



Building In The Age of Electric Vehicles

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Benefits

- Increased energy security
- Improved fuel economy
- Lower fuel costs
- Low or zero tailpipe emissions

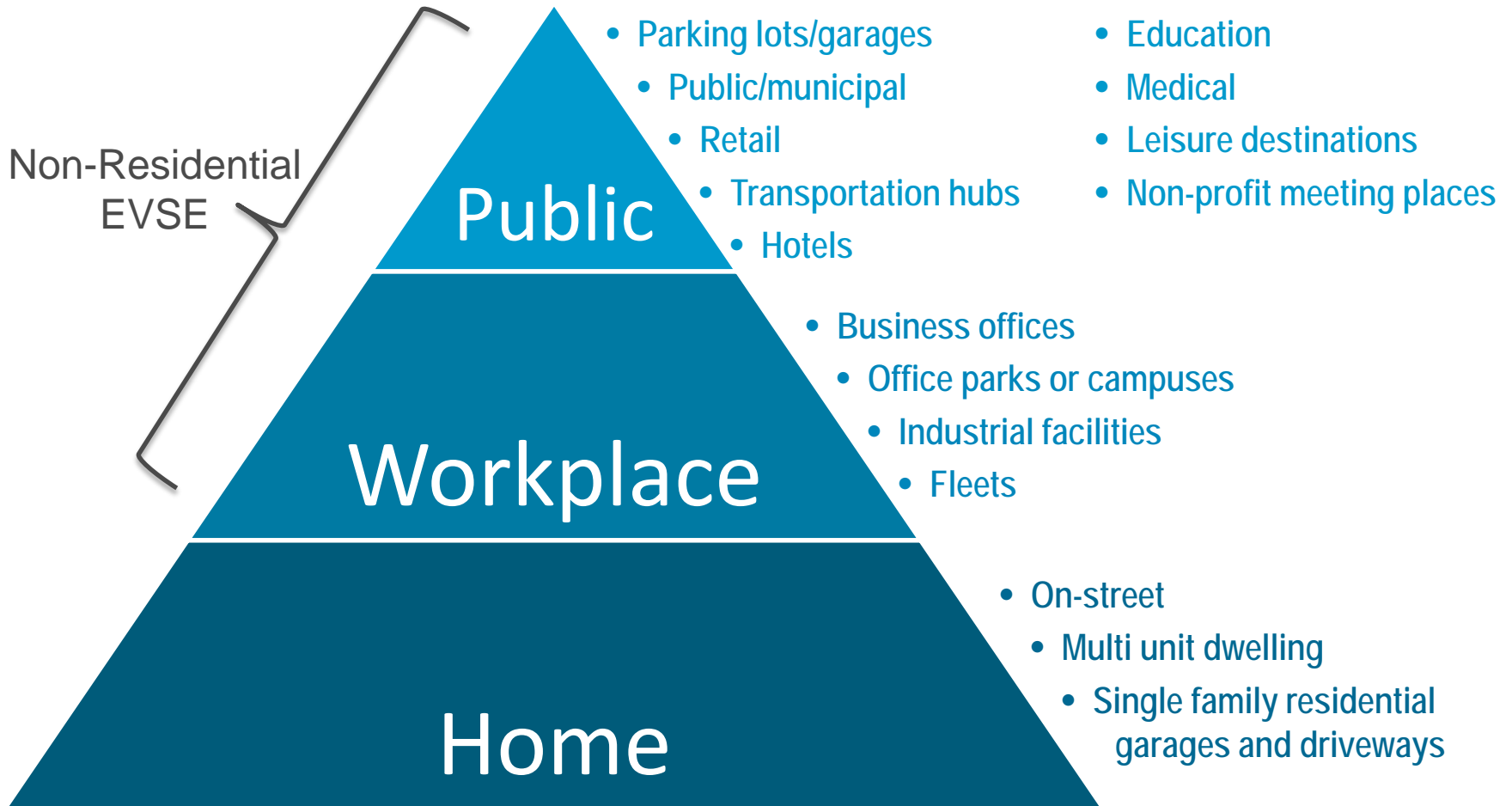
Considerations

- Higher initial vehicle cost
- Limited infrastructure availability
- Battery life
- Reduced all-electric range



Image: NREL Image Gallery #28974

Infrastructure Settings



Non-residential EVSE increases the electric driving range for PEV owners and enables drivers without access to home charging to own PEVs.

