EV Champion Training

Webinar 3: EV Site Design

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FEMP EV Champion Training Curriculum

EV Technology
- ICE, HEV, PHEV, BEV
- L1, L2, DCFC
- FAST VLD Reporting

EV Financials
- EV TCO calculations
- Utility bill analysis
- FAST EVSE reporting

EVSE & Energy
- EVSE charging/install
- Electric service review
- Working with your utility

Site Design
- Equipment requirements
- Construction planning
- Utility interconnection

Site Operations
- Advanced Technology
- Managed charging
- Cybersecurity considerations

Training 1

Training 2

Training 3

Training 4

July 12th

Today

July 12th
Course Learning Objectives:
• Understand how to perform basic EV site assessments
• Assess equipment upgrades for EVSE
• Minimize construction costs through planning
• Collaborate with local utility
• Plan for future expansion

Continuing Education Units:
• Navigate through WBDG to “My Account”
• “Proceed to Course”
• “Course Post Test”

Questions and Answers:
• Ask through “Q+A”
• Panelists will monitor “Chat” as well
• We address most questions at the end of each section
Agenda

01 Recap webinar 1 and 2
02 Infrastructure Requirements & Design Guidelines
03 Site Assessment Example
04 GSA BPA offerings
05 Electric Vehicles Supply Equipment and Fleets, Xcel Energy
EV Session 1

Key Federal Legislation


Energy Independence and Security Act (EISA) of 2007, Section 141

EO 14008, Tackling the Climate Crisis at Home and Abroad

EO 14057, Catalyzing America’s Clean Energy Industries and Jobs through Federal Sustainability
**EV Session 1**

**EV technology**

- **eGallon**
- BEVs and PHEVs are considered ZEVs. Hybrids are not ZEVs.
- EPA Fuel Economy Label $\rightarrow$ Fuel Consumption Rate

**Useful formulas**

\[
\text{Fueling Cost} = \text{Fuel Consumption Rate} \times \text{Fuel Price}
\]

\[
\text{Charging energy (kWh)} = \text{Efficiency (kWh/mi)} \times \text{Distance (miles)}
\]

\[
\text{Charge Time (hours)} = \frac{\text{Energy (kWh)}}{\text{Power (kW)}}
\]

**Utility Bill**

\[
= \text{Flat Charge} + \text{Demand Charge} + \text{Energy Charge}
\]
EV Session 2

EVSE

- Power level (level 1, 2, 3)
- Connector types (SAE J1772, CSS, CHAdeMo)

Useful formulas

- Charging energy requirement: \[ \frac{kWh}{charge} = \text{VMT} \times \text{Fuel Consumption Rate} \frac{KWh}{mile} \]
- Power Demand (kW): \[ \frac{kWh}{charge} \frac{kWh}{mile} \]
- Total Charging energy requirement: \[ \frac{KWh}{charge} \frac{kWh}{mile} \]
- Charging Window (hours)

- Power (Watts): \[ \text{Current}(A) \times \text{Voltage}(V) \]
National Electric Code Section 625

Branch Circuits: Each EVSE permanently installed must be supplied by an individual branch circuit.

Overcurrent Protection: Circuit breakers must be sized for 125% of the maximum EVSE load.

Useful formulas

**Level 1:** \(16 \times 1.25 = 20 \text{ A Breaker}\)

**Level 2:** \(32 \times 1.25 = 40 \text{ A Breaker}\)

Electrical requirements

1-phase and 3-phase services accommodate Level 1 or 2 units.
Article 625’s requirements boil down to following the manufacturer’s instructions

Markings

“For Use With Electric Vehicles”
“Ventilation Not Required”

Control and protection

Personal protection system

EV supply equipment shall have listed protection against personnel shock

Overcurrent protection

The maximum rated EVSE that could be installed on a 50A circuit is 40A rated equipment.

Location

Indoor or outdoor

Avoid flood zone

Indoor: 18” – 48”
Outdoor: 24” - 48” above the finished grade.
EVSE CONFIGURATIONS

Reference [1]
Agenda

01 Recap webinar 1 and 2

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03 Site Assessment Example

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05 Electric Vehicles Supply Equipment and Fleets, Xcel Energy
Infrastructure Requirements & Design Guidelines

**Vehicles**
Choose vehicles and technology.
- # of PHEVs
- # of BEVs

**EVSE**
Choose EVSE type and quantity.
- SSAE Level 1/2
- SAE CCS/CHAdeMO

**Analysis**
Determine necessary upgrades.
- Service Panel
- Circuit Breakers

**Utility**
Contact utility rep regarding new load.
- Equipment Upgrades
- Utility Rates

**Construction**
Install new infrastructure.
- Conduit/wiring
- EVSE
ZPAC

Zero Emission Vehicle (ZEV) Planning and Charging
Zero Emission Vehicle (ZEV) Planning and Charging (ZPAC) Tool
CEQ | FEMP | GSA

Identify ZEV Opportunities
Target Charging Stations
ZPAC – Identify Best ZEV Opportunities

Vehicle type ZEV replacement available?

