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FOR FLEET MANAGERS

Different fleets have different compositions and needs. While there is no ‘one size fits all’ model for deploying electric vehicles (EVs), there are certain considerations to take into account. This guide identifies a number of recommendations and practical tools that fleet decision makers can use to assess the benefits of EVs including:

» EV considerations for Sonoma County fleets
» Fleet manager experience
» Background of EVs in Sonoma County
» Incentives for purchasing or leasing an EV
» Lifecycle cost of EVs compared to gasoline vehicles

This guide is part of the Shift Sonoma County Low Carbon Transportation Action Plan¹, which evaluates strategies to support and accelerate the transition to EVs in order to reduce greenhouse gas (GHG) emissions from transportation while making our air cleaner and keeping money in the local economy.

Shift Sonoma County is a collaboration between the ten local jurisdictions within Sonoma County, two regional agencies tasked with planning for transportation solutions – the Sonoma County Transportation Authority (SCTA) and the Regional Climate Protection Authority (RCPA) – and other local and regional partners.

History of EVs in Sonoma County

Plug-in electric vehicles are not new to fleets in Sonoma County. In 2002, the first hybrid vehicle was added to the County of Sonoma’s fleet where a positive return on investment was seen. Over the next few years, the County fleet would continue to add more and more hybrids, making the decision that all vehicles in the fleet that could be supported by an electric-type drive vehicle would be replaced with one.

In 2008, Nissan North America partnered with the County of Sonoma and the Sonoma County Water Agency to facilitate the deployment of battery electric vehicles (EVs) in Sonoma County. Nissan saw public fleets as a well-suited product release partner for the LEAF model, while the local governments recognized an opportunity to reduce the carbon footprint of their fleet operations.

To maximize the benefits of the initiative and better coordinate the effort, the County and Water Agency engaged all of the local governments, along with the Northern Sonoma County Air Pollution Control District created the Sonoma County Local Government Electric Vehicle Partnership. The primary mission of the group is to collaborate with all local government agencies in Sonoma County toward the adoption of EVs for public fleets and to coordinate and collaborate in the development of the public-access charging network required throughout the county. The Local Government EV Partnership met on an as-needed basis over the years to discuss barriers and grant opportunities, and can continue to serve as the working group for local government collaborative EV policy and program efforts. Sonoma County local governments should consider designating a jurisdictional representative to participate in the Local Government EV Partnership.

Active local government fleet participation in regional grant programs have funded both EVs and EV charging stations in Sonoma County. For example, through the EV Fleet National Demonstration, a grant project in conjunction with 10 Bay Area public agencies, the County of Sonoma, Sonoma County Water Agency, and City of Santa Rosa fleets received funding to supplement the purchase of 22 EVs, 5 EVs, and 5 EVs respectfully. Additionally, 31 charging stations were installed between the three agencies to support these fleet vehicles.

Building on a successful past, Sonoma County local governments can continue to lead by example, incorporating EVs and plug-in hybrid electric vehicles into their public fleets. There is still a great opportunity within the county to increase the deployment of EVs within municipal fleets and reduce greenhouse gas (GHG) emissions and particle emissions, improving local air quality.

The County of Sonoma operates one of the largest hybrid electric and plug-in hybrid electric government fleets in the United States. The County has earned 26 awards as a leading fleet in the industry and for championing clean air for all residents of Sonoma County.
The use of EVs have not been limited to fleet operations. There are now many makes and models of EVs on the market, and many drivers in Sonoma County have embraced them. The number of EVs in Sonoma County have grown steadily since the first mass market EVs were sold in 2011. Sales of EVs have accounted for roughly 4% of new car sales in Sonoma County since 2014 (higher than the national average of 1%), with over 4,000 electric vehicles bought or leased in the county through 2017.1

### Vehicle Technology and Options2

The diversity of vehicle offerings available today reflects the automotive industry’s response to the broad range of consumer interests. It is important to note, however, that electric vehicle models are still limited. For instance, electric vehicles most commonly fall into two configurations: five-passenger sedans or hatchback vehicles. Electric vehicles are typically characterized as battery electric vehicles also known as BEVs (all electric, no gasoline engine) or plug-In hybrid electric vehicles also known as PHEVs (an electric vehicle with a gasoline engine backup).

**Plug-in hybrid electric vehicles** have both a high-capacity battery that powers an electric motor and an internal combustion engine fueled by gasoline. The vehicle is different from hybrids that consumers are used to: it can plug in to an external source of power (e.g., an outlet). Plug-in hybrids typically have a driving range that is comparable to a conventional vehicle (in the hundreds of miles). That range is a combination of miles traveled using electricity and miles traveled using gasoline. The range of miles traveled using electricity in plug-in hybrids ranges from 10 miles to 72 miles. When the battery pack is fully discharged, the gasoline engine powers the wheels.

**Battery electric vehicles** run solely on electricity; the high-capacity rechargeable battery packs propel the wheels using one or more electric motors. The vehicles are sometimes referred to as pure EVs or all electric vehicles. Regardless of the naming convention, these vehicles only use a larger battery that require longer charging times. The vehicles typically have a driving range of 60–100 miles, with some models offering a range as high as 240 miles.

> “My opinion is that the switch to EVs and plug-in type vehicles is probably the most significant thing that has happen to the industry since, maybe, the automatic transmission. Certainly electric is another one of those major game changers.”
> - Dave Head, Former Fleet Manager, County of Sonoma1

1. Department of Motor Vehicles, Registered Vehicles, 2017

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1. Department of Motor Vehicles, Registered Vehicles, 2017
Why should your organization add EVs to the fleet?

