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

Training 1

EVSE & Energy

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

Training 2

Site Design

- Equipment requirements
- Construction planning
- Utility interconnection

Training 3

Site Operations

- Advanced Technology
- Managed charging
- Cybersecurity considerations

July 12th

Training 4

Training 3: EV Site Assessment

Course Learning Objectives:

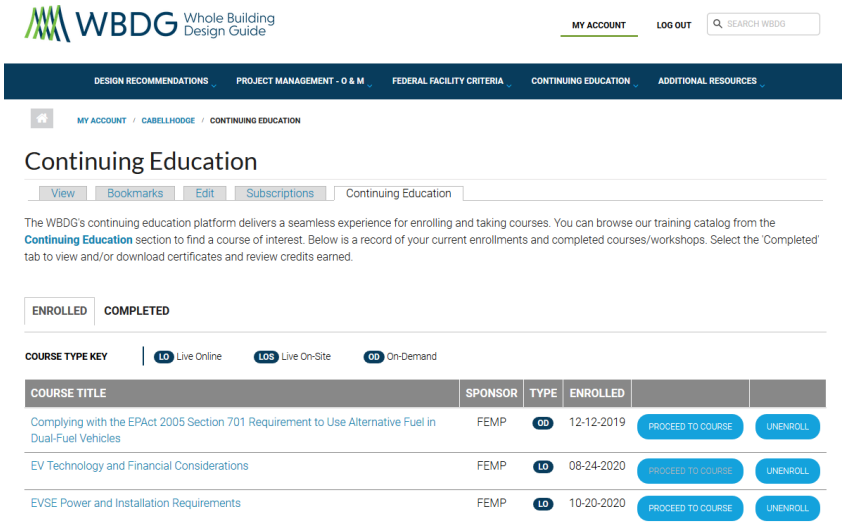
- Understand how to perform basic EV site assessments
- Assess equipment upgrades for EVSE
- Minimize construction costs through planning
- Collaborate with local utility
- Plan for future expansion

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**

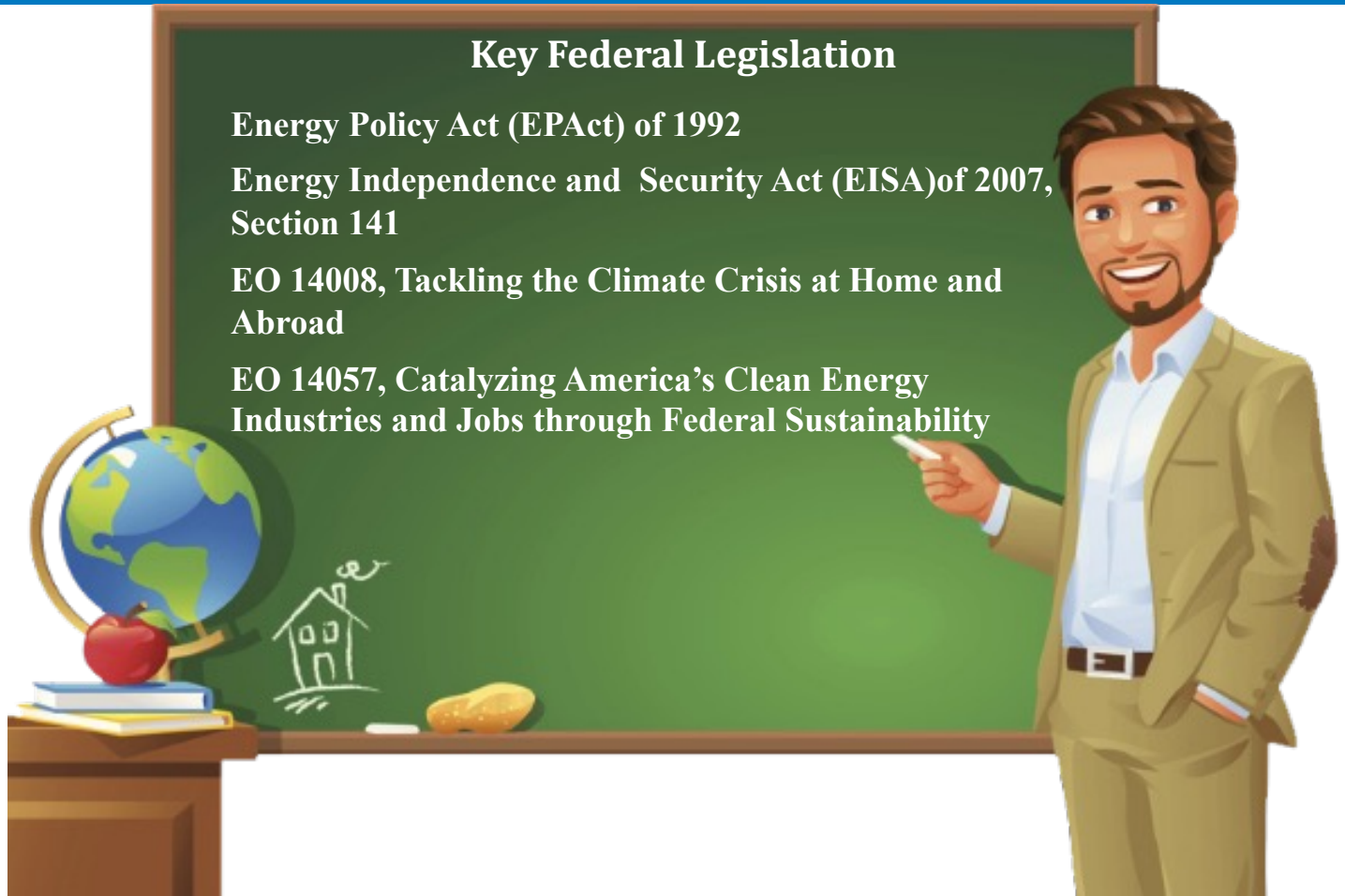
02 **Infrastructure Requirements & Design Guidelines**