Nightly charging sufficient? Limit mission disruption

Fuel, cost, and emissions benefits?

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Site Name (Entry Necessary to relate to EVSE Needs &amp; Prioritization Tab)</th>
<th>BEV SIN Availability</th>
<th>BEV Replacement SIN</th>
<th>Modeled BEV Range Concerns</th>
<th>Reported BEV Range Concerns (Dropdown)</th>
<th>BEV GHG Emission Reduction Potential</th>
<th>Quality of BEV Candidate</th>
<th>ZEV Preference (Agency Entry from Dropdown)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIN 6</td>
<td>GARAGE 1</td>
<td>1 - Identical BEV</td>
<td>9E</td>
<td>5 - Very Frequent Public Charging Likely</td>
<td>2 - Some Public Charging Likely</td>
<td>2 - High</td>
<td>2 - Good</td>
<td>BEV</td>
</tr>
<tr>
<td>VIN 7</td>
<td>GARAGE 1</td>
<td>3 - Consider PHEV</td>
<td>20P</td>
<td>5 - Very Frequent Public Charging Likely</td>
<td>1 - Minimal Public Charging Likely</td>
<td>2 - High</td>
<td>5 - Consider PHEV</td>
<td>PHEV</td>
</tr>
<tr>
<td>VIN 8</td>
<td>GARAGE 1</td>
<td>3 - Consider PHEV</td>
<td>20P</td>
<td>5 - Very Frequent Public Charging Likely</td>
<td>2 - High</td>
<td>5 - Consider PHEV</td>
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<tr>
<td>VIN 9</td>
<td>GARAGE 1</td>
<td>3 - Consider PHEV</td>
<td>20P</td>
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<td>1 - Very High</td>
<td>5 - Consider PHEV</td>
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<tr>
<td>VIN 10</td>
<td>GARAGE 1</td>
<td>4 - No FY22 ZEV Option</td>
<td>2 - High</td>
<td>5 - Consider PHEV</td>
<td>3 - Mediocre</td>
<td>3 - Mediocre</td>
<td>Other BEV</td>
<td></td>
</tr>
</tbody>
</table>

Output: # of BEVs & PHEVs at each site
FleetDASH AFV Screening Tool: Using Fueling Transactions to ID ZEV Candidates

Which vehicles have the greatest petroleum reduction potential?
Which technologies provide greatest cost savings?

The light-duty vehicle table displays the total fuel used in the prior fiscal year and estimates petroleum savings based on available AFVs in the existing vehicle segment and the availability of alternative fuel stations near the existing vehicle’s transactions from the prior fiscal year. AFV options that result in annual operating cost savings are shaded.

Download CSV

<table>
<thead>
<tr>
<th>VIN</th>
<th>Tag</th>
<th>Vehicle Segment</th>
<th>Total GGEs</th>
<th>BEV</th>
<th>PHEV</th>
<th>HEV</th>
<th>E85</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Sedan/St Wgn Subcompact</td>
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<td>118</td>
<td>72</td>
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<tr>
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<td>115</td>
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<td>107</td>
<td>81</td>
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<tr>
<td></td>
<td></td>
<td>Sedan/St Wgn Compact</td>
<td>102</td>
<td>102</td>
<td>77</td>
<td>38</td>
<td></td>
</tr>
</tbody>
</table>

* GGEs reduced compared to a base case where prior year GGE consumption is all petroleum use.

Estimated Annual Operating Cost Savings:
- > $500
- > $250
- > $0 - $250
- Added costs

Showing 1 to 10 of 200 entries
# Site Design Element

<table>
<thead>
<tr>
<th>Installation</th>
<th>Access</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charge Level</td>
<td>Network Connection</td>
<td>Host-Operator Agreements</td>
</tr>
<tr>
<td>Proximity to Power</td>
<td>Accessibility</td>
<td>Visibility</td>
</tr>
<tr>
<td>Mounting Approach</td>
<td>Proximity to Traffic</td>
<td>Location in Lot</td>
</tr>
<tr>
<td>Number of Cord Sets</td>
<td>Proximity to Building Entrance</td>
<td>Metering</td>
</tr>
<tr>
<td>Parking Space Dimensions</td>
<td></td>
<td>Future-Proofing</td>
</tr>
<tr>
<td>Environmental Conditions</td>
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<tr>
<td>Technology</td>
<td>Lighting</td>
<td></td>
</tr>
<tr>
<td>Hazards</td>
<td>Signage and Wayfinding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pedestrian Traffic</td>
<td></td>
</tr>
</tbody>
</table>

What type of EVSE to install?

