuel vehicle program have several fuels and technologies to choose from. Deciding which alternative fuel vehicles that best meet the applications in a fleet requires investigation and analysis of all the technologies in order to find the right fit. Much of this process is the same regardless of the fuel or fuels determined to best meet the needs of the fleet. This guide can be used as a blueprint for other alternative fuel programs. It is likely that a medium-sized or large fleet could deploy multiple technologies to meet clean fleet goals. The process in deploying different technologies will ask many of the same questions that are addressed in this guide, which makes this guide helpful in the planning process regardless of which AFV programs you choose to deploy.

Senior Management Commitment

All organizational policy direction, funding, and political support comes from the senior management team, elected board, council or some manner of chief executive officer or board of directors. It does not matter if the organization is a city, county, special service district or a major for-profit corporation. Without support from the highest level of the organization, any substantial alternative fuel vehicle program will likely be difficult to implement and sustain. Alternative Fuel Vehicle (AFV) programs can be challenging. Although many agencies have shown long-term savings that more than offset the start-up costs, senior management needs to understand the challenges, be supportive of the project team and be willing to be patient with the process and expense to see substantial results.

As will be shown later in the Guide, there are some very creative full-service vehicle leasing programs for PHEVs that can provide fleet operators with improved cash flow by reducing the initial outlay for a PHEV while including all operating costs in a vehicle-miles-traveled lease payment.

Not all technologies will work in every fleet application and the AFV technologies are in transition. Advancements are moving: some to be more efficient and cost effective over a wide range of applications, while others are finding specific application niches where they provide the greatest return on investment. There needs to be willingness among senior management to accept that results may or may not be what was expected, and to allow adjustments to the course, if necessary, to make their program a success. Without this level of commitment throughout the organization’s chain of command and responsibility, a successful program will be difficult to implement.

Technology Costs

All new technology comes at a price. The cost of the new innovation needs to be part of the calculation before you move forward with any project. In the case of PEVs, cost revolves around three major components of the overall system: the Vehicle, the Electric Vehicle Supply Equipment (EVSE or charging station), and the cost to install the EVSE.

Are PEVs more expensive to purchase? Today PEVs cost more to purchase than conventional vehicles of the same vehicle class. However, as with all new technology, costs rapidly decrease as technology matures and volume production increases (see Figure 4). While we wait for PEV prices to decrease there are several federal and state programs that offer economic incentives designed to achieve parity pricing for PEVs. These programs can amount to more than $10,000 per vehicle depending on location.

Factor in all costs: An analysis of the Total Cost of Ownership (see sidebar explaining TCO on the following page), also known as Life Cycle Cost, should be done on the vehicle types under consideration as one of the early steps in deciding the fuel type,
vehicle, size, and scope of your project. Also note that PEVs often come standard with accessories such as GPS and cruise control that are missing on basic vehicles. Such accessories make vehicles more enjoyable to drive, but more importantly can help save money through efficient routing and driving practices.

Consider a “full-service” lease plan: A recent development in fleet leasing of PHEVs is the full-service lease plan whereby all costs of acquiring, operating, and monitoring of a PHEV fleet are covered by a vehicle-miles-traveled lease payment. This service, which is conceptually similar to the power purchase agreement (PPA) that revolutionized the solar energy industry, covers the acquisition cost of the vehicle, cost of electricity, cost of infrastructure installation and maintenance, as well as providing vehicle use monitoring to encourage best practices for fleet drivers.

Cost of the EVSE: There is a wide range of EVSE systems and technology. They range from simple charging units for Level-1 charging with no data collection, to a top-of-the-line, fully computerized and network-integrated Level-2 or DC fast-charge EVSE. Consider what type and complexity of charging you need for each location before deploying. If you have a site with all PHEVs that have a 6-8 hour window between uses, a Level-1
EVSE would likely meet your needs. If you do not have a need to collect specific charging and vehicle data (such as the amount of electricity used by the cars) and you do not need to control access to your EVSE, there is no need to buy an EVSE that has those capabilities. For this type of site, an EVSE can be purchased for under $1,000 per unit.

As you add functionality to the EVSE, you will add cost. If you need data collection, the cost will be higher based on the amount of data you need. A networked Level-2 EVSE with the ability to track vehicle and charging data will likely be in the $3,000 to $5,000 per port price range. Additionally there may be network subscription fees, software license fees, extended warranty fees, and access card fees for networked EVSEs.

The most important thing is to buy an EVSE that will meet your long-term needs. Do your research; talk to Fleet Managers who have a working PEV program and to your fleet users (drivers) about their needs. Determine how much data you will need for whatever analysis and reporting you may be required to provide. Then discuss the options with the section of your organization that is responsible for reporting vehicle cost, usage and financial information to outside agencies such as State Auditors for grant programs. Make sure you purchase the EVSEs that provide all the information you will need. Replacing or upgrading an EVSE at a later date will add to the expense of your program.

EVSE installation cost is the third major cost factor in deploying PEVs in the fleet. There is a detailed discussion of considerations for installing EVSEs in Table 4 of this guide.

If the cost of purchase and installation of EVSEs is starting to make the program seem less viable, consider the cost of installing any fueling infrastructure at today’s costs. A simple card-lock fleet fueling station that requires all vehicles to return to the same location for fuel would likely be well over $1,000,000.00 to build. A lot of EVSEs can be installed in multiple locations for less money.

Acquisition and Operating Costs for EVs

Simply stated, PEVs may cost more to purchase than a comparable conventionally fueled vehicle, but typically cost less to operate. Therefore, when comparing the Total Cost of Ownership, it is likely that the PEV will cost less to own. A PEV may also cost less to lease, especially when considering the full-service lease. Note that with current Federal and State PEV purchase incentives (as of mid-2015) adjusted vehicle prices may be lower than conventional vehicles.

In Sonoma County, California’s hybrid vehicle program found that the lifecycle cost of a hybrid sedan versus a conventional vehicle was significantly less. This was attributed to the lower cost of maintenance, increased fuel economy, and higher residual value. Fuel and maintenance costs were about half that of a conventional vehicle, and the recovery when the vehicle was sold was two to three times more than that of a conventional vehicle.

The fact above can be applied as a safe assumption for PEVs in a fleet. The operational cost of PEVs has been even less than that of hybrid vehicles. For PHEVs, oil change intervals can be extended based on engine hours instead of vehicle miles traveled. For EVs, there is not an internal combustion engine so maintenance items are mostly tires, brakes and suspension parts. With regenerative braking on most PEVs there is less wear and tear on vehicle functionality. Therefore, even the brake pads, rotors, and rotors on most PEVs can last about twice as long as on a conventional vehicle.