Cost savings

Electric vehicles (EVs) can provide financial benefits and save money. Adding EVs to fleets can reduce operating expenses with lower fuel costs and maintenance costs. EVs have fewer moving parts, meaning less items to be replaced. Plus, organizations may qualify to save on EV purchases, leases or EV charging station installations through federal and state incentives and regional grant programs.

Reduction in air pollution and carbon emissions

EVs have no tailpipe emissions, and can help organizations meet their climate action goals. California has ambitious statewide greenhouse gas (GHG) emissions reduction targets and the transportation sector is a large contributor to air pollutants. Switching fuel to electricity, especially electricity with high renewable energy content, will significantly reduce fleet associated emissions.

Smother, quieter and more pleasant driving experience

Consumers generally have positive reports regarding EV handling and acceleration. EVs offer instant torque, responding to the driver's foot and delivering power immediately to the wheels for quick acceleration. Without the bulky internal combustion engine, riding in an EV is quiet and smooth sailing.
Recommendations for Sonoma County

Fleets in Sonoma County have demonstrated interest in adopting plug-in electric vehicles (EVs), which enhances the sustainability of fleet operations and enable financial efficiencies. However, fleet interviews and data reveal that EVs currently in Sonoma County’s fleets are used significantly less than comparable gasoline vehicles.

Key obstacles in using EVs include:
- trip distances in excess of the range of battery electric vehicles,
- unavailability of charging infrastructure at the destination, and
- staff unfamiliar with EVs and anxious with the perception of range.

To overcome these obstacles, fleets should consider implementing the following recommendations.

1. Create an Integrated Fleet Strategy
2. Expand fleet electrification
3. Maintain consistent fleet databases
4. Use robust metrics
5. Establish a staff education program
Create an Integrated Fleet Strategy

An integrated fleet strategy is an important way to define the organization’s approach to fleet management. The creation of a fleet strategy should start with vision, priorities and clear delineation of objectives. While fleet objectives can be defined along several variables, typically fleet EV programs are defined around greenhouse gas (GHG) mitigation objectives.

The Green Fleet Action Plan of the City of Seattle has a clear objective: the reduction of greenhouse gas emissions by 42 percent by the year 2020, relative to 2013.¹

¹ https://www.seattle.gov/fleet-management/green-fleet

Once fleet objectives and timelines are agreed upon, the plan or strategy should include the following elements:

» Guidance for the procurement of EV models that meet the duty cycles of segments of the fleet
» Planning of trips to make use of existing direct current (DC) fast charge infrastructure on route to more distant destinations
» Optimized planning of vehicle assignments that matches vehicle with distances and typical driving cycles

Linking the fleet strategy to other strategic organization priorities can strengthen the effectiveness of implementation. By creating an integrated fleet strategy, Sonoma County’s fleets can more successfully incorporate EVs and greatly expand the displacement of fossil fuel miles with electric miles.
Expand fleet electrification (Maximize EV Use)

In order to cost effectively incorporate EVs into fleet operations, EVs should be brought to the front and made the default alternative, so that electric miles, petroleum displacement, savings on operations, and emissions reductions are maximized.

Fleet managers should begin to identify the segments of their operations that can be adequately served with available EV models, and incorporate this information into their procurement process. To identify such segments, fleet managers can consider several variables, including trips served, the charging infrastructure strategy, education of drivers, and others.

Ready, Set, Charge, Fleets! EV Fleet Deployment Strategies provides details on EV basics, fleet challenges, and many different consideration in deploying EVs. The Guidebook can be downloaded at http://prospectsv.org/guidebooks/.

Many fleets are composed of medium-duty and heavy-duty vehicles, and currently there are not many plug-in models available in these categories that are competitive on a price basis. Medium- and heavy-duty vehicles are the main source of fuel consumption and emissions per mile. Fleets should explore hybrid vehicle models, which may be considered as a transition step toward plug-in models.

To identify the operations that can be suitable for EVs, fleet managers should also be intimately familiar with these vehicles. EVs represent in many ways a new paradigm, there is a learning process associated with their adoption. Since plug-in models ought to be the fleet’s default choice, fleet managers and fleet staff should spend sufficient time driving these vehicles. This way they will develop a first-hand understanding of their real-world capabilities, which will inform plug-in vehicle procurement opportunities.

A strategy to expand fleet electrification must include a plan to maximize EV use in suitable operations (where utilization refers to the displacement of fossil fuel miles, not to the addition of new miles). A strategy must also include the development of materials that present evidence-based information on the cost and emissions savings that can be achieved through the replacement of conventional vehicles with plug-in vehicles. Fleet managers need such materials to inform procurement decision making, from city councils to city management.

Higher utilization of EVs means a better return on asset investment and deeper reductions of GHG emissions for the fleet.
Maintain consistent fleet databases

Collecting more data, especially data that is consistent and granular, will help Sonoma County fleets identify opportunities for increasing efficiencies, reducing vehicle operation expenses and improving the sustainability of fleet operations. The collection and analysis of data are increasingly important to remain competitive and improve operations.

There are significant opportunities for fleets in Sonoma County to coordinate and identify synergies that can bolster the adoption of plug-in vehicles. For examples, fleets can collaboratively deploy and utilize charging infrastructure, and participate in car sharing. These opportunities that can be supported by the collection, pooling, and analysis of data. The first and essential step is to collect data of sufficient quality, consistently across fleets, that can be made readily available for analysis to help fleets identify areas for collaboration.

Determining what data should be collected depends on the goals set for fleets as well as the methods that would be used for analytics.