03 **Site Assessment Example**

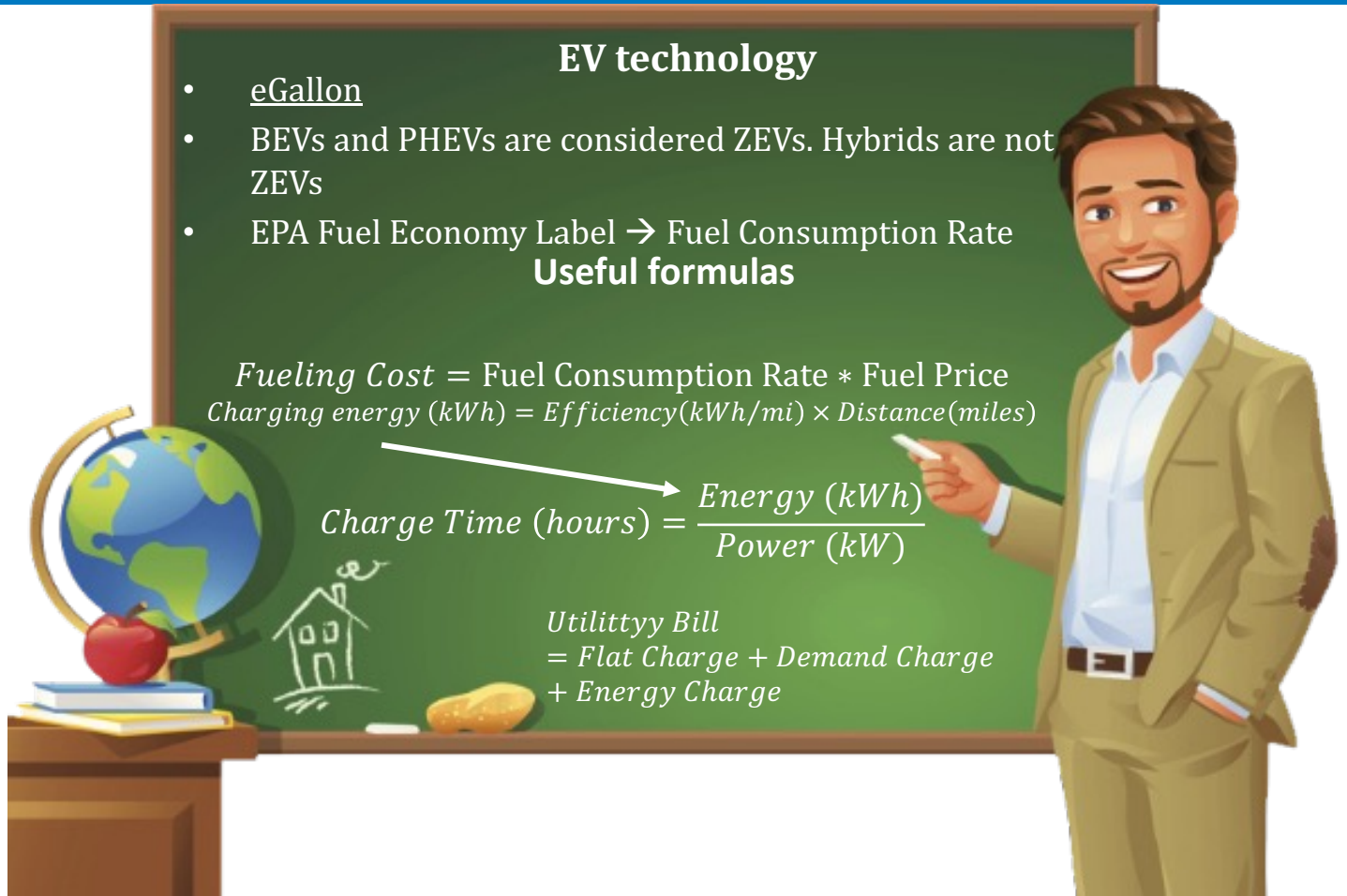
04 **GSA BPA offerings**

05 **Electric Vehicles Supply Equipment and Fleets, Xcel Energy**

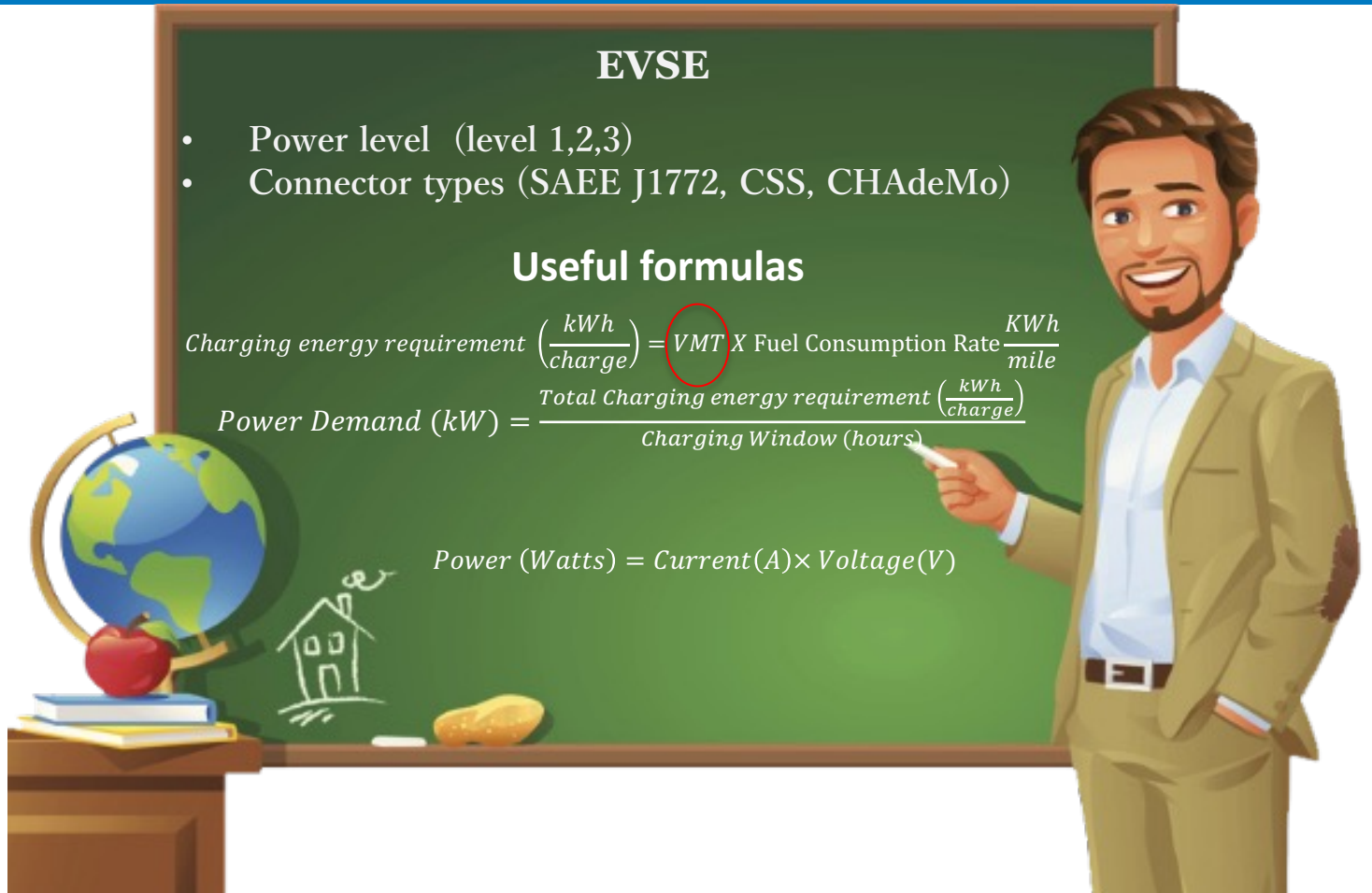
EV Session 1


Key Federal Legislation
Energy Policy Act (EPAct) of 1992
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

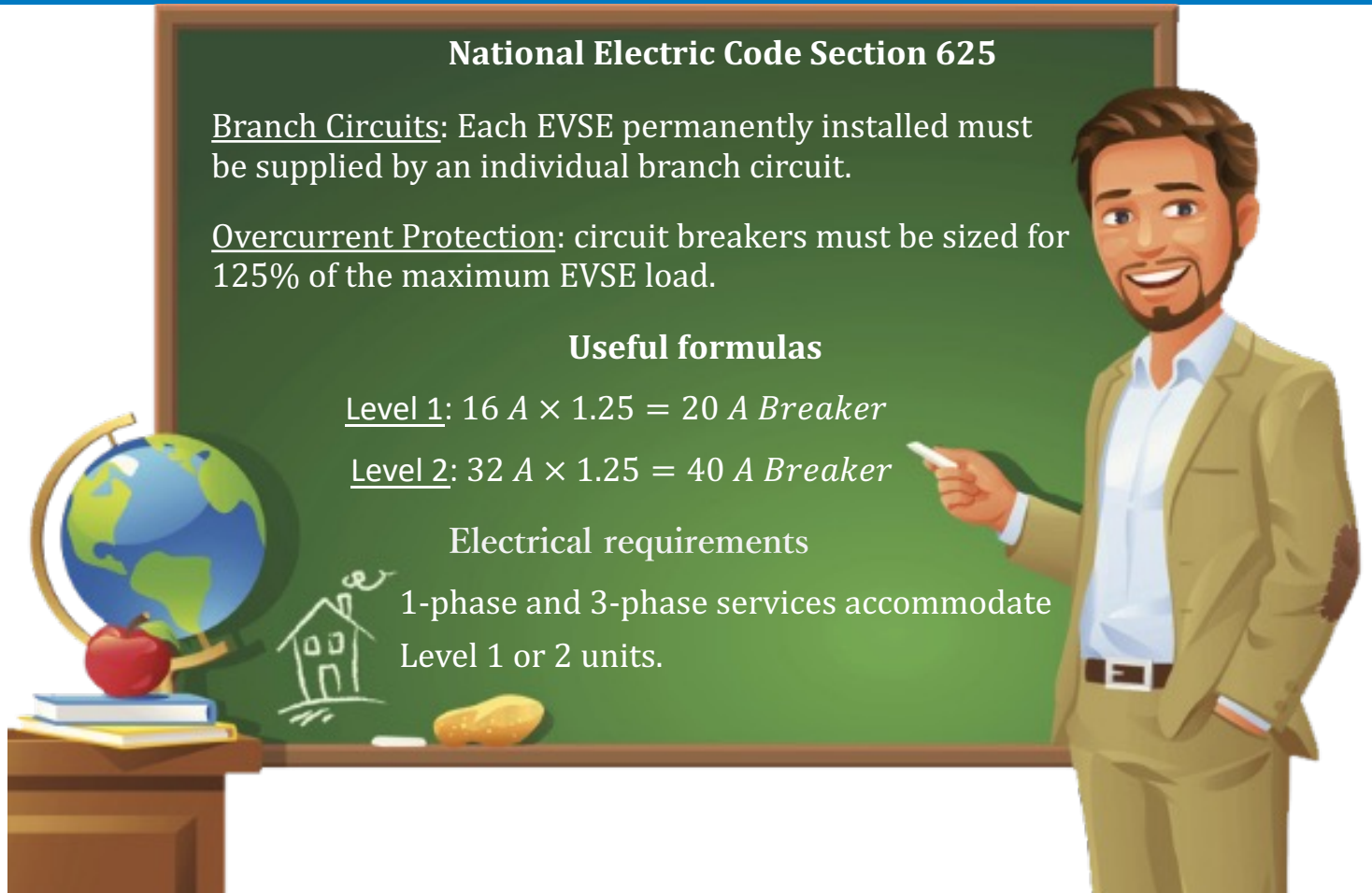
EV Session 1


EV technology
• eGallon
• BEVs and PHEVs are considered ZEVs. Hybrids are not ZEVs
• EPA Fuel Economy Label → Fuel Consumption Rate
Useful formulas
Fueling Cost = Fuel Consumption Rate * Fuel Price
Charging energy (kWh) = Efficiency(kWh/mi) × Distance(miles)
Charge Time (hours) = Energy (kWh) / Power (kW)
Utilittyy Bill
= Flat Charge + Demand Charge
+ Energy Charge

EV Session 2


EVSE
• Power level (level 1,2,3)
• Connector types (SAEE J1772, CSS, CHAdeMo)
Useful formulas
Charging energy requirement $\left(\frac{kWh}{charge}\right)$ = VMT X Fuel Consumption Rate $\frac{KWh}{mile}$
Power Demand $(kW) = \frac{Total\ Charging\ energy\ requirement\ \left(\frac{kWh}{charge}\right)}{Charging\ Window\ (hours)}$
Power $(Watts) = Current(A) \times Voltage(V)$

EV Session 2


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 A × 1.25 = 20 A Breaker
Level 2: 32 A × 1.25 = 40 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"

c UL us LISTED

c ETL us LISTED Intertek

ELECTRIC VEHICLE CHARGING STATION
FOR USE WITH ELECTRIC VEHICLES
MODEL NUMBER: HCS-40
PART NUMBER: 0909-00-003
SERIAL NUMBER: HC1C161044633
CONFIGURATION: HCS-40-C13-L25-45
Intertek 4003190