<table>
<thead>
<tr>
<th>Table 3: TCO Comparative Example¹</th>
<th>2015 Ford Focus SEL</th>
<th>2015 Ford Focus Electric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase Price</td>
<td>$21,224</td>
<td>$30,344</td>
</tr>
<tr>
<td>Tax Credits &amp; Rebates²</td>
<td></td>
<td>($2,500)</td>
</tr>
<tr>
<td>Net Purchase Price</td>
<td>$21,224</td>
<td>$27,844</td>
</tr>
<tr>
<td>Fuel Cost</td>
<td>$4,900</td>
<td>$1,545</td>
</tr>
<tr>
<td>Preventive Maintenance</td>
<td>$2,100</td>
<td>$525</td>
</tr>
<tr>
<td>Repairs</td>
<td>$6,300</td>
<td>$1,575</td>
</tr>
<tr>
<td>Resale value (25% of original price)</td>
<td>($5,306)</td>
<td>($7,586)</td>
</tr>
<tr>
<td>Total Lifecycle Cost</td>
<td>$29,218</td>
<td>$23,903</td>
</tr>
</tbody>
</table>

¹ Assumptions in this example:
   a. 25% resale value for both, Electricity cost 15 cents/kWh
   b. Gasoline cost $3.50/gal
   c. Ford Focus SEL mileage is 30 mpg
   d. Electric mileage: 4 miles/kWh
   e. Annual mileage: 6000
   f. Gasoline repair/maintenance cost: $0.20/mile
   g. Electric repair/maintenance costs: $0.05/mile
   h. Lifecycle: 7 years

² California EV Incentive of $2,500 for Ford Focus Electric. Other local and Federal incentives may apply. In particular for non-government fleets there is a $7,500 federal tax credit. Government fleets can use leasing to capture at least a portion of the federal income tax credit through capital cost reduction on the lease if the lessor can take advantage of the income tax credit.
brakes so replacement and repairs should be extended well beyond that of conventional vehicles. Experience has shown that regenerative braking extends brake life on fleet vehicles from an average of 30,000 miles to 100,000 miles.

Most fleets that are operating PEVs have not completed a full lifecycle on their vehicles and therefore total lifecycle costs are not yet completely understood. In particular, it is not known how well PEVs will retain their value as used cars because of the potential for battery system replacement. This is another argument in favor of vehicle lease or full-service lease programs.

Battery Life and Battery Residual Value

The PEV battery will have monetary value after its useful life as a PEV battery has expired. The residual value of the batteries and reasonable expected lifetime are not well known at this time. The vehicle manufacturers have been saying that under normal usage conditions, the batteries will perform well through the battery warranty and beyond. Factors such as charging cycle, excessive fast charging, and running the battery completely dead may, over a period of time, have an impact on battery life.

It is important to note that lithium-ion batteries slowly lose capacity with use over time, but remain useful even when capacity is diminished. Battery system manufacturers conservatively state that a lithium-ion battery will lose about 80% of its capacity after 1000 recharge cycles. Therefore, a vehicle such as the Nissan Leaf that has a 24kWh battery and averages 3.5 miles per kWh, will have a range of about 84 miles when new and a range of approximately 68 miles after about 75,000 miles of driving.

Vehicle manufacturers and other companies are exploring opportunities for recycle and re-use of batteries. The possibilities include remanufactured vehicle batteries as well as stationary energy storage (see Figure 5) to store energy from renewable energy generation systems and back-up power for the grid. Portable EV charging systems can also make use of second-use lithium-ion batteries.

Another option to be researched is to reclaim and recycle valuable materials for other uses. At this time there are few programs in place to implement these programs, but it is expected that over the next five to ten years there will be a number of uses for used electric vehicle batteries and, with increased demand, there will be increased residual value.

Different vehicle manufacturers have set different time and mileage intervals for warranty coverage. Fleet Managers should consider setting vehicle replacement intervals that will provide the next owner with reasonable battery life and storage, possibly between 6 and 8 years of fleet service life, depending on the vehicle. This will maximize resale value and provide the new owner with some of the remaining battery warranty.

When you buy or lease a PEV, you should not be concerned about replacing the battery any time soon. PEVs on the market today come with an extended warranty for their batteries. For pure BEVs, most have an 8-year/80,000 mile warranty, and PHEVs have a 10-year/100,000 mile warranty. Vehicle warranties change from time to time and it is important to understand what the battery warranty on the vehicle covers. You might consider including extended warranties on drive train and batteries as an option when purchasing vehicles. This will give the fleet manager the ability to decide if the cost of the warranty is a good value or not.

Figure 5: Stationary energy storage using lithium-ion batteries. (GreenCharge Networks)
Table 4: Considerations for Adding EV Charging

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property Ownership and Long-Term Plans for Property Use</td>
<td>Whether the property is leased or owned, planned occupancy period, expansions or consolidations under consideration. These factors have an effect on whether to install permanent charging stations or investigate other solutions such as mobile charging or off-the-grid solar powered charging.</td>
</tr>
<tr>
<td>Vehicle Issues</td>
<td>Estimating the number and types of vehicles, vehicle duty cycles, PHEVs vs. EVs, and range requirements.</td>
</tr>
<tr>
<td>User Base</td>
<td>Will the EVSE be restricted to fleet only, or will it be available for employee workplace charging or open to the public?</td>
</tr>
<tr>
<td>Time of Charging</td>
<td>Knowing if vehicles will be charged overnight or during the day, if vehicles need to be moved to free up charging stations, and if they apply, EV rate structures.</td>
</tr>
<tr>
<td>Source and Availability of Electrical Power</td>
<td>What are the sources of power? Is there enough power at this location for the number of vehicles planned? Will a service upgrade be required? Can this location be supported by a renewable power source?</td>
</tr>
<tr>
<td>Construction Issues</td>
<td>Permitting, budget, accessibility, distance to power, trenching, landscape removal/replacement, paving, signage, painting, lighting, ramps, walkways, etc.</td>
</tr>
<tr>
<td>Automated Charging</td>
<td>Will equipment and software be needed to automatically sequence charging operations among available EVSEs to maximize capacity of electrical system?</td>
</tr>
<tr>
<td>Public/Employee Access</td>
<td>Understanding additional design features that may be required, such as signage, lighting, accessibility, etc. if employees or the general public are to have access to the equipment. Possible differentiated fees for public use.</td>
</tr>
<tr>
<td>ADA Accessibility</td>
<td>Legislation is pending on accessibility requirement for EV charging stations. The current recommendation is to provide at least one parking space at an EV charging station that is accessible. See <a href="http://www.ada-pros.com/ada-electric-vehicle-charging-stations-in-california/">http://www.ada-pros.com/ada-electric-vehicle-charging-stations-in-california/</a> for more details.</td>
</tr>
<tr>
<td>Tracking Software – Data Collection</td>
<td>Ensuring systems are planned or in place to track use, performance, maintenance, VMT by type of fuel, electricity usage, etc. Consider acquiring software to help ensure that your vehicles are fully charged when you use them.</td>
</tr>
<tr>
<td>Policy and Procedures</td>
<td>Are any organization policies needed to help manage the use of charging stations to optimize their use and availability?</td>
</tr>
<tr>
<td>Other Site Considerations</td>
<td>Visibility, lighting, emergency contact, and other considerations when selecting a site for EVSEs.</td>
</tr>
</tbody>
</table>

Fleet Infrastructure Issues

The table above shows the primary considerations for fleet charging station installations. This quick overview is designed to develop awareness of many of the key considerations when planning a deployment of EVSEs for fleet use. Each item is discussed in greater detail in the following paragraphs. See Appendix A for an example EVSE Infrastructure Plan. Table 5 on the following page provides recommended infrastructure based on various conditions.

Property Ownership

This is the first consideration of any planned deployment of PEVs in a fleet. It goes beyond just who owns the property; an organization’s long-term plans for a facility must be part of the planning process. EVSEs can be expensive and difficult to have installed. In order to maximize the return on the investment in the infrastructure, an assessment needs to be done to determine how long the EVSEs will be used at each location. Each organization will have a different answer to this assessment, but if you do this...
Fleet Challenges

First it may save your need to explain later why money was spent to install infrastructure when the plan was to only use that facility for another year or two.