Electric Vehicle Supply Equipment (EVSE) Overview

EVSE consists of all the equipment needed to deliver electrical energy from an electricity source to a plug-in electric vehicle battery.

Charging Level	Vehicle Range Added per Charging Time and Power	Supply Power
AC Level 1	4 mi/hour @ 1.4kW	120VAC/20A <i>(12-16A continuous)</i>
	6 mi/hour @ 1.9kW	
AC Level 2	10 mi/hour @ 3.4kW	208/240VAC/20-100A <i>(16-80A continuous)</i>
	20 mi/hour @ 6.6kW	
DC Fast Charging	60 mi/hour @ 19.2 kW	208/480VAC 3-phase <i>(input current proportional to output power; ~20-400A AC)</i>
	24 mi/20minutes @ 24kW	
	50 mi/20minutes @ 50kW	
	90 mi/20minutes @ 90kW	

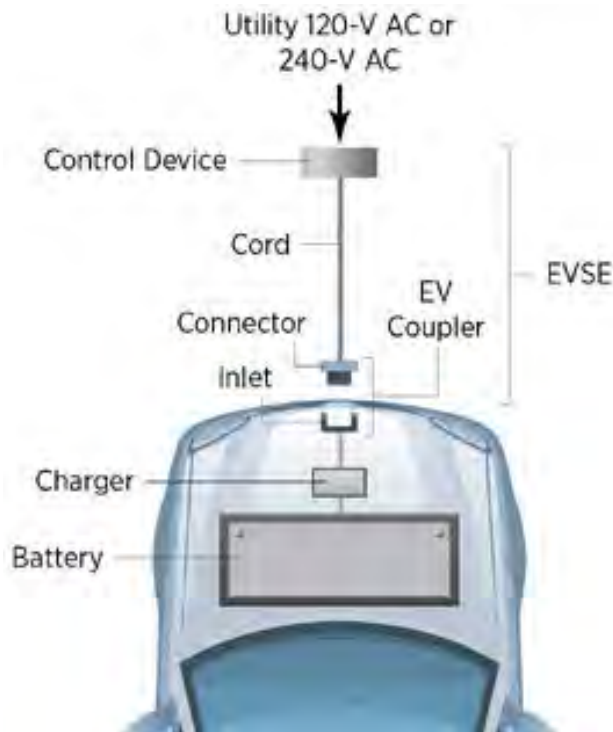


Photo from Angela Costanzo, NREL



Photo from WSDOT

Installation Costs – Level 1

Level 1 Installation

\$0-\$3,000



Photo from Steve Russell

Main L1 Installation Cost Factors

- Offer an existing electrical outlet for drivers to plug in cord set (\$0)
- Install an electrical outlet or a wall mounted Level 1 EVSE (\$300-\$1,000)
- Install a pedestal Level 1 EVSE (\$1,000-\$3,000 *assuming no major electrical work needed*)