User experience

day-to-day use of the EVSE

Reference [5]
The wider and/or longer parking spaces in a parking facility are usually best for installing EV charging stations.

Reference [1]
Rules of Thumb for EVSE

- Level 1 for PHEVs
- Level 2 for BEVs
- Use ENERGY STAR-certified charging equipment
- Install Level 2 charging equipment that can supply multiple parking spaces
- Prioritize sites where you want to install a lot of EVSE
- Install charging equipment closest to electrical supply services
- Consider utility incentives, site constraints, and simplicity of installation in prioritization
- Install more EVSE than you need for year one
- ~50% as many EVSE ports as LDVs at site is a good goal
Without power, there is no charge
Models for Utility Engagement

Models of Utility Investment in Electrical Vehicle Charging Infrastructure

Source: M.J. Bradley & Associates
Electric Infrastructure

From left to right: (1) pole-mounted transformers; (2) surface-mounted transformer and electrical panels; (3) circuit breakers in electrical panel

Reference [1]
Classification of Electrical Services

• **Frequency:** 50 Hz or 60 Hz
• **Number of phases:** single or three phase
• **Number of wires:** 2, 3, or 4 (not counting the safety ground)
• **Neutral present:**
  • *Wye* connected systems have a neutral
  • *Delta* connected systems typically do not have a neutral
• **Voltage classes:** (ANSI C84.1-2016)
  • **Low Voltage:** 1000 volts or less
  • **Medium Voltage:** greater than 1000 volts and less than 100 kV
  • **High Voltage:** greater than 100 kV and equal to or less than 230 kV
  • **Extra-High Voltage:** greater than 230 kV but less than 1000 kV
  • **Ultra-High Voltage:** equal to or greater than 1000 kV
# Power Interface

<table>
<thead>
<tr>
<th>Rate Plans</th>
<th>Rate Description</th>
<th>Panel Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Residential Plan</strong></td>
<td><strong>Tiered Rate</strong>&lt;sup&gt;*&lt;/sup&gt; Home and electric vehicle loads measured together</td>
<td>Use Existing Panel</td>
</tr>
<tr>
<td>(D) Single Meter</td>
<td></td>
<td>Option #1 (likely no meter change)</td>
</tr>
<tr>
<td><strong>Home &amp; Electric Vehicle Plan</strong></td>
<td><strong>Time of Use Tiered Rate</strong>&lt;sup&gt;*&lt;/sup&gt; Home and electric vehicle loads measured together; rates higher during the day and lower at night</td>
<td>N/A</td>
</tr>
<tr>
<td>(TOU-D-TEV) Single Meter</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Electric Vehicle Plan</strong></td>
<td><strong>Time of Use Rate</strong> Electric vehicle load metered separately from home load; home remains on current rate and meter; electric vehicle rate is higher during the day and lower at night</td>
<td>N/A</td>
</tr>
<tr>
<td>(TOU-EV-1) Two Meters</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
EVSE Needs

Will power sharing features mean I need half as many EVSE as EVs?

EVSE needs are dependent on different factors:
- Vehicle energy needs (daily VMT)
- Vehicle dwell period (charging opportunity)
- Parking capabilities (# of parking spots)
- Congestion (coincident vehicles)
- And more...

- Overestimate needs but consider where EVSE can be reduced.
  - Telematics analysis helps!
EV Utility Finder (EV U-Finder)

**EV U-Finder: Electric Vehicle Utility Finder**

Enter Zip Code to identify local utilities, electric vehicle support programs, and Clean Cities Coordinators.

**Utility Associations**
- State Level Incentives
  - State Incentives
  - Federal Tax Credits
  - Utility Incentives
- Additional Incentive Search Tools
  - Alternative Fuel Data Center (AFDC) Non-Incentives
  - Incentives for Clean Fuels (CCF)
  - Incentives for Clean Fuels (CCF)

**Identified Incentive Details**

**Edition Electric Incentive Investor Owned Utility Incentives**

**Website URLs for Additional Information**

- [https://www.energy.gov/eere/femp/electric-vehicles-toolkit](https://www.energy.gov/eere/femp/electric-vehicles-toolkit)
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Site Assessment 1
Site Assessment 1

Fleet’s Requirements

- 5 LD ICE Vehicles → 5 ZEVs
- Operated: 5 days/week from 9 am-5pm
- Average daily travel (VMT) ~ 50 miles
  - Occasional longer trips
  - Unpredictable schedule
  - AWD preferred

Design Note

The Outlander’s 13.8 kWh battery can be fully recharged in 3.7 hours with a Level 2 EVSE. This is limited by the 3.7 kW on-board charger.