The assessment on ownership needs to determine if the facility is owned by your organization or is leased from another property owner. If it is leased, what is the term of the lease and likelihood of the lease being renewed? Will the property owner allow EVSEs to be installed on the property and/or help offset some of the cost? What happens to the EVSEs when and if the lease expires without renewal or is terminated? Who pays for the electricity, how is it measured, and how is it paid for? Will installing EVSEs change the lease rate or term?

The next consideration is the same regardless of property ownership, but is still part of the facility long-term usage plan. Are there plans for the facility that may impact the number of vehicles located at the location? Are there expansions, consolidations, employee relocations, or other organization or operational changes that would impact the number of vehicles based at a facility and thus change the number of EVSEs required? If so, can the changes be incorporated in the installation process plan? Can additional electrical panel capacity and conduit be addressed based on the long-term expansion of the fleet’s PEV program? If you have to expand electrical capacity or install underground conduit for one EVSE, consider adding capability at the electrical panel, conduit and any junction boxes for additional EVSEs in the future. In particular, if you are trenching a parking lot, adding spare conduits is inexpensive and helps “future proof” the lot. Make sure you plan for the future expansion of EVSEs at the location.

Vehicle Issues

The types of vehicles based at a location will determine the number and configuration of EVSE connections. Again, planning is the key to this part of the project. If possible, project the number, size, and types of vehicles that will be based at each location. This can be difficult because the type of vehicles being produced and the organization goals will likely change before the fleet deployment is complete. However, using the best information available at the time, fleet managers need to make their best estimate of how many and what type of PEVs will be based at a location in the future.

User Base

Plan for how the EVSEs are going to be used. Answers to these questions will help determine number and type of EVSEs, how and where they will be installed and if they need to meet any special requirements for public access.

Example 1: Level-1 overnight charging

If vehicles are not used at night and are used for short-range daytime trips, it is possible to use Level-1 charging. Most EVs will completely charge at Level-1 within 12 hours. It may still be desirable to have access to Level-2 charging for times when a vehicle needs to be recharged more quickly. This is a particularly useful strategy when vehicles are distributed to many locations since it reduces Level-2 charging installation expenses.

Example 2: Level-2 charging at a single location

If vehicles are typically kept at a single location such as a fleet garage it may be better to install multiple Level-2 charging stations and charge vehicles sequentially. EVs will typically charge completely in 2-3 hours on Level-2 charging stations. Level-1 EVSEs are generally less expensive to purchase and install and require less of an electrical load. If Level-1 EVSEs meet the needs at a location, they should be considered. However, keep in mind that Level-2 EVSEs can be easier to share since they charge vehicles much more quickly.

<table>
<thead>
<tr>
<th>Condition</th>
<th>System Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is charging mostly done at night with occasional daytime charging?</td>
<td>Multiple Level-1 or Level-2</td>
</tr>
<tr>
<td>Are the vehicles mostly PHEVs as opposed to EVs?</td>
<td>Mix of Level-1 and dual-port Level-2</td>
</tr>
<tr>
<td>Is it necessary for all vehicles to be recharged as quickly as possible?</td>
<td>Multiple Level-2 and DCFC</td>
</tr>
<tr>
<td>Can charging be scheduled using a single EVSE to refuel multiple vehicles?</td>
<td>Dual-port Level-2</td>
</tr>
<tr>
<td>Will employees and/or the public be able to use EVSEs?</td>
<td>Multiple dual-port Level-2</td>
</tr>
<tr>
<td>If open to employees and/or the public, will they be billed for the electricity?</td>
<td>Multiple networked dual-port Level-2</td>
</tr>
</tbody>
</table>
Time of Charging

Time of charging is important for two primary reasons. First, it will help you decide how many and what types of EVSEs are needed. Second, many electric utilities have time-of-use or EV rates for usage during a specified time period. These special rates are generally at night when the electrical grid has lower demand. If special rates apply, as in the example depicted in Figure 6 above, charging done in an off-peak period could cost less. See the discussion on utilities and rates in section 10 of this guide for more on utility rates.

Source and Availability of Electrical Power

Now that it has been decided that PEVs will work for business conducted from a location or facility, it is time to see if the facility will support PEVs. The questions here seem simple, but often the answers are complex.

- **Is there enough power at this location for the number of vehicles planned?** Many older facilities may not have adequate utility service to support adding charging stations. Consult with a qualified electrician, building expert and/or local utility to assess power needs and building capabilities. Do not guess; be sure before you start construction. If a utility service upgrade is required there may be long lead times from the local electric utility company.

- **Will a service panel upgrade be required?** If so, get good cost estimates up front. Adding electrical panels and/or transformers can be expensive. Know what needs to be done and the cost of the upgrade before you approve the work.

- **How far is the electric panel from the desired location of the charges?** Distance adds cost.

- **What underground utilities might be in the way of trenching?** E.g. sewer, water, electrical, etc.

- **Can this location be supported by a renewable power source?**

- **What are the sources of power?** If a key element in deploying PEVs in your fleet is to “green” your operations, the source of the power becomes important in your assessment. If your power is from clean sources such as hydroelectric or natural gas, significant emission reductions can be achieved. If the source of power is generated by coal or oil powered generators, overall emission reductions will be less. The local utility company should be able to provide you with the emissions information for the electrical grid in your region. Note that in most regions, the electrical grid improves over time, so your vehicles’ net emissions will improve with it.

Construction Issues

Before you start drawing plans for installing charging stations, bring in professionals who know about construction, building codes and electrical systems to assist with your location evaluation. It is recommended to find an electrical contractor who has experience with EVSE installation in your community as they will know the permit requirements. The more you do up front, the...
fewer headaches you will have later. You will have already done some of the construction evaluation when looking at the power source and capabilities.

- Locate charging stations as near to the facility’s electrical room as possible. Most often transformers, electrical panels or rooms and other electrical facilities are in the rear of the building. The desired location for charging stations is near the front of the building.

- Trenching is expensive. Keep underground construction work to a minimum.

- Where possible maximize flexibility for cord sharing by installing EVSEs at head-to-head spaces in parking lots. This could allow for fewer EVSEs to be installed, but not require cars to be moved – e.g., swap cords, not cars.

- Discuss your plans with the local building permit office to ensure that the installation meets current building code, including any requirements for accessibility under the Americans with Disabilities Act (ADA). There are several discussions in progress about accessibility of charging stations. Although no state or federal guidelines have been issued on this topic (as of spring 2015), some local agencies have developed guidelines. Building codes are currently being revised – check for latest code revisions. (See section 12 references for “Ready, Set, Charge” and “County of Sonoma Electric Vehicle Charging Station Program and Installation Guidelines.” These guidelines have not been adopted by the State of California as law, but they offer ideas on how to best meet construction requirements of the ADA.)

- Do not take shortcuts. Even a simple installation will require design and formal plans. Putting in the necessary time and effort, and paying qualified professionals to do it right, will save much time and money later. A bad plan will someday need to be fixed.

**Automated Charging**

Automated charging may refer to “hands-free” charging and/or it may refer to automated scheduling of charging. Hands-free charging is still under development by several companies with both conductive and inductive versions being tested. Once available, hands-free charging will be useful for fleet charging because it will ensure that vehicles are completely charged without having to depend on drivers to plug in the vehicles.

