California electricity offers cost-effective, efficient electric fuel, improved air quality, a reduced carbon footprint and less dependence on imported petroleum.

**KEY MESSAGES**

- Most charging occurs at home, at night.
- Workplace charging is the second most frequent choice.
- There are more than 1000 public charging locations in California today; this will continue to expand over the next several years.
  - Public charging stations are available today at public parking lots, retail chains such as Kohls and Walgreens, tourist destinations, entertainment venues, and airports.

**HOME CHARGING**

- Empirical data show that most charging occurs at home, at night. Benefits include:
  - The convenience of fueling while asleep;
  - Lower cost of night-time, off-peak electric fuel;
  - A full “tank” every morning!

- Every new PEV comes with portable charging equipment that plugs into a regular household outlet (Level 1).

- To charge up faster, PEV drivers can also purchase and install charging equipment, using a dedicated 240 volt circuit similar to that used by a clothes dryer (Level 2 charging).

- Many manufacturers offer PEV charging equipment – referred to as Electric Vehicle Supply Equipment (EVSE). PEV drivers can choose among a number of brands (including many made by California companies).

  Some good sites:
  - [www.DriveClean.ca.gov/PEV](http://www.DriveClean.ca.gov/PEV)
  - [www.pluginamerica.org](http://www.pluginamerica.org)
  - [www.GoElectricDrive.com](http://www.GoElectricDrive.com)

**WORKPLACE CHARGING**

- Some workplaces allow employees to “top off” their charge while at work, to “re-fill” the charge that it took to drive to work. Employers offer both Level 1 and Level 2 charging opportunities.

- Companies such as Google, Apple, Netflix and electric utilities throughout California have already installed hundreds of Level 2 charging stations for employees to use at their work sites.

**PUBLIC CHARGING**

- PEV drivers can find public charging sites using web sites or mobile phone apps. For a list of the best resources go to the California PEV Resource Center, [www.DriveClean.ca.gov/PEV](http://www.DriveClean.ca.gov/PEV).

- A growing set of smart phone apps enable PEV drivers to plan, monitor, and program charging. PEV drivers can use these apps to schedule charging for times when electricity rates are lowest, to reserve charge time on a reservation-enabled charger, and to be notified if charging is interrupted.

- Different and faster options for charging PEVs are evolving.

  - **DC Fast Charging stations will be built in California in 2012. They can refuel up to 80% in approximately 30 minutes.**
  - **Battery Switching may offer Californians a different strategy for refueling PEVs in the future.**
  - **Inductive charging, where refueling is done “wirelessly”, is being tested.**

Source: California PEV Collaborative (CG3-1)
WHEN AND WHERE WILL I CHARGE?

Road Warrior Rick
Plug-in Hybrid Electric Vehicle (PHEV) Driver
Regional Sales Manager, Pharmaceutical Company
Northern California

“I drive hundreds of miles each week for my job, so fuel costs matter a lot!”

- Charge overnight in my condo’s underground garage – standard 120 volt outlet (Level 1)
- Drive to doctors’ offices north and west of San Francisco
- While parked to call on doctors, “top off” charge at hospital charging station, for 2 hours, Level 2
- Drive to doctors’ offices in Oakland and Berkeley
- Tickets to Oakland A’s game; pay $3.00 to “top off” at Level 2 public charger
- Drive home, plug car into standard 120 volt outlet; car programmed to start charging at night when electricity rates are lowest
- Fully charged in morning!

Multi-tasking Maya
Battery Electric Vehicle (BEV) Driver
Information Technology Manager and Mom
Orange County

“When between my family and work, I have a lot of people who depend on me all day.”

- Wake up to a fully charged car – 240 volt charger (Level 2)
- Drop kids off at school
- HOV lane in my Battery Electric car (BEV), arrive at work sooner
- Park at Level 2 charging station at work; “top off” charge, full by lunch
- Drive 35 miles back in HOV lane, pick up kids, get mom, go to one of the kid’s basketball games – in a neighboring town, 10 miles away
- Take mom home, pick up pizza, head home for dinner and homework! BEV is programmed to start charging at night, when electricity rates are low
- Go to bed at 11PM and start all over again the next morning!

Source: California PEV Collaborative (CG3-2)

HOW LONG DOES IT TAKE TO CHARGE A PEV?

How long it takes to charge a PEV depends principally on how far the PEV has been driven on “electric miles” and the size of the battery. Charging speed is also governed by the PEV’s on-board charger and power level of charging equipment, among other factors. The adoption of a standard connector (SAE J1772™) for Level 1 and Level 2 charging means virtually every new PEV can be charged up using any EVSE equipped with the standard connector.