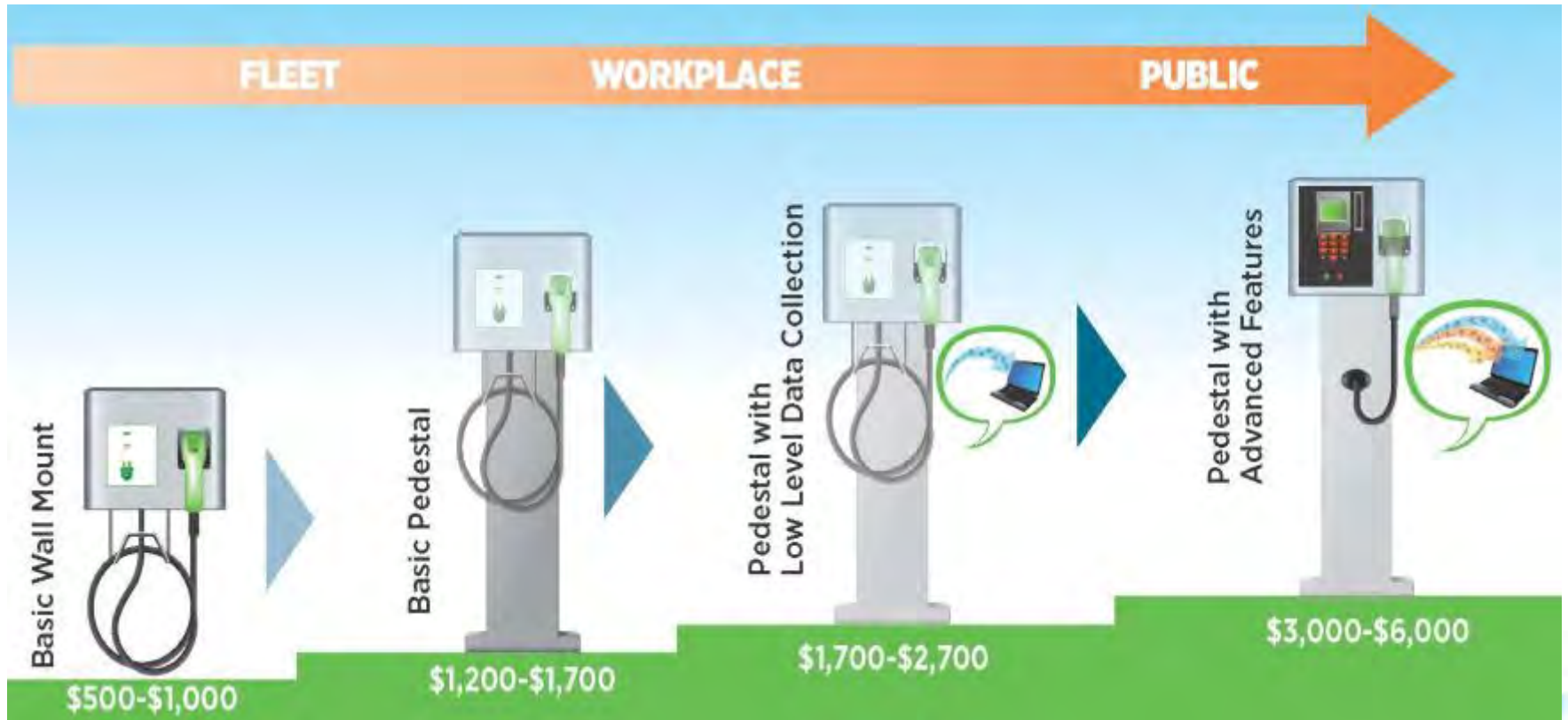
EVSE Unit Costs - Level 2

Level 2 EVSE Unit
(single port)
\$400-\$6,500

Main L2 EVSE Cost Factors

- Mounting (wall/pedestal)
- Communications capabilities
- Advanced features

Ballpark Cost Ranges for Level 2 EVSE



EVSE Unit Costs - DC Fast Charging

DCFC EVSE Unit

\$10K-\$40K

Main DCFC EVSE Cost Factors

- Power output ranges from 24-250kW (commonly 50-60kW)
- Number of ports (may have multiple connector standards but only charge one vehicle at a time)
- Advanced features



Photo from Don Karner



Photo from Margaret Smith

DCFC Connectors SAEJ1772 CCS and CHAdeMO



Photo from Margaret Smith

Installation Costs – Connecting EVSE to Electrical Service

Simple/lower cost – run conduit along the wall a short distance from the electrical service to the EVSE

Complex/higher cost – trench or bore through concrete to run conduit a long distance from electrical service to EVSE

Trenching cost varies by location but in some areas the cost for digging the trench, laying conduit, then back-filling is:

- \$10-\$20/ft. for soil
- \$100-\$150/ft. for asphalt or concrete



Photo from NYSERDA



Photo from INL

Concrete cut out and soil removed to access underground electric service



Photo from NYSERDA



Photo from INL

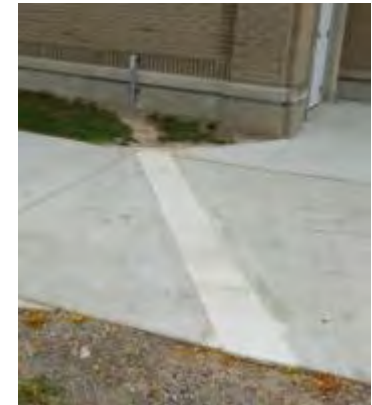


Photo from NYSERDA

Installation Costs – New Electrical Service or Upgrades



Photo from Don Karner



Photo from NYSERDA

3 Fundamental EVSE Electrical Needs

1. Sufficient electrical capacity from the utility connection to the electrical panel.
2. Sufficient electrical capacity at the panel.
3. A dedicated circuit for each EVSE unit on the electrical panel (in most cases).