**Data to be collected for each trip (at a minimum):**

- Vehicle ID
- Date and time of vehicle checkout and vehicle return
- Name of driver (should have an existing database with driver information and history of EV training and vehicle checkouts)
- Route definition: Stop locations and durations (time start and time end)
- Trip conditions: Average speed (more granular data recommended), average acceleration, number of passengers per segment
- For plug-in vehicles: battery state of charge at checkout and return, charging events (time, location, maximum power)
- For vehicles with combustion engines: fuel at checkout and return, refueling events (time, location, and gallons or cubic feet for gaseous fuels)

These data should be complemented with data collected in non-operation mode. These include data on charging/fueling events at the vehicle base as well as maintenance and repairs events.

Data collection can be time consuming and expensive. It is not recommend that data collection falls upon the fleet manager or her/his staff—this is generally inefficient and tedious. Fleets can work with companies that specialize in helping with the collection, organization, and reporting of data (generally, these services entail the tracking of the vehicles during operations). Important to note, fuel consumption, GHG emissions, vehicle degradation, and vehicle damage depend not only on trip distances (as typically reported) but also on driving performance.
Use of robust metrics

No matter how granular, robust and consistent data may be, data is not worth much if not used in conjunction with a strong analytical framework that can draw key insights. High level metrics typical for public fleets include measurements of carbon emissions and fuel expenditures. Granular data opens opportunities to develop more specific metrics to identify areas for intervention. For instance, specific routes could be matched to the vehicles that would maximize sustainability goals and minimize financial burden on the particular route.

The adoption of strong metrics and the use of suitable data analysis will help identify gaps and opportunities for the integration of EVs in local jurisdiction fleets. The determination of strong metrics should result from a collaborative process that takes into account objectives and strategy, and as such it is beyond the scope of this report. In fact, metrics are typically defined first, and the metric will help determine the type of data that needs to be collected.

Sonoma County local governments should consider including the follow metrics:

» Prioritize EV models to replace retiring vehicles, whenever possible;
» Continuously increase the type of trips that are considered EV-suitable (for example through strategic planning of investments on and partnerships around charging infrastructure that enable battery electric vehicles to charge before returning to base);
» Continuously increase the electric miles share of the total miles driven in a month.
Establish staff education program

There are many opportunities to increase the utilization of EVs in the fleet by educating users on the technical/operational, economic, and societal aspects of these technologies. Based on conversations with fleet managers and the examination of data for Sonoma County, it appears that users are generally not yet comfortable using plug-in vehicles, and they tend to default to internal combustion vehicles that are more familiar to them. To encourage drivers to opt for electric fleet vehicles, municipal fleets with bold electrification goals have improved their communication with the users. Individuals learn the most about EVs by driving them. In addition to having staff test drive EVs, basic training and education about the differences of EVs is needed.

A successful staff education program will include:

- Test drives for potential users
- Demonstration of charging station technology
- Reference resources on vehicle operation, including how to start, and charge EVs, and the available range
- Consistent communication with users including on-boarding guide for new staff

The cities of Seattle and Houston, both of which have in excess of 40 plug-in vehicles, have adopted programs to encourage the use of these vehicles instead of fossil fuel vehicles whenever possible. These cities have had significant success using different approaches.

- City of Seattle established plug-in vehicles as the default choice and only when these vehicles are not suitable can users opt for a different vehicle.¹
- City of Houston implemented a tracking process that identifies users that check out conventional vehicles for trips that could have been completed with plug-in vehicles. Fleet staff then performs targeted education to encourage them to use plug-in vehicles.

¹ https://www.seattle.gov/fleet-management/green-fleet

Fleet management is a critical part of any user education program. Since fleet managers will be in charge of implementing the staff education program they need to prepare to effectively communicate it to users.

Action: Implement a policy that staff must use an EV before other fleet or personal car.
Interviews with Fleet Managers

Fleet managers from the City of Santa Rosa, Sonoma County, and the Sonoma County Water Agency all generously provided insight into the work to date by fleets to adopt and use plug-in electric vehicles (EVs), and to install the associated charging infrastructure for both fleet, employee and community uses.

Driven largely by sustainability measures to reduce emissions, fleet managers began exploring a variety of alternative fuel vehicles for their fleets and recognized EVs as a natural fit for their needs. Over the past 10 to 20 years, their fleets have gone through an evolution of electric drive technologies, starting with hybrids, then plug-in hybrid conversions, and now the current generation of EVs. These fleets have been engaged for years in EV implementation, even testing vehicles for manufacturers as they became available. Sonoma County has been a leader in fleet electrification, operating EVs since the 1990’s, with the City of Santa Rosa beginning 15 years ago and SCWA since 2006.

Most fleet EVs have been purchased using grant funding, with fleets continuing to apply for funding both for more vehicles and for charging stations. For the portion of these fleets with electric drive, they are primarily using a mix of hybrid electric and plug-in electric light-duty sedans.

As of December 2017, the Water Agency has 20 hybrid and 5 all-electric vehicles, representing approximately 17% of their fleet. The all-electric vehicles are powered predominantly by carbon-free electricity, making them even greener. As of January 2016, the City of Santa Rosa has 75 hybrid light-duty vehicles as well as electric motorcycles and hybrid buses, which is approximately 10% of their fleet. Sonoma County has 56 plug-in EVs, along with 235 hybrid vehicles including four heavy-duty hybrid trucks.

Maintenance

Fleets have observed benefits in the cost and ease of EV operations. Overall, the hybrid and plug-in models need fewer oil changes, brake replacements, and less preventive maintenance than conventional internal combustion vehicles. The County of Sonoma has been auctioning their used hybrids with the original brake pads, as the current wear cycle extends beyond the fleet life, which has resulted in thousands of dollars in savings on brake changes. Some early model hybrids experienced premature battery issues, but these were replaced under warranty, and current hybrid vehicles are often retired before the battery
needs replacement, as batteries in newer hybrid models are designed to last the life of the vehicle. While average fleet vehicle replacement schedules vary amongst models, these are typically in the order of 8-10 years or 90,000-100,000 miles. Some of the current hybrid vehicles are already well in excess of 100,000 miles, surpassing normal expected lifecycle. Replacement schedules for plug-in EVs are not fully known yet as these vehicles continue to be tested, though some of the fleet managers believe that they will exceed the typical lifecycle length. The expectation for longer lifecycle is based in part on the inherent technical characteristics of electric motors and drivetrains, which have fewer moving parts. Another important note - is that EVs in these fleets have seen much lower usage rates relative to other types of vehicles.