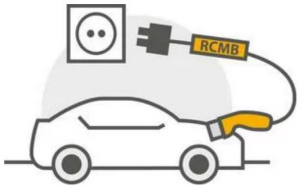
40A BRANCH CIRCUIT PROTECTOR
INPUT: 208-240 VAC, 50/60Hz, 120V TO GND
32AMPS CONTINUOUS
OUTPUT: 208-240 VAC, 50/60Hz, 120V TO GND
32AMPS CONTINUOUS
SHORT CIRCUIT RATING:
5000RMS SYMMETRICAL AMPS at 240VAC
SAE J1772 COMPLIANT / TYPE 4 ENCLOSURE
AMBIENT TEMPERATURE RATING: -30°C to +50°C

LA STATION DE RECHARGE POUR UTILISATION
AVEC DES VÉHICULES ÉLECTRIQUES
NUMÉRO DE MODEL: HCS-40
NUMÉRO DE PIÈCE: 0909-00-003
NUMÉRO DE SÉRIE: HC1C161044633
CONFIGURATION: HCS-40-C13-L25-45
Intertek 4003190

40A PROTECTOR DE CIRCUITS DE DÉRIVATION
ENTRÉE: 208-240 VAC, 50/60Hz, 120V À LA TERRE
32AMPS CONTINU
SORTIE: 208-240 VAC, 50/60Hz, 120V À LA TERRE
32AMPS CONTINU
CLASSIF DE COURT-CIRCUIT:
5000RMS SYMÉTRIQUE AMPS À 240VAC
SAE J1772 CONFORME / COFFRET TYPE 4
TEMPÉRATURE NOMINALE: -30°C to +50°C

Control and protection

nec



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

Level 1 EV supply equipment

Level 2 EV supply equipment

DC fast charger

Reference [1]

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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.

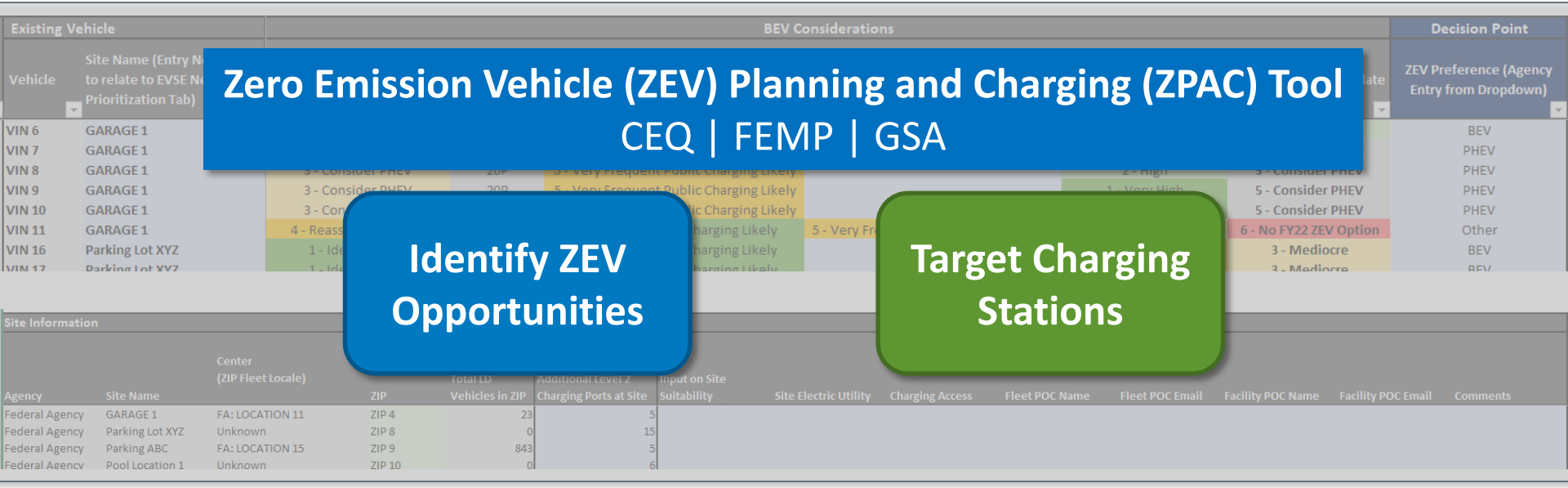
Conduit/wiring
EVSE

ZPAC

Zero Emission Vehicle (ZEV) Planning and Charging

ZPAC

CEQ: The White House Council on Environmental Quality
FEMP: Department of Energy Federal Energy Management Program Federal Fleet Management
GSA: U.S. General Services Administration Fleet



ZPAC – Identify Best ZEV Opportunities

Output:
# of BEVs & PHEVs at each site

Existing Vehicle		BEV Considerations						Decision Point
Vehicle	Site Name (Entry Necessary to relate to EVSE Needs & Prioritization Tab)	BEV SIN Availability	BEV Replacement SIN	Modeled BEV Range Concerns*	Reported BEV Range Concerns (Dropdown)	BEV GHG Emission Reduction Potential	Quality of BEV Candidate	ZEV Preference (Agency Entry from Dropdown)
VIN 6	GARAGE 1	1 - Identical BEV	9E	5 - Very Frequent Public Charging Likely	2 - Some Public Charging Likely	2 - High	2 - Good	BEV
VIN 7	GARAGE 1	3 - Consider PHEV	20P	5 - Very Frequent Public Charging Likely	1 - Minimal Public Charging Likely	2 - High	5 - Consider PHEV	PHEV
VIN 8	GARAGE 1	3 - Consider PHEV	20P	5 - Very Frequent Public Charging Likely		2 - High	5 - Consider PHEV	PHEV
VIN 9	GARAGE 1	3 - Consider PHEV	20P	5 - Very Frequent Pub		1 - Very High	5 - Consider PHEV	PHEV
VIN 10	GARAGE 1			5 - Very Frequent Pub			5 - Consider PHEV	PHEV
V		4		1 - Minimal Public	Public Charging Like		6 - No FY22 ZEV Option	Other
V				1 - Minimal Public			3 - Mediocre	BEV
V				1 - Minimal Public			3 - Mediocre	BEV

Vehicles by garage location

Vehicle type ZEV replacement available?

Nightly charging sufficient?
Limit mission disruption

Fuel, cost, and emissions benefits?