Consult with electrician and utility to determine if electrical work is needed and estimate cost.

- **Service upgrade** – Increasing the electrical capacity from the utility to an existing electrical panel, e.g. new transformer. *\$10,000-\$25,000 (WCEH).*
- **New electrical service** – Bringing electricity from the utility to a site that did not previously have electricity. *\$3,500-\$9,500 (EV Project)*
- **Electrical panel work** – Replacing or upgrading the panel, re-working the panel to provide more breaker positions, or adding a sub-panel. Cost is very site specific. *About 72% of Level 2 commercial installations required panel work (EPRI)*

Tips for Minimizing EVSE Costs – EVSE Unit Selection

EVSE Unit Selection

- ❖ Minimum level of features needed
- ❖ Wall mounted EVSE unit (if possible)
- ❖ Dual port EVSE minimizes installation costs per charge port.
- ❖ Choose the quantity and level of EVSE units to fit within that available electrical capacity

Location

- ❖ Minimize the trenching/boring distance.
- ❖ Place the EVSE unit close to the electrical service
- ❖ Use signage to direct PEV drivers to the EVSE unit
- ❖ Choose a location that already has space on the electrical panel with a dedicated circuit

Long Term Planning

- ❖ Discuss electrical service needs and charges with your utility
- ❖ Avoid demand charges
- ❖ Upgrade your electrical service for your anticipated long term EVSE load and run conduit to your anticipated future EVSE locations.
- ❖ Consider the electricity infrastructure for EVSE when building a new facility

The Future for the Built Environment - Residential

Draft/suggested EV-Ready Regulations

- **N1104.2 (R404.2) Electric Vehicle Service Equipment (EVSE) Ready (Mandatory).** In accordance with 527 CMR and this section, at least one minimum 40-ampere branch circuit shall be provided to garages and/or the exterior of the building to accommodate a future dedicated Society of Automotive Engineers (SAE) standard J1772-approved Level 2 EVSE. The circuits shall have no other outlets. The service panel shall provide sufficient capacity and space to accommodate the circuit and over-current protective device. A permanent and visible label stating “EV READY” shall be posted in a conspicuous place at both the service panel and the circuit termination point.

Type of Building	Number of spaces
Single-family dwelling:	1
Two-family dwelling:	1
3 or more unit building:	1 per two units

One Final thought - Resiliency

Using the batteries in cars and Buses for:

Vehicle to grid (V2G) and Vehicle to Building (V2B)

- Managed charging
- Use battery storage to offset demand charges
- Charge battery with energy from renewables (solar or wind)
- Participate in energy markets



References and Resources

- AFDC Vehicle Cost Calculator (<http://www.afdc.energy.gov/calc/>)
- AFDC EV Emissions page (http://www.afdc.energy.gov/vehicles/electric_emissions.php)
- AFDC Alternative Fuel and Advanced Vehicle Search (<http://www.afdc.energy.gov/vehicles/search>)
- AFDC Station Locator Database (<http://www.afdc.energy.gov/locator/stations/>)
- FuelEconomy.gov's Alternative Fuel Vehicles (AFV) page (<http://www.fueleconomy.gov/feg/alternatives.shtml>)
- Clean Cities Plug-In Electric Vehicle Handbook for Fleet Managers (http://www.afdc.energy.gov/pdfs/pev_handbook.pdf)
- Clean Cities Plug-In Electric Vehicle Handbook for Workplace Charging Hosts (http://www.afdc.energy.gov/uploads/publication/pev_workplace_charging_hosts.pdf)
- Clean Cities Plug-In Electric Vehicle Handbook for Public Charging Station Hosts (<http://www.afdc.energy.gov/pdfs/51227.pdf>)
- Clean Cities 2015 Vehicle Buyer's Guide (<http://www1.eere.energy.gov/cleancities/publications.html>)
- Argonne National Laboratory's (ANL) *Well-to-Wheels Energy Use and Greenhouse Gas Emissions Analysis of Plug-in Hybrid Electric Vehicles* report (<http://www.transportation.anl.gov/pdfs/TA/559.pdf>)
- Electric Drive Transportation Associations (EDTA) Electric Drive Sales Dashboard (<http://electricdrive.org/index.php?ht=d/sp/i/20952/pid/20952>)
- National Fire Protection Association EV Safety Training (<http://www.evsaftytraining.org>)
- National Alternative Fuels Training Consortium First Responder Safety Training (http://www.naftc.wvu.edu/course_workshop_information/first_responders)
- Plug In America's Vehicle Tracker (<http://www.pluginamerica.org/vehicles>)