Automated scheduling of charging can be a useful tool for fleets and can help the organization take advantage of special use or off-peak rates as well as avoid increased utility demand charges. Charge scheduling can be done in several ways. Networked EVSEs have the ability to be scheduled so that they will only provide charge at predetermined times which can be set to correspond to off-peak rate times. Most PEVs have a means of setting up a charging schedule for the vehicle regardless of where it is plugged in. Some PEVs have the ability to have charging completed at a predetermined time, with the charge start time based on the battery state-of-charge and time necessary to complete a charge. An area that is very promising is the development of fleet management software that can read each vehicle’s state of charge, battery health, and other factors such as utility rate schedules, to manage charging. This ensures availability of the vehicle while optimizing charging times to take advantage of time-of-use rates and avoid excessive utility demand charges.

You will need to determine what features are available on your vehicle and EVSE and whether you will need to purchase additional software or equipment to manage charging. It is recommended that fleet managers investigate the latest information on EV fleet management software and be prepared to adopt one of these systems in order to maximize your investment in PEVs.

**Tracking Software – Data Collection**

If part of your PEV program includes comparative analysis between PEVs and conventional vehicles, tracking software and data collection procedures will need to be part of the implementation plan. For small projects, this could be accomplished by drivers reporting vehicle miles traveled and amount of energy used (typically in kWh). Most PEVs provide this information to the driver at the end of each trip. For larger projects, automated data collection might be required. Discuss data collection with the EVSE supplier or other data collections systems (e.g., fleet management software or GPS systems) you might already be using to see if the data can be collected and provided to you.
Sharing Charging Stations with Employees and/or the Public

Are you going to allow employees and/or the public to use the charging stations? If so, additional signage, ADA accessibility, and rules may need to be established to ensure that access is managed and EVSEs are available to fleet vehicles when needed. This access should also open the discussion about charging fees for employees and/or the public. Also be aware that some air quality management districts may offer grants or incentives for EVSEs with limited public access. Check your local district for what may be available.

Policy and Procedures

As PEV’s new technology is introduced to fleets, a number of policy and procedure questions arise as soon as the first charging station is turned on. The questions range from “who can use the station and when can it be used?” to “how does this thing work?” Organizational policies will need to be developed that explain the goals of the PEV program and clearly set how the organization plans to deploy, expand and manage the program. Procedures will also need to be developed to outline to operators of vehicles and EVSEs the how’s and why’s of the new equipment they will be expected to use properly. Training on the policy and procedures should be offered (required, if possible) to all interested parties and required for operators of vehicles and equipment.

Think through potential issues and discuss your thoughts with fleet managers who have already deployed PEVs in their fleet. If you are a member of a fleet management association, contact other members to discuss their deployment issues. Use their experience to address issues before they arise in your organization.

EVSEs will add an additional load to the local electrical grid. In many cases, the capacity of the grid is adequate to handle the additional load. Adding a few Level-1 charge points will likely have little effect on the facility or the grid. In fact, adding a few Level-2 charging outlets will most likely have little impact. However, when adding many EVSEs or when installing in an older facility, the electrical capacity may reach its limit.

When selecting locations for EVSEs, you need to work with your facility manager and/or local utility company to ensure that the electrical grid at the given location can support the load from vehicle charging. If your organization has a facility manager who is responsible for maintenance, construction or building add-ons, this would be a good place to start. The facility manager should know how to evaluate the electrical load on the building and the grid to determine if the existing facility can support vehicle charging or if additional resources need to be added.

If you do not have a facility manager or professional that can help you, contact your local electrical utility to see if they can help assess your facility’s power capabilities and the electrical grid in your area. Most utilities have staff that can help with this assessment.

Signage

In March 2013, the California Department of Transportation adopted Policy Directive 13-01, which established proper signage and pavement markings of charging stations, parking lots and facilities for Electric and Zero Emission Vehicles. This signage is important for two reasons. It has standardized directional and regulatory signs which will be consistent throughout the state to help drivers know where, when, and how to charge their vehicle. Also, if you intend to manage or regulate time of charge or charging restrictions, you must use approved signage to impose any restrictions or fines.
Additional signage information is available from the California DOT here: www.dot.ca.gov/hq/traffops/policy/13-01.pdf

Other Site Considerations

Locations of charging stations can be critical to the success of any program. As discussed earlier, there are several considerations to try and reduce the cost of installing EVSEs. However, there also needs to be consideration for visibility, lighting and proximity to supported services, i.e., what is the driver doing while the vehicle is charging? If all charging is done overnight at a secured facility where there is little or no activity after normal business hours, the site plan can be less extensive as long as drivers plug in and unplug with appropriate lighting and visibility. However, if the charging stations are used around the clock by many different drivers and possibly employees or the public, the site plan needs to be much more comprehensive and include additional access and safety. This could include the need for more and better lighting, improved visibility from adjacent facilities or emergency phones located in close proximity to charging areas.

Non-Traditional EV Charging Systems

There are a number of non-traditional charging systems being developed that may be of interest where trenching and connecting to the grid are impractical. Examples include Envision EV ARC™, an off-the-grid solar powered EV charging system, and FreeWire Mobi, a robot-inspired charging system that can autonomously roam a parking lot and charge PEVs. These options may be valuable in scenarios where PEVs will be highly beneficial but infrastructure is especially expensive to deploy.

Figure 8: Typical parking sign at an EVSE equipped parking spot.

Figure 9: Examples of non-traditional charging infrastructures: Envision Solar’s EV ARC™ solar powered charging system (left), and the FreeWire MOBI™ mobile charging station using second-life automotive lithium-ion batteries (right).
In order to have a successful deployment of PEVs there are several factors to take into consideration. These include ensuring that the vehicle is matched to its use, driver training and long-term management support. It is also important for the organization to understand that procurement of PEVs may not follow the same procurement practices for conventional vehicles.

Table 6: PEVs Available in Today's Market

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Estimated Range</th>
<th>Battery Capacity</th>
<th>Estimated Charge Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current BEVs</td>
<td>65-100 miles</td>
<td>18-24 kWh</td>
<td>5 – 7 hours, Level-2</td>
</tr>
<tr>
<td>Next Generation BEV</td>
<td>200-300 miles</td>
<td>50-60 kWh</td>
<td>7-12 hours, Level-2</td>
</tr>
<tr>
<td>PHEV (including EREV)</td>
<td>10-50 miles</td>
<td>4-20 kWh</td>
<td>1.5-5 hours, Level-2</td>
</tr>
</tbody>
</table>

2. **Terrain** – Driving in hilly terrain will reduce overall EV mode range. Regenerative braking recovers some, but not all, of the energy used for hill climbing.

3. **Overloading** – carrying unnecessary equipment increases the overall vehicle weight and reduces range.

4. **Speed** – Excessive speed in highway driving will reduce EV range. Normal city or country driving at less than highway speeds has little impact on expected vehicle range.

5. **Driver behavior** – Aggressive driver behavior such as speeding, high-acceleration starts and late braking have a negative impact on range. Good rules to follow to increase EV mode range are:
   - Avoid excessive speed on highways.
   - Maintain constant speeds; use cruise control when possible.
   - Make smooth starts and stops. Heavy acceleration will use more power and short stops will not allow for maximum regeneration from the braking system.
   - Lengthen your following distance. This will give you more time and distance to accelerate without excessive load and will maximize brake regeneration.
Deploying PEVs

PEV performance as far as acceleration, handling, braking and stopping will equal, if not exceed, that of similar conventional vehicles; however, aggressive driving will reduce range in electric mode. Following the rules above will maximize EV range (and reduce accidents).