Despite the described benefits, fleets do not currently anticipate expanding their EV portfolios, unless
» new grant funding is obtained,
» specific requests are put forth by governing bodies to increase EV adoption,
» car companies start offering cost-effective sedan EV models with range in excess of 120 miles, or
» cost-effective EV models are offered in the medium- and heavy-duty segments.

**Charging Infrastructure Availability**

According to the fleet managers interviewed, many round trips are longer than current fleet battery electric vehicles (BEVs - which have no gasoline backup) might be able to travel without being recharged. Fleets have installed chargers in multiple locations to ensure that drivers can make most daily trips to satellite facilities, and fleets continue to increase their existing charging infrastructure.

The fact that offices and facilities are often located on leased property limits opportunities to install charging stations; such has reportedly been the case for County of Sonoma’s fleet. The County will be including charging station requirements in their future lease contracts as a solution. Many property managers struggle with meeting the new Americans with Disabilities Act (ADA) parking requirements if they were to install charging stations, so have avoided installing any charging.

Interviews with fleet managers revealed that two key impediments to increase the use of EVs: distance of the destination (for example, Sacramento) exceeds the range of the battery electric vehicles in their fleet, or that the destination does not currently have charging infrastructure. In the past, several of these fleets have worked together to share gasoline fueling options.

Similar sharing of and coordination of investment in charging stations in the future may increase opportunities for using EVs. While infrastructure is a limiting factor, fleet managers believe that EVs with significantly longer electric range are more suitable for fleet operations.
Driver Operations

As with any new technology, drivers had to be introduced to hybrids or EVs when fleets first adopted them. As the technology has further evolved, most drivers became completely comfortable operating hybrid vehicles. User acceptance of BEVs however has been slower, mainly because of concerns about running out of charge.

To educate staff on new EVs in the fleet, the Water Agency created a handout to introduce staff to important battery electric vehicle features, explaining that the range was adequate for the typical countywide trip. Fleets successfully partnered with dealerships to provide ride and drive opportunities for employees of not just the vehicles being added to their fleets, but the other makes and models available for employee purchase, in an effort to help employees embrace the new hybrid and electric technologies. Santa Rosa also completed specific training for the drivers of their hybrid buses.

Drivers do however enjoy California’s high occupancy vehicle (HOV) and high occupancy toll (HOT) exemptions for PEVs, allowing them to utilize the faster HOV and HOT lanes regardless of occupancy. Fleet managers noted that their hybrid and PEV vehicles are not used to their maximum efficiency or electric range, in part because drivers do not adjust their driving to extract the best performance out of these technologies.

Station Accessibility

The California Building Standards Commission approved a building code in 2017 that requires ADA accessibility for PEV charging stations in many situations. Specific private parking scenarios, such as fleet parking, are exempt from these requirements. According to fleet managers, these requirements have prevented the expansion of public charging infrastructure, due to the level of effort and cost required to not only install an ADA-compliant charging space, but to regrade the surrounding parking lot, curb, and path of travel to meet ADA standards. The first spaces must be large enough to be van-accessible as well.

A public charging space, brought up to current ADA compliance.

2 [https://www.opr.ca.gov/docs/PEV_Access_Guidelines.pdf](https://www.opr.ca.gov/docs/PEV_Access_Guidelines.pdf)
Employee Charging

The City of Santa Rosa and the County make charging stations available for employee use. However, there are no formal workplace charging programs in Sonoma County that integrate the installation of stations with assessments of demand, outreach and education of the employees to increase utilization, or other elements.

Santa Rosa has public chargers available in their employee parking lots and is working to increase these charging stations through grant funding. The Water Agency is exploring the option of workplace charging as they switch over to networked charging station, but at the moment have no way to charge employees should they use the charging stations in the fleet yards and have not installed public charging due to the challenges of also meeting the new ADA requirements. Encouraging workplace charging has been linked to increased employee EV adoption.

Sonoma County is participating in the U.S. Department of Energy’s Workplace Charging Challenge, earning recognition and gaining support for their workplace charging efforts, and other governments and fleets should take advantage of programs such as this.3

Fleet managers suggested charging stations being installed should be 75% level 1, 25% level 2, and 5% DC Fast Charge, to better support the needs of the users.

3 http://energy.gov/eere/vehicles/workplace-charging-challenge-partners
Incentives

Incentives are available to Sonoma County residents, commercial, and government entities who purchase or lease plug-in vehicles. Incentives are offered at the federal, state, and local levels and include tax credits, vehicle rebates, carpool lane access, insurance discounts, and charging rate reductions.

Table 1 provides an overview of the available government incentives to support the purchase or lease of an EV. In addition to these government incentives, electric utilities make available time of use rates, allowing PEV users to further reduce their fuel costs by charging their vehicles at hours in the day with lower demand for electricity. Table 2 summarizes the incentive programs available in Sonoma County to support the deployment of charging infrastructure.

Some of the incentives available in the state apply to disadvantaged communities, as defined in SB 535 (De Leon). There are no communities in Sonoma County that are classified as disadvantaged communities.