Additional Resources

1. Costs Associated with Non-Residential EVSE:
http://www.afdc.energy.gov/uploads/publication/evse_cost_report_2015.pdf
2. Alternative Fuel Data Center EVSE page: http://www.afdc.energy.gov/fuels/electricity_stations.html
3. Clean Cities' Plug-In Electric Vehicle Handbook for:
 - Workplace Charging Hosts:
http://www.afdc.energy.gov/uploads/publication/pev_workplace_charging_hosts.pdf
 - Fleet Managers: http://www.afdc.energy.gov/pdfs/pev_handbook.pdf
 - Public Charging Station Hosts: <http://www.afdc.energy.gov/pdfs/51227.pdf>
 - Consumers: http://www.afdc.energy.gov/uploads/publication/pev_consumer_handbook.pdf
 - Electrical Contractors: <http://www.afdc.energy.gov/pdfs/51228.pdf>
4. INL Lessons Learned papers from the EV Project: <http://avt.inl.gov/evproject.shtml>
5. Electric Vehicle Supply Equipment Installed Cost Analysis study by EPRI:
<http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002000577>
6. DOE Workplace Charging Challenge: <http://energy.gov/eere/vehicles/ev-everywhere-workplacecharging-challenge>
 - ADA Guidance: <http://energy.gov/eere/vehicles/ada-requirements-workplace-charging-installation>
 - Signage Guidance: <http://energy.gov/eere/vehicles/workplace-charging-challenge-signage-guidance>
 - Request for Proposal Guidance: <http://energy.gov/eere/vehicles/downloads/request-proposal-guidance>
7. Siting and Design Guidelines for EVSE:
http://www.transportationandclimate.org/sites/www.transportationandclimate.org/files/EV_Siting_and_Design_Guidelines.pdf

Contact Information

Thank You

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Workplace Charging Resources

Workplace Charging Challenge

<http://www.energy.gov/eere/vehicles/ev-everywhere-workplace-charging-challenge>

PEV Handbook for Workplace Charging Hosts

http://www.afdc.energy.gov/uploads/publication/pev_workplace_charging_hosts.pdf

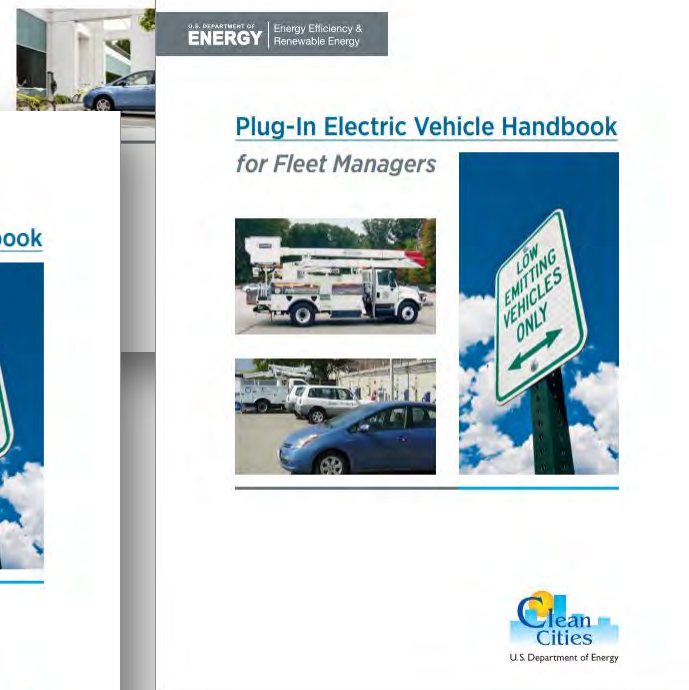
More PEV and Charging Information:

http://www.afdc.energy.gov/fuels/electricity_basics.html



Helpful Resource:

Clean Cities PEV Handbooks are great resources for fleet managers, station owners, and individuals who are ready to start using PEVs and infrastructure.



afdc.energy.gov/publications