**Management Considerations**

As documented above, the challenges in deploying an alternative fuel vehicle technology can appear daunting. However, if there is support throughout the organization from management to drivers, everyone will share in the success of the program. Management needs to set reasonable goals and milestones for any program so that progress can be measured and evaluated, and changes can be made if necessary. Management consideration should include:

- **Letter of support from senior management.** This ensures that PEV adoption is supported by the organization.
- **Establishing project goals, milestones and timelines in order to measure success.**
- **Flexibility in project design.** Leave flexibility in the plan and a process to adjust goals, milestones and timelines based on unforeseen problems or issues.
- **Establish a realistic budget and project cost analysis.** Budget projections should be made through the lifecycle of the first vehicles deployed, which for some organizations could be seven or eight years. Make cost analysis part of the timeline to stay on track with projections or to help bring potential problems to light before they become critical.
- **Ensure that all aspects of a project are included.** PEV projects include charging station deployment, which in turn requires facility management and coordination with electric services.
- **Plan for possible facility upgrades.** Defining responsibility for facilities and construction management in the plan is essential to meeting project budget, goals and timelines.
- **Create program evaluation and adjustment processes.** There will be necessities along the way to make plan adjustments and changes, but without good project evaluations these opportunities will be missed, and the impact will be in lost time, efficiency or dollars.
- **If you received federal, state, regional or local grant funds for your project, there is likely a requirement for reporting progress to the grantor.** Make sure your plan identifies reporting requirements and intervals, and build those dates into the project timeline.

**Procurement**

Options for procurement of PEVs are very similar to those of a conventional vehicle. Primarily there are four options: direct purchase, purchase loan, conventional dealer or third-party lease, and full service lease. Some manufacturers and third-party leasing agencies can provide municipal lease programs to public agencies. Table 7 on the following pages provides details on each of these options, as well as the benefits and drawbacks of each.

Every agency has its own purchasing rules, regulations, and procedures. Processes range from very simple to very complex. Because of the number of vehicles purchased by most organizations, fleet managers should be well versed in their system. One of the biggest challenges with buying PEVs is the limited number of products available from a limited number of manufacturers. Even though product availability is improving all the time, most manufacturers have PEVs in limited market segments and are not providing options in other segments. Many market segments only have one or two vehicle offerings available. This can be a challenge to some organizations that demand multiple bids or want to evaluate products from multiple manufacturers. There may not be enough manufacturers in the market segment to meet the requirement for multiple vendors.

Tax credits, government rebates or reimbursements, and other incentives are often available to fleets and the public. There are provisions in these programs for non-taxed agencies to reap benefits from tax credits. Most of these programs either have projected end dates or have to be re-authorized periodically. It is difficult to keep up with these programs as they are always changing and may be different between corporate and government fleets. Vehicle dealerships may have some information about the latest incentives, but may not be knowledgeable on how to get your rebate. The Department of Energy Clean Cities Program will have information on any federal government programs. For state or regional programs, contact a local Clean Cities Coalition. A list of local coalitions can be found at [www.doe.gov](http://www.doe.gov).
### Table 7: Procurement Options for EVs

<table>
<thead>
<tr>
<th>Procurement Type</th>
<th>Description</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct Purchase</strong></td>
<td>Paying for the vehicle in one payment after acceptance of the vehicle.</td>
<td>Vehicle is paid for at time of purchase, ownership is the purchasing organization, no interest or special costs or fees. Can be the least expensive method of purchasing a vehicle. Most straightforward and lease complex method of purchasing. No restrictions on resale.</td>
<td>Initial cost of vehicle is highest because the vehicle is paid for in full up front. When buying several vehicles, the cost could be prohibitive. Technology and value risks are assumed by the purchasing organization. Requires use of capital, which may be used for other projects.</td>
</tr>
<tr>
<td><strong>Loan Financing</strong></td>
<td>Vehicle is paid for over a pre-negotiated time with interest charges applying to the balance of the financed amount. Vehicle title is transferred at the completion of payment.</td>
<td>Spreads the capital cost over months or years so up-front cost is reduced, a large down payment will reduce the monthly payment.</td>
<td>Loan interest and processing fees can add significant additional overall cost to the purchase. Technology and value risks are assumed by the purchasing organization.</td>
</tr>
<tr>
<td><strong>Vehicle Lease</strong></td>
<td>Vehicle is paid for through monthly lease payments for a pre-negotiated lease term. Lease payments are based on initial vehicle price minus predicted residual value. Leasing company retains title to the vehicle after the lease period. Agency can purchase, re-lease, or cede vehicle at the end of the lease period.</td>
<td>Can capture tax credits, lowering vehicle costs. Spreads the capital cost over months or years so up-front cost is reduced, usually has lower monthly payment because leases have the large balance at the end of the lease term. Provides the opportunity to evaluate the vehicle in the fleet for several months or years without taking ownership. Technology and value risks are assumed by the leasing company.</td>
<td>Ownership remains with the lien holder until final payment is made, loan interest and processing fees can add significant additional cost to the purchase. Early termination can be difficult. Some government agencies have no-lease policies.</td>
</tr>
<tr>
<td><strong>Service Lease</strong></td>
<td>Vehicles and all vehicle services are leased on an agreed to “per vehicle mile traveled” basis. Services may include vehicle, infrastructure, fuel, maintenance, and monitoring.</td>
<td>Vehicles are leased on a “per VMT” basis and include vehicle, infrastructure, fuel, maintenance and monitoring. Often has terms that include guaranteed cost reduction and fleet right-sizing as well as pre-assessment of the fleet to ensure success.</td>
<td>Requires a major long-term commitment from municipality. May be viable only with larger fleets. Fewer vendors are offering this type of service.</td>
</tr>
</tbody>
</table>
8. Driving and Maintaining PEVs

Once a fleet manager has made the decision to incorporate PEVs into the fleet it is imperative that programs be put into place to prepare and train drivers and maintenance technicians.

Driving a PEV

As discussed in section 7, the driving experience is much the same as that of a conventional vehicle. The vehicles are responsive to the driver’s actions, are very quiet, and feel firm on the road. However, the success of a PEV program rests on the ability of the driver to use the vehicle properly.

Employee Readiness

A move to PEVs in the fleet requires a change in human behavior and can be one of the greatest challenges to fleet managers. Even more progressive minded drivers may feel challenged and confused about driving PEVs and may be reluctant to be the first to try them. Drivers often voice concerns over:

- Range Anxiety – getting stuck somewhere
- Plugging and unplugging – safety, usage
- New driving techniques – maximizing range through moderate driving and route selection
- Use of accessories – maximizing range by minimizing electrical usage in the vehicle

Identify some enthusiastic drivers in the fleet to be early adopters for PEVs. Word will get around about how fun, safe and dependable these new vehicles are. When you relieve drivers’ insecurities about driving a PEV, they will be your best promoters of the technology. Some early success with a few early adopters will improve the driver’s perception of the vehicle and help your whole program succeed.

Driver Perception

It has been several years since the Nissan Leaf first appeared on the roads and highways of California. Many drivers have been watching and listening about new PEVs since those early days. The vehicles are out there in larger quantities, and drivers want to try them. However, there are still many drivers whose perception of driving a PEV is based on a comment or complaint about first generation PEVs or from what they heard or remember about the vehicles that were available in the mid-1990s. Most of the 1990s vehicles performed poorly. Even drivers that never drove old PEVs have a poor perception of what modern PEVs can do. Many also have an unrealistic perception of what capability they need in their daily fleet vehicle. Many think they must be able to drive over 100 miles on a charge and still have extra range available in case they need to make an unexpected change in their work on a given day.