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

Search:

Fiscal Year 2020 Light-Duty Vehicle Data				Estimated Petroleum GGEs Reduced*			
VIN	Tag	Vehicle Segment	Total GGEs	BEV	PHEV	HEV	E85
[redacted]	[redacted]	Sedan/St Wgn Subcompact	159	159	118	72	N/A
[redacted]	[redacted]	Sedan/St Wgn Compact	151	151	115	56	N/A
[redacted]	[redacted]	Sedan/St Wgn Compact	145	145	110	54	N/A
[redacted]	[redacted]	Sedan/St Wgn Compact	135	135	95	31	N/A
[redacted]	[redacted]	Sedan/St Wgn Compact	128	128	90	29	N/A
[redacted]	[redacted]	Sedan/St Wgn Compact	126	126	89	29	N/A
[redacted]	[redacted]	Sedan/St Wgn Compact	118	118	89	44	N/A
[redacted]	[redacted]	Sedan/St Wgn Compact	108	108	76	25	N/A
[redacted]	[redacted]	Sedan/St Wgn Compact	107	107	81	40	N/A
[redacted]	[redacted]	Sedan/St Wgn Compact	102	102	77	38	N/A

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

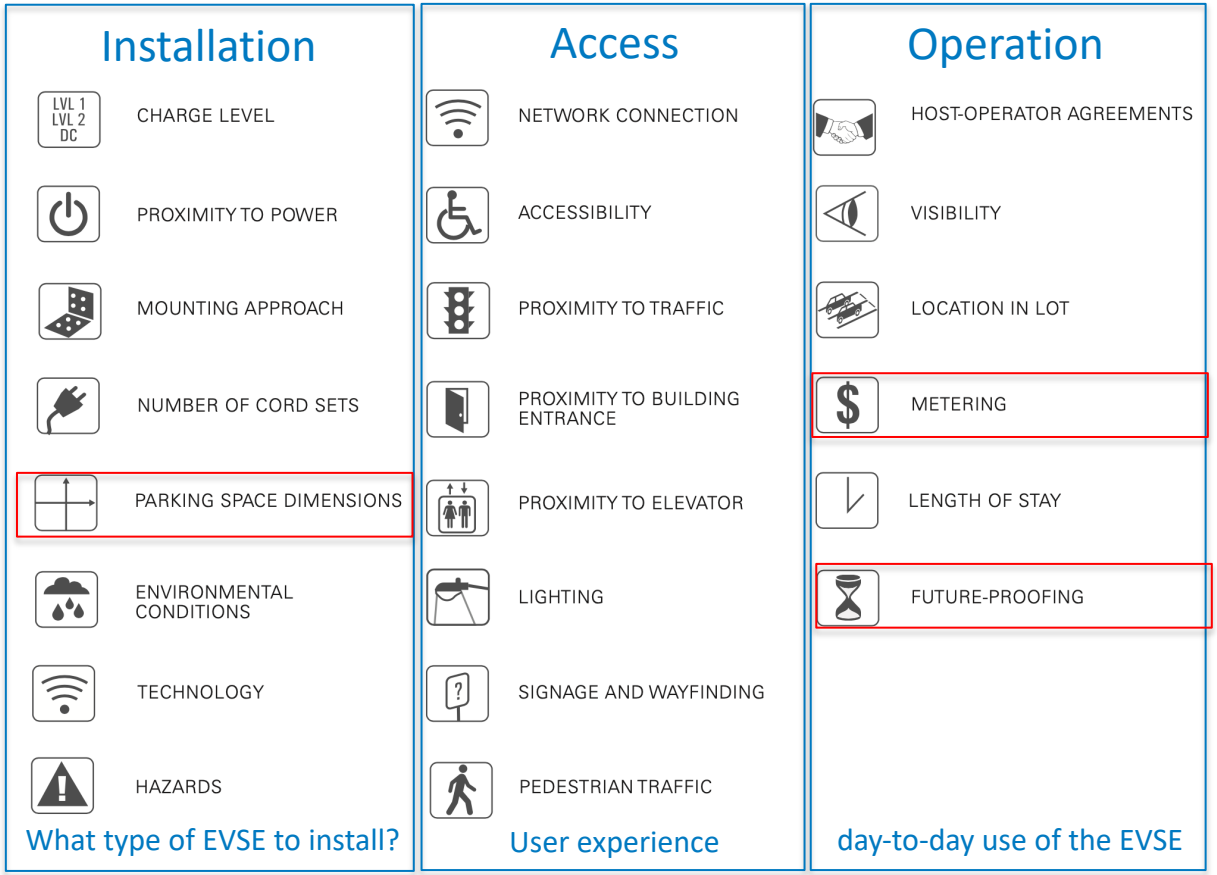
* GGEs reduced compared to a base case where prior year GGE consumption is all petroleum use.

Showing 1 to 10 of 200 entries

Previous 1 2 3 4 5 ... 20 Next

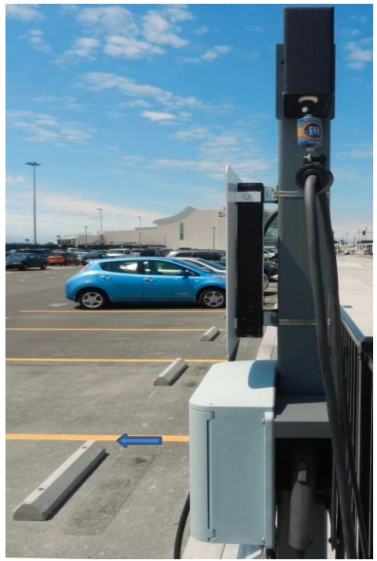
Infrastructure Requirements & Design Guidelines

Site Design Element



Reference [5]