For the evaluation of the lifecycle cost of ownership of plug-in vehicles, the state Clean Vehicle Rebate Program is predominantly included. Some of the incentives listed above are available to private, but probably not to public fleets, or vice versa. Furthermore, some of the funding is not automatically available and is contingent on applications and granting processes. The results in the next section must be understood with this context in mind.
## Table 1. Incentives for Plug-in Electric Vehicles

<table>
<thead>
<tr>
<th>Government Entity</th>
<th>Incentive Program</th>
<th>Funder/Administrator</th>
<th>Available To</th>
<th>Available Through</th>
<th>Incentive Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>Plug-In Electric Drive Vehicle Tax Credit</td>
<td>Federal (IRS)</td>
<td>Individuals, businesses, government entities</td>
<td>Not specified</td>
<td>$2,500-7,500, depending upon battery capacity; applies to vehicles acquired after December 31, 2009. Tax credit can be combined with State level rebates.</td>
</tr>
<tr>
<td>State of California</td>
<td>Clean Vehicle Rebate Program (CVRP)</td>
<td>California Air Resources Board (CARB)</td>
<td>Individuals, businesses, government entities in CA</td>
<td>2023</td>
<td>$1,500-6,500 for the lease or purchase of new, ARB-certified PEVs. Rebate can be combined with federal PEV tax credit.</td>
</tr>
<tr>
<td>State of California</td>
<td>Hybrid Truck and Bus Voucher Incentive Program (HVIP)</td>
<td>CARB</td>
<td>Businesses, fleet owners in CA</td>
<td>2023</td>
<td>$12,000-110,000 per medium- and heavy-duty PEV vehicle, depending upon vehicle technology, vehicle weight, amount purchased, and if the truck is in a disadvantaged community</td>
</tr>
<tr>
<td>State of California</td>
<td>Increased Incentives for Public Fleets in Disadvantaged Communities (Public Fleet Pilot Project)</td>
<td>CARB</td>
<td>State and local public entities in CA</td>
<td>Not specified</td>
<td>$5,250-$10,000 for purchases light-duty, ARB-certified PEVs. Entity must be located in a disadvantaged community. Rebate cannot be combined with CVRP rebate or federal tax credit.</td>
</tr>
<tr>
<td>Local Government</td>
<td>Transportation Fund for Clean Air (TFCA)</td>
<td>Bay Area Air Quality Management District</td>
<td>Public agencies and non-public entities within Air District’s jurisdiction</td>
<td>Not specified</td>
<td>Provides grant funding for projects that result in the reduction of motor vehicle emissions. Eligible projects include: •Purchase or lease of three or more CARB-approved PEVs in a fleet registered to a single owner •Purchase or lease of heavy-duty zero- and partial-zero- emissions vehicles</td>
</tr>
<tr>
<td>Local Government</td>
<td>PEV Rebate Program</td>
<td>Bay Area Air Quality Management District TFCA</td>
<td>Public agencies within Air District’s jurisdiction</td>
<td>Check Air District pages</td>
<td>Provides vouchers that can be redeemed for the purchase or lease of qualifying vehicles: •$2,500 per light-duty BEV/fuel cell vehicle •$1,000 per light-duty PHEV •$500 per neighborhood electric vehicle •$2,500 per zero-emission motorcycle •Vouchers are issued prior to the purchase or lease of the vehicle(s). Up to $2 million is available on a first-come, first-served basis.</td>
</tr>
<tr>
<td>Local Government</td>
<td>TFCA County Program Manager Fund</td>
<td>Bay Area Air Quality Management District</td>
<td>Public and private entities within Air District’s jurisdiction</td>
<td>Not specified</td>
<td>Forty percent of the TFCA fund revenues are distributed to the County Program Manager Fund. Grant funding is available to for a variety of projects including the purchase or lease of clean fuel buses for school districts and transit operators; implementation of vehicle-based projects to reduce mobile source emissions, including, but not limited to, fleet modernization and alternative fuels.</td>
</tr>
<tr>
<td>State of California</td>
<td>Clean Air Vehicle Stickers</td>
<td>CARB</td>
<td>Individuals in CA</td>
<td>2019</td>
<td>Access to carpool lanes through January 1, 2019 for an unlimited number of BEVs and the first 40,000 PHEV applicants.</td>
</tr>
<tr>
<td>State of California</td>
<td>Insurance Discount</td>
<td>Farmers Insurance, AAA</td>
<td>Individuals, businesses in CA</td>
<td>Not specified</td>
<td>Farmers Insurance provides a discount of up to 10% on all major insurance coverage for PEV owners. AAA offers up to a 5% discount.</td>
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</tbody>
</table>
Table 2. Incentives for Electric Vehicle Charging Infrastructure

<table>
<thead>
<tr>
<th>Government Entity</th>
<th>Incentive Program</th>
<th>Funder/Administrator</th>
<th>Available To</th>
<th>Available Through</th>
<th>Incentive Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>Low and Zero Emission Vehicle Research, Demonstration, and Deployment Funding</td>
<td>Federal Transit Administration</td>
<td>Local, state, and federal government entities; public transportation providers; private and non-profit organizations; and higher education institutions</td>
<td>Not specified</td>
<td>Financial assistance is available for research, demonstration, and deployment projects involving low or zero emission public transportation vehicles. Funding may cover up to 80% of project costs, with a required 20% non-federal cost share requirement. Eligible vehicles must be designated for public transportation use and significantly reduce energy consumption or harmful emissions compared to a comparable standard vehicle.</td>
</tr>
<tr>
<td>State of California</td>
<td>EVSE Loan and Rebate Program - California Capital Access Program (CalCAP)</td>
<td>California Energy Commissions (CEC)</td>
<td>Small businesses in CA</td>
<td>Not specified</td>
<td>Provides loans for up to $500,000 for the design, development, purchase, and installation of EVSE at small business locations in California.</td>
</tr>
<tr>
<td>State of California</td>
<td>Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP)</td>
<td>CEC</td>
<td>Businesses, workforce training partners, fleet owners, consumers, and academic institutions in CA</td>
<td>2023</td>
<td>Competitive grant program that provides funding for EVSE infrastructure, light duty PEV deployment, workforce training and development, and regional PEV readiness plans. The proposed 2015-2016 investment plan includes $18 million in EVSE infrastructure and $3 million in workforce training and development.</td>
</tr>
<tr>
<td>State of California</td>
<td>Low Carbon Fuel Standard (LCFS) Credits</td>
<td>CARB</td>
<td>Public agencies, employers, fleet owners in CA</td>
<td>N/A since regulation extends beyond 2020</td>
<td>Plug-in electric vehicle service providers and fleet operators dispensing electricity as a transportation fuel are eligible to generate LCFS credits.</td>
</tr>
<tr>
<td>Local Government</td>
<td>Charge! Program</td>
<td>Bay Area Air Quality Management District</td>
<td>Businesses, non-profits, and public agencies</td>
<td>March 9, 2018</td>
<td></td>
</tr>
</tbody>
</table>
Lifecycle Costs of EVs