Fleet managers need to be aware of these perceptions and address them with a sensible plan where the driver does not feel forced to do something they do not want or feel that they will be stranded. Training in a classroom environment will help to open drivers’ minds to PEVs, but they will not be convinced that a PEV will work for them until they use it in their daily assignments and discover for themselves that the vehicle performs well, is comfortable, easy and fun to drive, and rewards them for good driving habits with extended range. Find ways to get drivers in the seats of the vehicles and let them drive them. Have someone available to help plug and unplug them and be able to answer their questions in simple language or actions. This is not the time to be technical.

Training the Driver

This section is not called driver training because your driver already knows how to drive. Although the experiences on
accelerating, braking, steering and maneuvering are nearly the same as a conventional vehicle, the driver will notice differences that need to be explained before they are turned loose with the car. A short training session for potential drivers and a handout with FAQs will significantly reduce phone calls, questions and driver issues later. Also, consider providing a one-page explanation of how the vehicle works with some statistics about how PEVs will save money over time, reduce emissions and help the organization meet its environmental goals. Make these handouts simple to understand; avoid technical or industry terminology. Call an EVSE a “charger,” relate the cord to a gas hose explaining that this is just a new kind of fueling station and that here they do not have to hold the nozzle. Make the training understandable, open, helpful, and most importantly: required.

The most significant change for the driver will be how the vehicle is fueled, that the vehicle is very quiet and the noises it makes are different than what they are used to and that their gauges and instruments will tell them in miles how much further they can go on the current battery charge. Every manufacturer is a little different, so the training for each vehicle should be based on the vehicle being driven. Attached is a sample “PEV Driver Orientation Checklist” (Appendix C). The checklist or one developed specifically for your organization will be helpful in providing drivers with the information about how the vehicle works and how to get the most out of the vehicle. Make sure you write down questions asked and answers given during your training and orientation. This is a great way to develop FAQs for your organization. There is a good list of FAQs on the Plug-in America website (www.pluginamerica.org). Use some of these to start a list and add questions and answers as you get them from your customers. A short FAQ starter list is attached (Appendix D).

Charging a PEV

For most drivers, charging PEVs is a simple and normally pretty low-stress experience. But the industry is still in its infancy, and many customers do not understand some of the requirements to keep the vehicle charged and equipment working properly. Managing cords, using card readers, following the instructions on the LED readout on the EVSE are challenges for many drivers. Even though drivers have been using similar technologies and interfaces at gas stations and fleet fueling facilities for years, there seems to be a major disconnect between actions they have done for years and how to plug in a PEV.

Procedures

Clear, well-written and well-communicated procedures will help make your EVSEs more accessible, and help ensure a higher availability rate. The two most difficult things about charging PEVs seem to be: what to do with the cord and use of a card reader or activation device to start and stop charging. For some reason, customers seem to be confused about these two issues and often leave cords lying on the ground or do not start or stop charging properly; often leaving the EVSE unusable until it can be reset either by completing a transaction or by calling the EVSE company to have them reset the machine remotely. Customer training and well-written procedures will help alleviate these problems, but be prepared to address them again and again as new drivers use these vehicles.

Although some EVSE manufacturers have installed retractable cord mechanisms on the units, which have helped keep cords off the pavement, there are still many units in the field with manual wrap around cord storage hooks or mounts. Some people struggle to wrap the cords around the mounts or hooks, especially in cold weather, so they often will leave them on the pavement where they can become damaged or be a tripping hazard. We therefore highly recommend systems that have cord management and/or retraction mechanisms. This also helps reduce the likelihood of injury from tripping over a cord.

For EVSEs that have card readers or other devices to authorize access to charging, customers seem to forget the process and sequences required to activate and de-activate the charger. Many times the sequence requires the card to be scanned before the connector is removed from the storage point and scanned again to end the charging cycle before removing the connector from the vehicle. Failure to follow the sequence will disable the EVSE until it can be cleared either by self-clearing, repeating the sequence properly or having it reset remotely by the EVSE service provider. Making this issue more of a problem, often the EVSE does not provide a warning signal to the customer to let them know they did something wrong, so the failure goes unreported until the next customer tries to use the EVSE.
Finally, EVSEs are different in design and card reader sequence, so if you have different manufacturers’ units supporting your fleet, each one may be a little different in how they are activated or how the cord is stored. Simple but clear procedures will need to be written for each different EVSE you use. The procedures should be “step by step” for each unit starting with how to tell which unit is being used. Time spent writing and training on well-written procedures will save time and phone calls from customers later.

**Dead Battery Considerations**

There will come a time when a driver of a BEV will run out of battery power. This is similar to running out of gasoline in a conventional vehicle, but can be more difficult to manage since the vehicle is disabled and it is not possible to easily refuel it. There are several considerations for fleet managers.

First of all, virtually all BEVs give the driver a substantial amount of warning before the car becomes completely disabled. Drivers and fleet managers should be aware of the process of finding a near-by charging facility. Smart phone and computer applications such as those available from PlugShare (plugshare.com), ChargePoint (chargepoint.com), and Alternate Fuels Data Center (afdc.energy.gov) provide location maps that will show the nearest charging station location.

If and when the vehicle is no longer drivable (special note: all PEVs protect their battery systems by disabling the drive system before the battery is completely dead) there are two approaches. The first approach is to tow or flatbed the vehicle to a charging station or back to its home location. The second approach is to have a roadside assistance service such as the Automobile Association of America send a portable EV charger equipped truck to the disabled vehicle.

**PEV Maintenance**

With the exception of the drive system, the other parts of the PEV functions are the same or similar to vehicles that fleets have maintained all along. Vehicles still will need periodic inspections to ensure that brakes, tires, suspension, and overall safety of the vehicle meet the organization’s standards. The primary difference will be for fluid replacements and drive train warranties.

**Fluid replacements** (engine oil changes): For BEVs, there is no need for engine oil changes because there is no engine. Underhood and drive train inspections should be done based on manufacturer’s recommendations and any problems should be reported to the manufacturer’s dealership for maintenance or repair. At this time OEMs (Original Equipment Manufacturers) are not training fleet staff to diagnose or repair electric drive systems. If this changes in the future, fleets will need to make the decision to train employees in these technologies or continue to send vehicles to the dealer.

**Drive train warranties**: PHEVs are different in that these vehicles have both an electric drive system and a gasoline engine that power the vehicle. The maintenance requirements of the electric drive system are similar to BEVs (above). The maintenance program for the gasoline engine should follow OEM requirements. Since all PHEVs shut the engine off and/or switch back and forth between gas and electric drive, using vehicle miles traveled to establish oil change intervals will likely mean that oil will be changed more often than necessary. Alternatives to setting oil change intervals would be to change oil based on engine miles or hours or to do oil testing and only change oil when the test indicates the oil needs to be changed.
9. Safety Considerations for PEVs

PEVs are as safe as or even safer than conventional vehicles. They carry no flammable liquids for fuel that can cause fires and environmental issues when spilled. However, it is important for all who are involved with PEVs to understand that the battery system of a PEV stores a substantial amount of electrical energy and must be treated with respect.