Parking Interface

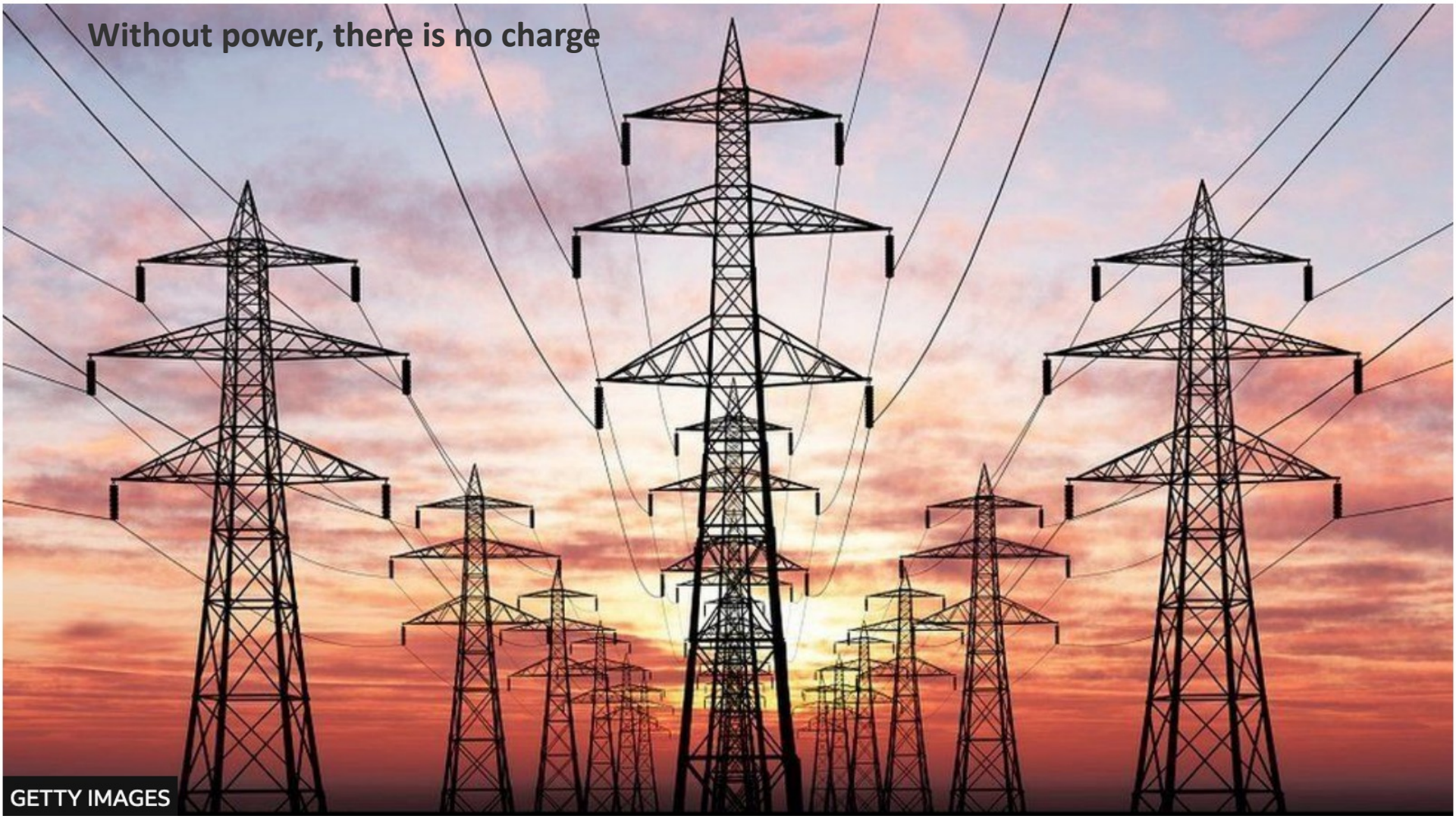


The wider and/or longer parking spaces in a parking facility are usually best for installing EV charging stations.

Reference [1]