Investment decisions on any type of asset typically look at lifecycle cash flows. Procurement decisions for fleets, however, often emphasize upfront capital expenditures, which places plug-in vehicles, which often have a higher upfront capital cost, at a competitive disadvantage versus conventional and hybrid vehicles. The comparative analysis of lifecycle cost of ownership (LCO) of a set of vehicle types and models is a better approach to evaluate the cost effectiveness of EVs. Lifecycle net cost analyses can provide fleet managers and city governments interested in plug-in vehicles with the necessary information to develop sound procurement decisions.

A number of very simple vehicle LCO calculators have been developed over the years. A recent study led by the University of California at Davis (Burke, Collantes, Miller, and Zhao, 2014) describes the limitations of such calculators, which include:

- Not being comprehensive;
- Not accounting for the effect of time on the key variables;
- Relying heavily on hypothetical vehicle configurations;
- Not being adaptable to specific regional contexts;
- Not accounting for local conditions (ambient conditions, road grades, typical traffic conditions, etc.);
- Not accounting for vehicle depreciation;
- Ignoring risk and uncertainties;
- Not designed to be incorporated into program development.

The UC Davis team developed a comparative LCO tool that is significantly better than earlier calculators. Among the key improvements of this tool that may be of interest to fleet managers and procurement decision makers are:

- Accounts for local conditions (topography, driving conditions, etc.) in several areas in Northern California
  - Provides risk assessments by accounting for future trends on fuel prices and volatility
  - Incorporates estimates of depreciation for the various types of vehicles

For the following LCO analysis, ICF followed the approach taken by the UC Davis team, choosing from the available settings those that more closely reflect conditions in Sonoma County. For more information on the characteristics of the model, refer to Burke, Collantes, Miller, and Zhao (2015).

**Results for Sonoma County**

Among the menu of routes available in the UC Davis model to determine lifecycle cost of ownership, the route and travel conditions between San Rafael and San Francisco were selected as being the most representative of Sonoma County. Three different vehicle types, representing a battery electric Nissan LEAF, a plug-in hybrid Chevy Volt, and a conventional gasoline engine Chevy Cruze, were compared using three different scenarios of expected use:

- 12,000 annual miles and 20-mile average trip distance between charging stations
- 10,000 annual miles and 20-mile average trip distance between charging stations
- 12,000 annual miles and 40-mile average trip distance between charging stations

The assumptions about average trip distance between charging stations are arbitrary and are meant to reflect different levels of densities of the network of charging stations (i.e. EVs have more opportunities to charge when more charging stations are available) include situations in which plug-in electric models are able to run only on electricity and others where they may need to use their combustion engine. The results of these scenarios are summarized in Tables 3-5, with Figure 4 showing the ranges of lifecycle net cost of ownership for the three vehicle types.
Figure 3. Ranges of lifecycle cost of ownership for three types of vehicles

### Table 3. Estimated lifecycle cost of ownership for Sonoma County - Case 1

<table>
<thead>
<tr>
<th>Measure</th>
<th>Compact BEV</th>
<th>Compact PHEV</th>
<th>Compact Gasoline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean cost of ownership</td>
<td>$57,444</td>
<td>$68,027</td>
<td>$62,416</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>$697</td>
<td>$684</td>
<td>$1,743</td>
</tr>
<tr>
<td>Lower bound cost of ownership</td>
<td>$55,352</td>
<td>$65,976</td>
<td>$57,186</td>
</tr>
<tr>
<td>Upper bound cost of ownership</td>
<td>$59,535</td>
<td>$70,078</td>
<td>$67,645</td>
</tr>
<tr>
<td>Lower bound per-mile cost of ownership</td>
<td>$0.46</td>
<td>$0.55</td>
<td>$0.48</td>
</tr>
<tr>
<td>Mean per-mile cost of ownership</td>
<td>$0.48</td>
<td>$0.57</td>
<td>$0.52</td>
</tr>
<tr>
<td>Upper bound per-mile cost of ownership</td>
<td>$0.50</td>
<td>$0.58</td>
<td>$0.56</td>
</tr>
</tbody>
</table>

Assumes 12,000 annual miles and 20-mile average trip distance between charging stations