Vehicle Safety

Plug-in electric vehicles are as safe as conventional vehicles. The vehicles themselves are held to the same safety requirements set by the National Highway Traffic and Safety Administration. PEVs also meet electrical and safety standards set by the Society of Automotive Engineers, the National Electric Vehicle Infrastructure Working Council, and others.

Charging Safety

Charging of PEVs is completely safe and easy. The charging cable, connector, vehicle inlet and charger itself all have built-in safety protections that are tested and certified to national codes and standards, as well as automotive standards for PEV charging. Energizing of the cable and connector does not begin until a proper inlet and safety ground connection are verified between the vehicle and EVSE. In addition, the charger has an auto disconnect or de-energizing feature to prevent any hazard if for any reason the connector is inadvertently disconnected from the vehicle inlet. The connector, cable and vehicle inlet are operable in all weather conditions. The vehicle itself has built-in sensors and surge protection capabilities as well to protect the vehicle electronics from any damage due to changes in voltage or current from the electric grid.

Battery Safety

The batteries used in PEVs also pose no additional risks over a conventional vehicle. PEV batteries are sealed and all high-voltage circuits are protected from accidental contact. High-voltage circuits are also color-coded orange and posted with warnings to advise of their presence. First responders have access to training so they are prepared to deal with potential emergency situations involving electric vehicles.

First Responder PEV Knowledge

Training for firefighters, emergency medical personnel and law enforcement regarding advanced technologies such as PEVs has been underway at the federal, state and local levels, as well as by auto manufacturers. The National Fire Protection Association’s (NFPA) Electric Vehicle Safety Training Project helps firefighters and other first responders prepare for the growing number of electric vehicles on the roads. In addition, NFPA collects safety information from hybrid and electric vehicle manufacturers specific to their own vehicles. In California, the Office of the State Fire Marshal has developed training manuals for each of the alternative fuel technologies so that first responders can make informed decisions at the scene of a vehicle emergency.
10. Utility Considerations

It is important to know the electricity rates where your PEV fleet vehicles will be charged. Commercial electricity rate schedules vary from utility to utility, as well as from customer to customer. To minimize the impact on the electrical bill that an organization will be paying, the fleet manager and the facilities manager need to work together to devise a plan for charging the PEVs at the right time of day and avoiding peak energy use periods.

Utility Rates and Utility Demand Charges

Rates and demand charges from utilities will vary between providers, so the local utility should be engaged to discuss the best way to optimize charging windows at the lowest cost. Large organizations often have special or industrial electric rates already. Some analysis is required to determine which program would be best for your organization. A program that provides special rates for charging stations may require additional meters, or other hardware to track electricity use for vehicles. The cost to install these systems may be passed on to you as the customer. These costs need to be balanced with the savings you might get from lower, off-peak rates for vehicle charging. If all your vehicles are charged at night during off-peak rates, the savings could be substantial. However, if your charging cycles are throughout the day and night, the savings may not be enough to offset the cost to install additional meters. Policies, procedures, and possibly automated control mechanisms should be put in place to minimize charging during peak load periods. The cost of electricity during peak periods can be four or five times more than some of the special off-peak rates that may be available from your utility. You never want to deny someone a charge if they really need it. However, you want to avoid charging during a peak load period if possible. Most utilities will have a section or key staff that works with customers to determine how to best provide and manage power to support the addition of EVSEs into the existing grid network.

Alternatives to Grid Power

If your organization uses or plans to use alternative energy sources such as solar, wind or internal power plants such as fuel cells or geothermal power, these alternatives need to be considered when planning your network of charging stations. You also need to look toward the future as battery back-up systems that would make solar and wind generation more dependable may only be a few years away from becoming a viable alternative to drawing power directly from the power grid. Finally, vehicle to grid (V2G) systems in which the battery on the vehicles is used as a backup to support the power grid during peak load demands may be available in a few years.

These technologies are all being explored and researched by many companies around the world. As these systems become available they could provide even lower cost power to your PEVs. Staying current with emerging technologies should be part of any long-term PEV program.

Utility Costs Will Rise

The increase in cost of electricity for one or two PEVs will barely be noticeable. However, if you add several PEVs at a location, the increase in cost may be a shock to whoever is receiving and paying the bill. Make sure you remind them that although they are paying more for electricity, their gasoline bill has been significantly reduced. Ideally, you should try to have the electric bill sent to the fleet operation so that the cost can be measured and allocated to the appropriate vehicle. When you can do this, the customer agency will only see that fuel cost is lower not that electricity cost is higher. Also, if you can allocate electric cost to the vehicle, you will be able to do cost comparisons between types of vehicles and better be able to show success for the program. Furthermore, carefully managing charging behavior to mitigate demand charges can help keep cost increases in check.
PEVs are in their infancy. There will be many innovations in technology as well as cost reductions over the next several years. Fleet managers are advised to stay current with developments in this fast growing automotive segment.

PEV Technology Evolution

PEVs are becoming less expensive as battery systems continue to evolve. Battery systems will offer larger capacity at less cost and take up less space in the vehicle, while also weighing less. This translates to larger range vehicles for less expense. We can also expect that there will be a larger selection of vehicle classes in the near future such as SUVs, larger sedans and pickup trucks. Even medium and heavy duty trucks are expected to offer electrification within the next few years. Specifically, several manufacturers including GM, Ford, Tesla, BMW, VW and others are already pre-announcing BEVs with 200+ mile range at a $30,000 price point.

Energy Management

Vehicle charging station technologies are also developing rapidly. As use cases develop, we expect to see charging systems that are tied to building management systems to intelligently use energy to minimize demand charges, and optimize time-of-use rate systems. We can also expect to see vehicle charging combined with energy storage and renewable energy in many different ways. In fleet charging, we can expect to see systems that automatically determine the correct time and amount of charge for each vehicle based on its state of charge and expected next use.

Energy Storage

One of the most exciting developments in PEVs has to do with energy storage. There are several aspects of energy storage to discuss and we can touch only briefly on each. Firstly, stationary battery systems will soon become available that help manage demand charges in locations where there are many charging stations. Some of these stationary battery systems will use “second-life” vehicle battery cells. Secondly, vehicles themselves can be considered energy storage systems since they have large (and getting larger) battery systems. Technology is being developed to make PEVs, and especially fleet PEVs part of the electric grid by making the charging of PEVs controllable by the grid operator and/or utility. As an extension to this concept, it is also possible for PEVs to be considered a source of emergency electrical power for grid emergencies and technologies are being developed that would provide this ability.

Renewable Energy

PEVs and renewable energy go hand-in-hand. As the generation sources of electricity becomes more renewable, the fuel that powers PEVs also becomes cleaner. PEV charging stations that are linked to renewable power sources such as wind and solar power offer the ability for vehicles to become net zero energy systems. Off-the-grid solar charging stations that incorporate energy storage are already in trial use and are expected to become more widespread over time.
“County of Sonoma, Electric Vehicle Charging Station Program and Installation Guidelines” County of Sonoma, CA, July 2011.

“Ready, Set, Charge California” Bay Area Climate Collaborative, November 2011.