<table>
<thead>
<tr>
<th>Charging Level</th>
<th>Power Supply</th>
<th>Charger Power</th>
<th>Miles of Range for 1 Hour of Charge</th>
<th>BEV</th>
<th>PHEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>120VAC Single Phase</td>
<td>0.4 kW @ 12 amp (on-board charger)</td>
<td>~3 - 4 miles</td>
<td>~17 Hours</td>
<td>~7 Hours</td>
</tr>
<tr>
<td>Level 2</td>
<td>240VAC Single Phase up to 19.2 kW (up to 90 amps)</td>
<td>3.3 kW (on-board)</td>
<td>~8 - 10 miles</td>
<td>~7 Hours</td>
<td>~3 Hours</td>
</tr>
<tr>
<td>DC Fast Charge Level 2</td>
<td>200 - 450 VDC up to 90 kW (approximately 200 amp)</td>
<td>6.5 kW + kW (on-board)</td>
<td>~17 - 20 miles</td>
<td>~3.5 Hours</td>
<td>~1.4 Hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45 kW (off-board)</td>
<td>~50 - 60 miles (~80% per 0.5 hr charge)</td>
<td>~30 - 45 Minutes (to ~90%)</td>
<td>~10 Minutes (to ~80%)</td>
</tr>
</tbody>
</table>

Source: California PEV Collaborative (CG3-3).

SAE Assumptions: BEV = 25kWh usable battery; PHEV = 8kWh usable battery. Calculations reviewed and edited by EPRI.
Battery Electric Vehicle (BEV) assumes a 25 kWh usable battery pack size; for purposes of this table SAE data reflect a charging scenario of “empty to full” where charging starts at 20% State of Charge (SOC) and will stop at 100% SOC.
Plug-in Hybrid Electric Vehicle (PHEV) assumes an 8 kWh usable battery pack size; charging starts from 0% SOC since the hybrid mode is available.
**WHAT DOES IT COST TO INSTALL CHARGING AND WHAT STEPS DO I TAKE?**

- **Level 1 (120 volt)** home charging simply requires access to a standard household dedicated circuit (with available capacity) and use of the standard Level 1 portable charging device included with a PEV. The cost of charging is the effective electricity rate at the time.

- **Charging at home with Level 2 (240 volt)** charging equipment requires both buying and installing Level 2 equipment, which together cost around $1,500 (or more) for a typical California household.
  - EVSEs cost between $500 and $1,100 today, but this cost is expected to decline over time, with higher volume production.
  - In California, permit costs for home EVSE installations vary widely – the average permit cost is about $200, but permits can range from $50 - $600.
  - Some automakers offer package pricing for EVSE and its installation. This is available through companies such as AeroVironment (Nissan LEAF™), SPX (Chevrolet Volt) and Best Buy (Ford Focus Electric).
  - Incentives are available to help offset the cost of home charging equipment and installation. Current information on EVSE and home charging installation incentives can be found at [www.DriveClean.ca.gov/PEV](http://www.DriveClean.ca.gov/PEV), [www.GoElectricDrive.com](http://www.GoElectricDrive.com), and [www.afdc.energy.gov/afdc](http://www.afdc.energy.gov/afdc).

- The cost to “fill up” using workplace or public charging ranges from free to several dollars per hour, or via paid subscription services.

**STEPS FOR INSTALLING LEVEL 2 CHARGING AT HOME**

1. **Consult PEV Automobile Dealers**
   - Ask utilities about available incentives.
   - Determine whether Level 1 or Level 2 charging meets your needs.

2. **Research Incentives**
   - PEV manufacturers may recommend an EVSE or have partnerships with EVSE manufacturers, retailers or installation providers; or PEV drivers can choose from a wide variety of EVSEs that are now available on the market.
   - Focus on UL or ETL listed EVSE products.
   - Consult automaker websites and Plug In America to learn more about different EVSE options.

3. **Select a Level 2 EVSE to Buy**
   - Learn how to maximize fuel cost savings.
   - Take advantage of rebates, incentives, and meet utility requirements.
   - Find step-by-step EVSE installation instructions on all major California utility websites.

4. **Contact Your Local Utility**
   - A qualified EVSE installer is key.
   - Consult automakers, utilities, cities or state organizations to find licensed and insured electricians. Consider obtaining multiple quotes.
   - A building permit for the new circuit, and field inspection by a local building official, is typically required.
   - Once the Level 2 EVSE is installed, utility coordination complete, and the installation is approved by a building inspector, you are ready to charge.

5. **Contact a Licensed Electrical Contractor and Install a Level 2 EVSE**
   - A qualified EVSE installer is key.
PEV DRIVERS CAN USE SMART PHONES TO ENABLE SMART CHARGING

Photos include examples from BMW ActiveE, Recargo, Chevy Volt, and Nissan LEAF™ and are a small representation of their capabilities.

RESOURCES

- Blink
  www.blinknetwork.com/locator.html
- California Energy Commission
  www.energy.ca.gov/drive/index.html
- California PEV Collaborative, Taking Charge, 2010
  www.PEVCollaborative.org
- California PEV Resource Center
  www.DriveClean.ca.gov/PEV
- ChargePoint Network
  www.chargepoint.net
- Clean Fuel Connection, Inc. For information on charging infrastructure installation costs:
  www.cleanfuelconnection.com/presentations
- Electric Drive Transportation Association (EDTA)
  www.epri.com
- Plug In America - We Drive Change
  www.pluginamerica.org
- Recargo
  www.recargo.com
- Society of Automotive Engineers
  www.sae.org
- U.S. Department of Energy’s Vehicle Technologies Program - Plug-in Electric Vehicle Real-World Data from DOE’s
  AVTA (SAE Gov’t - Industry 2012) Jim Francfort - Idaho National Laboratory - January 2012 - Page 19
  For information on PEV drivers charging at home and workplace: avt.inl.gov/pdf/phev/G100SAE3GovtIndustryJan12.pdf