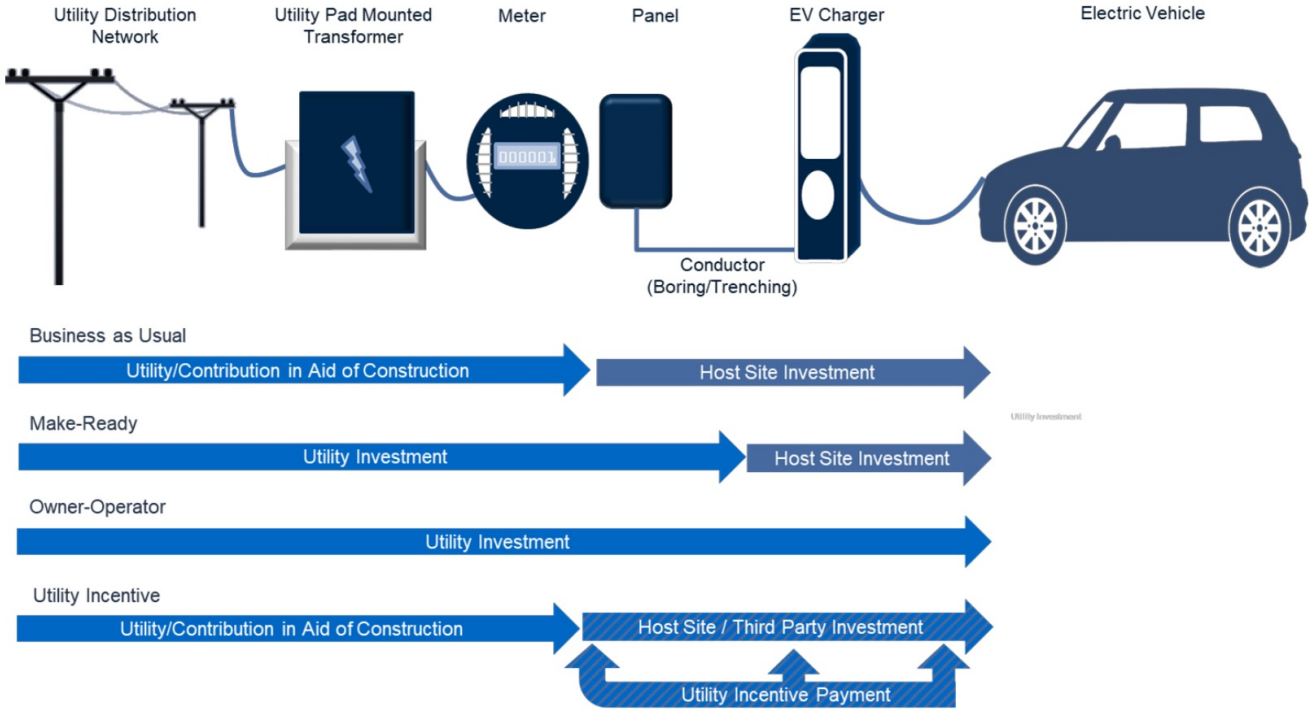
Rules of Thumb for EVSE

- 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
GETTY IMAGES

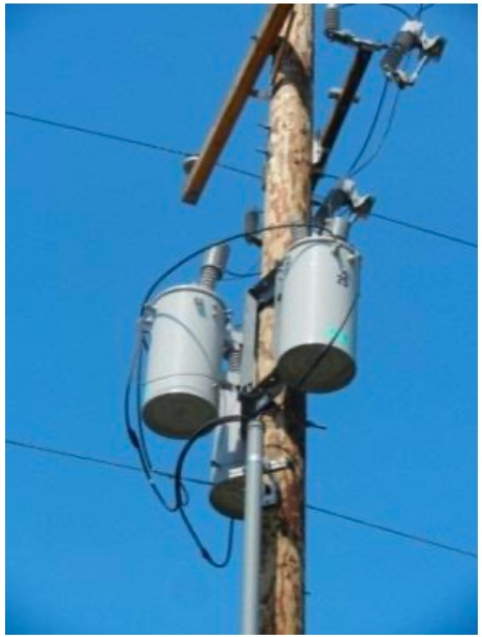
Models for Utility Engagement

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

In addition to ensuring safety where EVSE is installed, utilities are concerned with overloading local transformers.

Power Interface

Rate Plans	Rate Description	Panel Choices		
		Use Existing Panel	Add 2nd Panel or Meter Socket Box	Upgrade Existing Panel
Residential Plan (D) *Single Meter*	**Tiered Rate*** Home and electric vehicle loads measured together	 **Option #1** (likely no meter change)	N/A	 **Option #2** (likely no meter change)
Home & Electric Vehicle Plan (TOU-D-TEV) *Single Meter*	**Time of Use Tiered Rate*** Home and electric vehicle loads measured together; rates higher during the day and lower at night	 **Option #3** (meter may need to be replaced)	N/A	 **Option #4** (meter may need to be replaced)
Electric Vehicle Plan (TOU-EV-1) *Two Meters*	**Time of Use Rate** 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	N/A	 **Option #5** (panel upgrade or addition must be complete before second meter is installed)	 **Option #6**

See page 4 for detailed panel configurations.

*With tiered rates, cost per kWh increases with the amount of electricity used.

Reference [2]

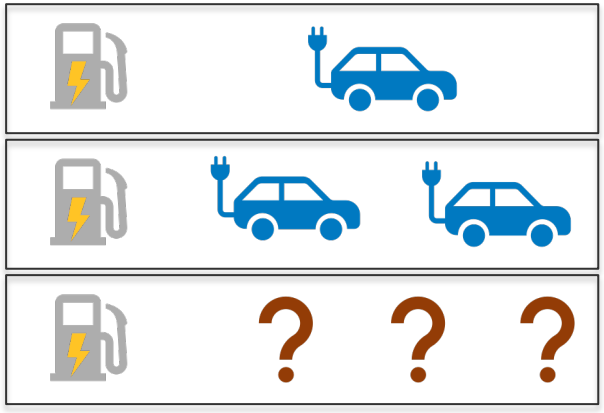
EVSE Needs

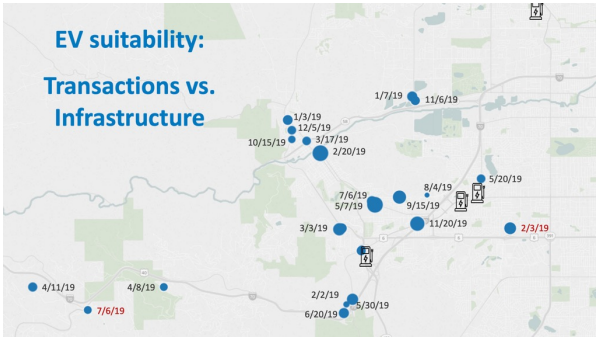
Will power sharing features mean I need half as many EVSE as EVs?

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)

Enter Zipcode

EV U-Finder: Electric Vehicle Utility Finder

Enter ZIP Code to identify local utilities, electric vehicle support programs, and Clean Cities Coalitions.

80401

Powered by the U.S. Utility Rate Database (https://openei.org/apps/USURDB/)
Utility territories last updated February 2021.

See Introduction worksheet for notes on using EV U-Finder.

FEMP Federal Energy Management Program

NREL Transforming ENERGY

Identified active utilities in 80401

*Customer Types: G: Government or Public; C: Commercial; R: Residential

Utility	Utility Name	Utility Ownership	Known EVSE Funding Eligibility?*	Known Advisory Services Eligibility?*	Known Federal EVSE Incentives?	GSA Areawide Contract?	Identified Utility Contact or Phone Number (as available)	Identified Utility Contact Email	Known UESC Contact?	Known UESC Email?
1	Intermountain Rural Elec Assn	COOPERATIVE						Cooperative Contact		
2	Public Service Co of Colorado	INVESTOR	GCR	CR		Y	DiLorenzo, Steven	steven.j.dilorenzo@xcelenergy.com	DiLorenzo, Steven	Steven.J.DiLorenzo@xcelenergy.com
3	NA	NA								
4	NA	NA								
5	NA	NA								
6	NA	NA								
7	NA	NA								
8	NA	NA								
9	NA	NA								

Utility Associations

Utility Ownership	Directory or Contact
INVESTOR	EEI Utility Federal Contacts
PUBLIC	APPA Utility Directory
COOPERATIVE	NRECA Utility Directory
Cooperative Contact	NRECA Federal Coordinator Lauren Khair; Lauren.Khair@nreca.coop

https://www.eei.org/about/affiliates/nationalkeyaccounts/Pages/Federal-Utility-Directory.aspx
https://www.publicpower.org/where-public-power
https://www.electric.coop/our-organization/nreca-member-directory

State Level Incentives

State:	CO
Known EVSE Funding Eligibility?*:	GCR

*Customer Types: G: Government or Public; C: Commercial; R: Residential

Clean Cities Coalition

Coalition:	Drive Clean Colorado, a Clean Cities Coalition
Coordinator:	Bonnie Trowbridge
email	bonnie@drivecleancо.org
website:	https://drivecleancolorado.org/

Additional Incentive Search Tools

Alternative Fuels Data Center (AFDC) Laws and Incentives
https://afdc.energy.gov/laws/state
Database of State Incentives for Renewables & Efficiency (DSIRE)
https://www.dsireusa.org/
Demand Response and Time-Variable Pricing Programs
https://www.energy.gov/eere/femp/demand-response-and-time-variable-pricing-programs

Identified incentive details are listed below.

Edison Electric Institute Investor Owned Utility Incentives

For more details see "EEI Database" worksheet

Increase row heights to view complete details.