“PEV Resource Center” www.driveclean.ca.gov


California PEV Collaborative: www.evcollaborative.org

Plug-in America: www.pluginamerica.org

ChargePoint: www.chargepoint.com

Schneider Electric: www.schneider-electric.com

PlugShare: www.plugshare.com

Alternative Fuels Data Center: www.afdc.energy.gov
13. Appendix A - Example EVSE Installation Planning Outline

<table>
<thead>
<tr>
<th>Item</th>
<th>Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Property Ownership</td>
<td>Owned? Leased?</td>
</tr>
<tr>
<td>2 Long-term Plans for Property Use</td>
<td>Planned occupancy period? Planned expansion or consolidation?</td>
</tr>
<tr>
<td>3 Vehicles</td>
<td>Total number of PEVs? Types of PEVs? Charging duty cycles? Daily range requirements?</td>
</tr>
<tr>
<td>4 EVSE Users</td>
<td>Fleet only? Employee use? Public use?</td>
</tr>
<tr>
<td>5 Time of Charging</td>
<td>At night only? Daytime charging? Will vehicles be moved after charge is complete?</td>
</tr>
<tr>
<td>6 Source and Availability of Electrical Power</td>
<td>What are the sources of power? Is there enough power at this location for the number of vehicles planned? Will a service upgrade be required? Can this location be supported by a renewable power source?</td>
</tr>
<tr>
<td>7 Construction Issues</td>
<td>Permitting requirements? Budget? Environmental requirements? Accessibility requirements? Distance to power panel? Will trenching, landscape removal/replacement, re-paving be required? Requirements for signage, painting, lighting, bollards, ramps, walkways, etc.?</td>
</tr>
<tr>
<td>8 Automated Charging</td>
<td>What is the strategy for automated charge timing? Possibility for hands-free charging?</td>
</tr>
<tr>
<td>9 Public/Employee Access</td>
<td>Differentiated fees for fleet/employee/public use.</td>
</tr>
<tr>
<td>10 ADA Accessibility</td>
<td>Determine ADA requirements based on current state and local ordinances.</td>
</tr>
<tr>
<td>11 Tracking Software – Data Collection</td>
<td>Ensuring systems are planned or in place to track use, maintenance, VMT by type of fuel, electricity usage, etc. Consider acquiring software to help ensure that your vehicles are fully charged when you need them.</td>
</tr>
<tr>
<td>12 Policy and Procedures</td>
<td>Are any organization’s policies needed to help manage the use of charging stations to optimize their use and availability?</td>
</tr>
<tr>
<td>13 Other Site Considerations</td>
<td>Visibility, lighting, emergency contact and other considerations when selecting a site for EVSEs.</td>
</tr>
</tbody>
</table>
Listed below is a recommended sequential set of steps to be followed when installing PEV charging equipment.

1. Determine number and type of EVSEs required.
2. Decide which parking lots and/or structures to locate EVSEs.
3. Within each parking site, determine the candidate locations for installation.
4. Engage facilities engineering and/or contract engineering firm to finalize site and location based on panel locations, electrical service, and installation requirements. Engineering drawings should be created at this step to be used in the permit request process. This step may be iterative with previous steps.
5. Check local regulations to determine what permits are required including environmental review, building, safety, electrical, etc. Again, this may become iterative as part of the final location determination.
6. Get competitive bids on EVSE acquisition and installation. These can be done separately or as a package. EVSE manufacturers can supply recommended installers.
7. Award contracts. Recommend using EVSE experienced installers.
8. Installer should be responsible for obtaining all permits.
9. Install charging stations.
10. Install any required or desired signage, bollards, and parking lot striping.
11. Commission and activate EVSEs. Test to ensure that everything is working properly.
12. Receive approval, sign-off on all permits.
Plug-In Electric Vehicle (PEV) Orientation Checklist

This is a sample of a Driver Orientation checklist to assist in showing drivers the difference between a PEV and conventional vehicle. It’s best used in conjunction with the vehicle owner’s manual so that drivers can look up the reference and system information while doing the orientation.

**Walk Around Pre-Inspection**

- Find charging connector port.
- Look for damage connector port, charger or cord
- Show how to connect and disconnect cord

**Safety Information**

- The Vehicle Owner’s Manual is in the glove box. Please review as part of Orientation.
- If the charge port or plug connector appears to be damaged in any way, do not plug in the vehicle. Contact Fleet Services immediately.
- Only use the electrical cord supplied with the vehicle or connector from a Level 2 charger to recharge the battery pack.

**Operation of PEV System**

- Some PHEV vehicles have on/off switch for EV system. Make sure the switch is in the proper position for the type of driving being done on this trip. Refer to the owner’s manual for location and operation of the switch.
- From the driver’s seat and using the Owner’s manual, find the cages and screens that will provide you with information about the PEV drive system.
- Become familiar with how the gages and screens provide information and how it will help maximize vehicle range.

**Charging**

- Only use the supplied cord or appropriate connector at a Level 2 charging Station.
- Watch for the tail lights to flash or illuminate to verify a proper connection for charging. Check Owner’s Manual.
- Be aware of the time required to fully charge the vehicle battery. Check Owner’s Manual.
- Do not use any cord that shows any evidence of damage.
- How to use the Charging Stations Access Cards.

Questions? Contact Fleet Services at XXX-XXXX
16. Appendix D – Sample PEV FAQ

FREQUENTLY ASKED QUESTIONS – Use this to start your own FAQ list.

Are electric cars efficient?
EVs are the most efficient cars on the road. See the federal government’s report on energy use:
http://fueleconomy.gov/feg/byfuel/byfueltypeNF.shtml

How long does it take to charge a plug-in car?
That depends on the amperage of the charging system and the size of the battery. Keep in mind that most of the time, the battery will not be empty when you plug in, thus reducing charging time. To recharge a completely empty car battery from an ordinary 120-volt socket, the Chevy Volt plug-in hybrid would need 10 hours and the Nissan Leaf EV would need 20 hours. Using a faster 240-volt outlet and a charging station, the Volt recharges in about 4 hours and the Leaf in 8 hours. PHEVs have smaller batteries and take less time to recharge.

What happens when the batteries run out of power?
You charge them back up. When electric vehicles (EVs) and plug-in hybrids (PHEVs) are commonplace, charging stations will be everywhere, and thousands of them are being installed in the coming year thanks for government stimulus funds. Restaurants, grocery stores and other retail establishments will offer free or low-cost charging as enticements to get customers. Of course, anyone with access to a plug at home will set the car’s timer to charge late at night, when cheap surplus power is readily available. Studies indicate that 80% of Americans have ready access to plugs where they park at night. PHEVs will not need to be charged since their internal combustion engine allows the same range as gasoline cars for long trips. However, to minimize pollution, cost, and the other ills associated with the use of oil, PHEV drivers would do well to plug in whenever possible to maximize the use of the electric grid.

Are plug-in vehicles dependable?
Battery electric vehicles are the most dependable vehicles. Well-made production EVs have the potential to last as long or longer than gasoline automobiles, with less regular maintenance. There are many fewer moving parts in an EV, and therefore less ongoing preventative maintenance. Brake life is significantly extended since the motor is used to slow the car, recapturing the kinetic energy and storing it back in the battery. Electric motors will outlast the body of the vehicle. Major automakers are offering warranties on the batteries of 8 years or 100,000 miles of driving.

Is plugging in a hassle?
Not at all. Plugging in literally takes less than 5 seconds of your time. There is no going out of your way to a gas station and jockeying for a pump. You can charge anywhere there is an electric outlet. Most EV drivers plug in when they get home and forget about the car until the next morning, when the fully charged car is waiting for them. The car’s timer allows the car to recharge the battery overnight while the driver sleeps, at times of low electricity rates. Plus, thousands of public charging stations will be installed over the next few years to make it easy to add charge on trips away from home, too.