### Table 4. Estimated lifecycle cost of ownership for Sonoma County - Case 2

<table>
<thead>
<tr>
<th>Measure</th>
<th>Compact BEV</th>
<th>Compact PHEV</th>
<th>Compact Gasoline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean cost of ownership</td>
<td>$56,467</td>
<td>$66,560</td>
<td>$59,510</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>$586</td>
<td>$567</td>
<td>$1,423</td>
</tr>
<tr>
<td>Lower bound cost of ownership</td>
<td>$54,710</td>
<td>$64,860</td>
<td>$55,242</td>
</tr>
<tr>
<td>Upper bound cost of ownership</td>
<td>$58,224</td>
<td>$68,260</td>
<td>$63,778</td>
</tr>
<tr>
<td>Lower bound per-mile cost of ownership</td>
<td>$0.55</td>
<td>$0.65</td>
<td>$0.55</td>
</tr>
<tr>
<td>Mean per-mile cost of ownership</td>
<td>$0.56</td>
<td>$0.67</td>
<td>$0.60</td>
</tr>
<tr>
<td>Upper bound per-mile cost of ownership</td>
<td>$0.58</td>
<td>$0.68</td>
<td>$0.64</td>
</tr>
</tbody>
</table>

Assuming 10,000 annual miles and 20-mile average trip distance between charging stations
Table 5. Estimated lifecycle cost of ownership for Sonoma County - Case 3

<table>
<thead>
<tr>
<th>Measure</th>
<th>Compact BEV</th>
<th>Compact PHEV</th>
<th>Compact Gasoline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean cost of ownership</td>
<td>$57,444</td>
<td>$68,021</td>
<td>$62,390</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>$723</td>
<td>$699</td>
<td>$1,713</td>
</tr>
<tr>
<td>Lower bound cost of ownership</td>
<td>$55,276</td>
<td>$65,923</td>
<td>$57,251</td>
</tr>
<tr>
<td>Upper bound cost of ownership</td>
<td>$59,612</td>
<td>$70,119</td>
<td>$67,530</td>
</tr>
<tr>
<td>Lower bound per-mile cost of ownership</td>
<td>$0.46</td>
<td>$0.55</td>
<td>$0.48</td>
</tr>
<tr>
<td>Mean per-mile cost of ownership</td>
<td>$0.48</td>
<td>$0.57</td>
<td>$0.52</td>
</tr>
<tr>
<td>Upper bound per-mile cost of ownership</td>
<td>$0.50</td>
<td>$0.58</td>
<td>$0.56</td>
</tr>
</tbody>
</table>

Assuming 12,000 annual miles and 40-mile average trip distance between charging stations

These results provide a few important considerations to support fleet planning:

» For the duration of ownership (10 years) and annual mileages (10,000 and 12,000 miles) considered in the analysis, BEV have a competitive advantage over conventional gasoline and PHEV platforms on a lifecycle cost of ownership basis.

» Conventional gasoline vehicles constitute a riskier asset investment. The standard deviation of the estimated lifecycle cost of these vehicles is typically an order of magnitude higher than that of PEVs (either BEV or PHEV)

» PHEVs are expected to be a costlier asset than conventional vehicles even when taking risk into account.

» As expected, increasing the number of charging stations in the network has in itself no impact on the cost of owning battery electric vehicles. Increases in the number of stations help decrease the cost of ownership of PHEV, but the marginal decrease in cost will depend on the electric range of these vehicles. For PHEV with higher electric range the marginal benefit of increasing the network of charging stations is smaller.

» The competitive advantage of BEVs versus conventional vehicles increases with the total lifecycle mileage of the vehicles.

As reported by fleet managers, unfamiliarity with the technology and concerns (often unfounded) about range among staff have resulted in BEVs having much lower annual miles than conventional vehicles. This is more a social than technical factor and it influences strongly the return on investment on these vehicles. Assuming that the battery electric vehicle was driven only 4,000 miles per year, keeping the 10-year ownership duration fixed, the simulation found that the mean per-mile cost would go up dramatically to $1.30, compared to the lower values shown in the tables above. This shows that in underutilization scenarios, BEVs are less cost effective than conventional vehicles.

Thus, investments in PEVs must include strategies to avoid social deterrents to the use of these cars. Such strategies, including driver education, have been successfully implemented by public fleets in a number of jurisdictions across the country, including the cities of Houston and Seattle. Elements of these strategies are described in the recommendations.
Low Carbon Fuel Standard Credits

The California Low Carbon Fuel Standard (LCFS) is a state policy adopted with the goal of creating incentives for the production and commercialization of fuels with lower lifecycle carbon emissions (using the technical jargon, lower carbon intensity). The sale or use of fuels with lower lifecycle carbon emissions than the corresponding baseline (gasoline for light duty vehicles and diesel for heavy duty vehicles) generates credits that can be monetized in a market. The LCFS offers an additional financial incentive for the adoption of plug-in vehicles. With the use of electricity to charge plug-in vehicles displacing consumption of gasoline, agencies could sell LCFS credits at market-clearing prices. Table 6 shows the revenue that could be generated through the sale of LCFS credits, expressed in dollars per kilowatt-hour consumed to charge a plug-in vehicle. Revenue per unit depends on the carbon intensity of the electricity (representative of the savings in carbon emissions relative to gasoline) and the market-clearing price of the credits in any given period. So for example, if the market price of a credit at any given time is $80, using electricity with state-average value of carbon intensity, could generate 5-6 cents in revenue per kilowatt-hour through the sale of LCFS credits.