Range 24 miles on electricity/320 miles

https://www.fueleconomy.gov/feg/Find.do?action=sbs&id=44460
Worksheet – EV Adoption Plan

1. Which vehicles in your fleet are good candidates for electrification?
   a. Consider daily vehicle miles traveled (VMT) and assess travel consistency and garage locations.
   b. Estimate the daily energy needs for each vehicle.
   c. Review BEV and PHEV options while considering each vehicle’s rated electric range.

**EV Adoption Plan:**

Vehicle Fuel consumption Rate = 45 kWh/100 miles

Energy (kWh) = 24 miles * 45 kWh/100 miles

= 10.8 kWh*/vehicle/ day

*Total Charging energy requirement* = 10.8 kWh* 5(vehicles)

= 54 kWh/day

*daily electricity needs per vehicle, assuming no mid-day charging

**Pro Tips:**

- Consistent parking locations create opportunities for daily charging.
- BEVs are ideal for use cases with a majority of daily VMT less than the rated range (e.g., 98% of days within the 250-mile Chevrolet Bolt range)
- Extreme temperature days can negatively impact driving range and may require mid-day charging.
- PHEVs are great for vehicles with varying travel & garage locations where frequent mid-day charging would be a challenge.
- Most BEV sedans operate at an efficiency around 3.6 mi/kWh so a 50 kWh battery pack should translate to 180 miles of range.

\[ \text{Energy (kWh)} = \frac{\text{miles}}{3.6} \]
## Site Assessment 1: Charging Window

### When is the best time to charge your EV?

Average power demand (\(kW\)) = \[\frac{54 \text{ kWh}}{\text{Charging Window (hours)}}\]

**Vehicle in operation**

<table>
<thead>
<tr>
<th>Time</th>
<th>Average power demand ((kW))</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00 AM - 5:00 AM</td>
<td>$$$</td>
</tr>
<tr>
<td>6:00 AM - 8:00 AM</td>
<td>$$$</td>
</tr>
<tr>
<td>9:00 AM - 10:00 PM</td>
<td>$$$</td>
</tr>
</tbody>
</table>

**Vehicle in operation**

Per-vehicle charging rate (\(kW\)) = \[\frac{6.75 \text{ kW}}{5 \text{ vehicles}} = 1.35 \text{ kW/vehicle}\]
Worksheet – EVSE Requirements

**Per-vehicle charging rate (kW) = 6.75 kW ÷ 5 vehicles = 1.35 kW/vehicle**

2. **What type and how many EVSE units will be needed for these EVs?**
   a. Estimate recharge session duration for Level 2 EVSE, based on daily vehicle energy needs.
   b. Compare vehicle recharge times to typical dwell periods to estimate EVSE needs.
   c. Consider how vehicles could share EVSE infrastructure based on vehicle dwell and charge times.

<table>
<thead>
<tr>
<th>AC Level 1</th>
<th>1.35 kW &lt; 1.9 kW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design Note</strong></td>
<td>The level of battery charge, connector speed, and on-board charger will be tailoring to energy &amp; installation requirements</td>
</tr>
</tbody>
</table>

**EVSE Requirements:**

**Daily Vehicle Energy Needs: 10.8 kWh**

**AC Level 1:** (120 V x 16 A = 1.9 kW)

Charge time: 10.8 kWh / 1.9 kW = 5.7 hours

Additional panel capacity for 5 Level 1 units

16 A x 1.25 x 5 = 100 A

**AC Level 2:** (240 V x 32 A = 7.7 kW) ➔ 3.7 kW*

Charge time: 10.8 kWh / 3.7 kW = 3 hours

Additional panel capacity for 3 L2 dual-port units

32 A x 1.25 x 6 = 240 A

*On-board charger limitation

**Pro Tips:**

- Typical Level 2 EVSE operates around 7 kW (1.5 kW for Level 1)
  
  \[ \text{Session (hrs)} = \frac{\text{Energy (kWh)}}{\text{Power (kW)}} \]

- Every 25 miles a vehicle travels will require about one hour to charge with most Level 2 EVSE units.
- Most fleet BEV applications use Level 2 charging, but some three-shift operations require DCFC and low VMT applications or PHEVs could use Level 1
- Depending on energy needs and usage patterns fleets do not always require a 1:1 ratio of EVSE to EVs.
- The EVSE to EV ratio can become more flexible with more EVs based in a single location.

**Design Note**

Wall mount units and dual port units offer the most affordable unit prices per port.