Electric vehicle overview

Building In The Age of Electric Vehicles

Stephen Russell
Department of Energy Resources
Massachusetts Clean Cities Coalition
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**EV Basics: Benefits and Considerations**

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Considerations</th>
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<tbody>
<tr>
<td>• Increased energy security</td>
<td>• Higher initial vehicle cost</td>
</tr>
<tr>
<td>• Improved fuel economy</td>
<td>• Limited infrastructure availability</td>
</tr>
<tr>
<td>• Lower fuel costs</td>
<td>• Battery life</td>
</tr>
<tr>
<td>• Low or zero tailpipe emissions</td>
<td>• Reduced all-electric range</td>
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</tbody>
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**Image:** NREL Image Gallery #28974
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.

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

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Photo from Angela Costanzo, NREL

Photo from WSDOT
Installation Costs – Level 1

Level 1 Installation

$0-$3,000

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)
**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**
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

DCFC Connectors
SAEJ1772 CCS and CHAdeMO
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

**Concrete cut out and soil removed to access underground electric service**
Installation Costs – New Electrical Service or Upgrades

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

**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

**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
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.

<table>
<thead>
<tr>
<th>Type of Building</th>
<th>Number of spaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-family dwelling:</td>
<td>1</td>
</tr>
<tr>
<td>Two-family dwelling:</td>
<td>1</td>
</tr>
<tr>
<td>3 or more unit building:</td>
<td>1 per two units</td>
</tr>
</tbody>
</table>
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/)
- Clean Cities Plug-In Electric Vehicle Handbook for Public Charging Station Hosts (http://www.afdc.energy.gov/pdfs/51227.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)
1. Costs Associated with Non-Residential EVSE: 


3. Clean Cities’ Plug-In Electric Vehicle Handbook for:
   • Workplace Charging Hosts: 
   • Public Charging Station Hosts: http://www.afdc.energy.gov/pdfs/51227.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

   • ADA Guidance: http://energy.gov/eere/vehicles/ada-requirements-workplace-charging-installation
   • Signage Guidance: http://energy.gov/eere/vehicles/workplace-charging-challenge-signage-guidance

7. Siting and Design Guidelines for EVSE: 
Contact Information

Thank You

Stephen Russell
Email: stephen.russell@state.ma.us
100 Cambridge Street Suite 1020
Boston MA 02114
617 626-7325
Workplace Charging Resources

Workplace Charging Challenge
http://www.energy.gov/eere/vehicles/ev-everywhere-workplace-charging-challenge

PEV Handbook for Workplace Charging Hosts

More PEV and Charging Information:
http://www.afdc.energy.gov/fuels/electricityBasics.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