Table 6. Potential revenue from LCFS credits from the use of electricity to charge plug-in vehicles (compliance year, 2017)

<table>
<thead>
<tr>
<th>Carbon intensity (gCO2e/MJ)</th>
<th>LCFS Credit Market Price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$50</td>
</tr>
<tr>
<td>0</td>
<td>$0.06</td>
</tr>
<tr>
<td>10</td>
<td>$0.06</td>
</tr>
<tr>
<td>20</td>
<td>$0.06</td>
</tr>
<tr>
<td>30</td>
<td>$0.05</td>
</tr>
<tr>
<td>40</td>
<td>$0.05</td>
</tr>
<tr>
<td>50</td>
<td>$0.05</td>
</tr>
<tr>
<td>60</td>
<td>$0.05</td>
</tr>
<tr>
<td>70</td>
<td>$0.05</td>
</tr>
<tr>
<td>80</td>
<td>$0.04</td>
</tr>
<tr>
<td>90</td>
<td>$0.04</td>
</tr>
<tr>
<td>100</td>
<td>$0.04</td>
</tr>
<tr>
<td>110</td>
<td>$0.04</td>
</tr>
<tr>
<td>120</td>
<td>$0.04</td>
</tr>
<tr>
<td>130</td>
<td>$0.04</td>
</tr>
</tbody>
</table>
Participating in the LCFS market, local governments and the county could potentially reduce the cost of ownership of the plug-in vehicles in their fleets. In order to participate, additional staff time would be needed. It should be noted that the clearing price of the LCFS credits cannot be predicted with precision ahead of time and it would depend on the actions and strategies taken by market participants collectively.

As mentioned above, the credits depend on the carbon intensity of the electricity used to charge the plug-in vehicles. This is an aspect of the market that should be interesting to Sonoma County because the electricity sold in the county is significantly cleaner than the state’s average. At the moment, the state does not provide mechanisms to account for the lower carbon intensity in certain regions of the state. However, local jurisdictions can discuss with the state accepted practices for documenting the carbon intensity of the electricity used by its fleets.
Fleet Data Analysis

ICF conducted an analysis to assess opportunities for expanding the adoption and use of plug-in vehicles in Sonoma County public fleets. To this end, ICF asked fleet managers to share with ICF the following data items:

» Fleet composition: Vehicle make, model and year;
» Vehicle use: miles and number of trips, at the monthly level or annual level; and
» Fuel consumption per vehicle: gasoline/diesel gallons, CNG cubic feet or equivalent, electricity kilowatt-hours, at the monthly or annual level.

ICF was only able to obtain a small part of the data needed for a deeper analysis. Using the data that was received on hybrid and electric vehicle use, some basic analysis was completed. ICF looked at the staff that drove a Prius hybrid electric vehicle from one of the fleets in the county, and Figure 4 shows the average fuel economy of all trips taken by each staff. The chart shows a clear and informative pattern: fuel economy decreases and increases rapidly toward the ends of the spectrum.

For about 80 percent of the drivers, driving performance (as measured by the fuel economy they obtain) varies more or less between about 40 and 55 miles per gallon. Fifteen miles per gallon is a significant range. Fuel economy performance can be affected by a variety of factors, some of which are to a large degree independent of the driver—for example, highway trips will tend to have lower fuel economy than trips on urban streets. However, driver behavior is generally a strong determinant of fuel economy.

Improving driving efficiency, also known as eco-driving, would help reduce emissions and fuel expenditures. For the purpose of this report, ICF is concerned with the impact of driver behavior on opportunities for plug-in vehicle adoption and emissions savings. For conventional and, particularly, hybrid vehicles, the benefits of efficient driving are predominantly social (lower emissions and climate impacts), not personal.

For plug-in vehicles, and especially for battery electric vehicles, efficient driving has a strong personal benefit: it positively impacts vehicle utility by extending electric range, consequently fostering user experience and acceptance. These considerations are particularly relevant in the context of information shared by fleet managers regarding the low acceptance of plug-in vehicles among fleet users.
Figure 4. Average fuel economy for individual drivers of fleet Prius hybrid vehicles

According to data obtained, hybrid vehicles in the fleet are driven much more than plug-in electric vehicles. On average, a hybrid vehicle in the analyzed sample was driven about 7,800 miles in the months of July through December of 2015. Plug-in electric vehicles, on the other hand, were driven on average under 1,600 miles in the same period. The average amounts of travel done per day and per checkout for PEVs were approximately 70 miles and 8 miles, respectively. Each checkout episode typically involves several trips which, for PEVs was on average under eight miles long. In contrast, hybrid vehicles were driven on average over 300 miles per checkout episode, although there was not sufficient data on the time span of or number of trips during vehicle checkouts.

While not robust enough to make solid analysis and draw data-driven inferences, the data that were available suggest significantly lower utilization of PEVs in the fleet, at least relative to hybrid vehicles (conventional vehicles data was not provided). Since data for other types of conventional fleet vehicles were not available, it was not possible to compare the estimated average trip lengths for PEVs against average trip lengths for other vehicle types, so it is unknown whether trip lengths of about 8 miles are low or high for this particular fleet. The data did reveal an apparent increase in estimated trip length over time, as shown in Figure 5. This might suggest that some users become more comfortable over time with the vehicles and are able to better utilize the vehicle capabilities—although without more complete data, it is not possible to say if the apparent trend may be caused by other reasons.

1 Not able to obtain estimates for conventional vehicles because data for those vehicles were unavailable.
Fleet data shows the price of gasoline on the days that hybrid vehicles were used. These data, shown in Figure 6, illustrates one of the economic benefits of plug-in vehicles, namely that they hedge against the volatility of petroleum fuel prices. The analyses presented in Section 3 already showed that this volatility creates uncertainty about the cost of operation of vehicles that run on conventional fuels, which in turn makes financial planning more difficult.
Resources


Clean Cities

PEV Resource Center
https://www.driveclean.ca.gov/pev/

Veloz http://www.veloz.org

Plug-In America https://pluginamerica.org/
PlugShare, an EV charging station map, https://www.plugshare.com/

Alternative Fuels Data Center https://www.afdc.energy.gov/
The Alternative Fuels Data Center (AFDC) provides information, data, and tools to help fleets and other transportation decision makers find ways to reach their energy and economic goals through the use of alternative and renewable fuels,
For More Information
Visit scta.ca.gov/shift for information and tools related to the Shift Plan.