Incentive	EEI Electric Company	EEI Holding Company	Program Name	Description	Website (if available)
1	Public Service of Colorado	Xcel Energy	Public and Community Charging Hub	Public and Community Charging Hub EV Solutions help expand Level 2 and fast charging options for EV drivers away from home. Businesses,	https://co.my.xcelenergy.com/s/business/ev/public-fast-charging
2	Public Service of Colorado	Xcel Energy	Accelerate your Fleet & On-The-Go	0	
3	Public Service of Colorado	Xcel Energy	Accelerate Your Fleet	Advisory Services to support electrification of fleets within Xcel's service territory.	https://co.my.xcelenergy.com/s/business/ev/fleet
4	Public Service of Colorado	Xcel Energy	Multifamily EV solutions	Existing multifamily properties hosting charging for residents and guests can work with an EV Concierge to participate in one of the Company's	https://co.my.xcelenergy.com/s/business/ev/multifamily-charging
5	Public Service of Colorado	Xcel Energy	Income Qualified EV Purchase or Lease	The EV Rebate is available to the Xcel Energy's income-qualified customers and provides $3,000 off the purchase or lease of a pre-owned EV and	https://ev.xcelenergy.com/ev-rebate-co
6	Public Service of Colorado	Xcel Energy	EV Dealer Network	In an effort to help our customers wherever they are on their EV journey, Xcel Energy launched an EV Dealer Network in March of 2021. Through the	https://ev.xcelenergy.com/dealers
7	Public Service of Colorado	Xcel Energy	Accelerate At Home	The EV Accelerate At Home program launched on August 5, 2021. Through the program, residential electric customers are provided a Level 2	https://ev.xcelenergy.com/ev-accelerate-at-home-co
8	Public Service of Colorado	Xcel Energy	Home Wiring Rebate	Through the Home Wiring Rebate program, launched on August 5, 2021, residential electric customers can receive a rebate of up to $500 (income-	https://ev.xcelenergy.com/home-wiring-rebate
9	-	-	-	-	
10	-	-	-	-	
11	-	-	-	-	
12	-	-	-	-	
13	-	-	-	-	
14	-	-	-	-	
15	-	-	-	-	
16	-	-	-	-	
17	-	-	-	-	

- https://www.energy.gov/eere/femp/electric-vehicles-toolkit

Agenda

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03 **Site Assessment Examples**

04 **GSA BPA offerings**

05 **Electric Vehicles Supply Equipment and Fleets, Xcel Energy**

Site Assessment 1

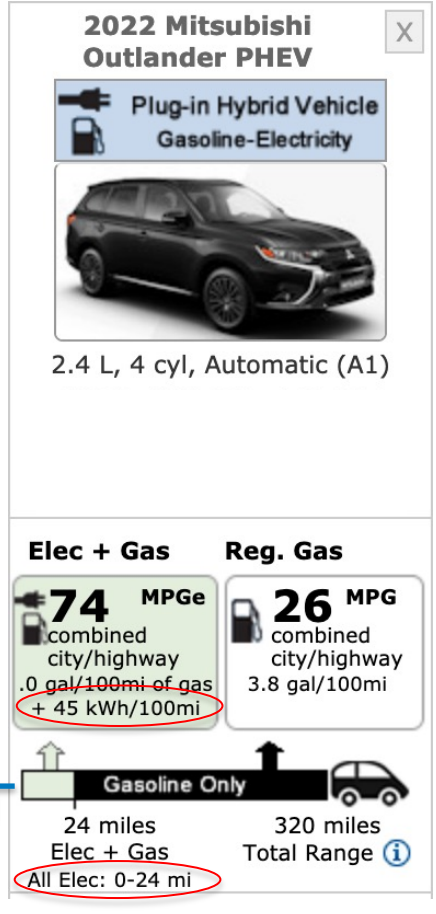
Site Assessment 1

- 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

Range 24 miles on electricity/320 miles

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.



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.

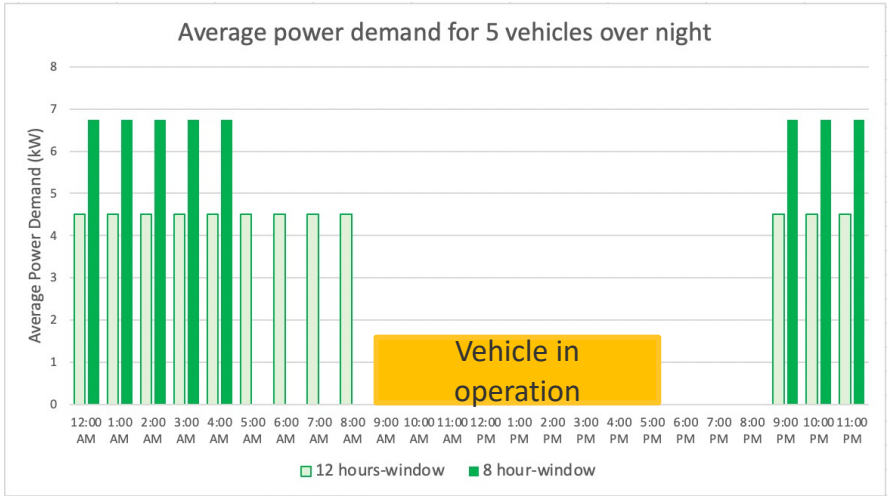
$$Energy\ (kWh) \approx \frac{miles}{3.6}$$

Site Assessment 1: Charging Window

24 hours in a Day	12:00 AM	Availble time to charge	Off Peak hours	9-hrs window
	1:00 AM			
	2:00 AM			
	3:00 AM			
	4:00 AM			
	5:00 AM			
	6:00 AM			
	7:00 AM			
	8:00 AM			
	9:00 AM	**Vehicles in operation**	$$	**Vehicle in Operation**
	10:00 AM			
	11:00 AM			
	12:00 PM			
	1:00 PM			
	2:00 PM		$$$	
	3:00 PM			
	4:00 PM			
	5:00 PM			
	6:00 PM	Availble time to charge		Avoid Charging during time
	7:00 PM		$$	
	8:00 PM			
	9:00 PM		Off Peak hours	3-hrs window
	10:00 PM			
	11:00 PM			

When is the best time to charge your EV?

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



$$Average\ power\ demand\ (kW) = \frac{54\ kWh}{12\ (hours)} = 4.5\ kW$$

$$Average\ power\ demand\ (kW) = \frac{54\ kWh}{8\ (hours)} = 6.75\ kW$$

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

AC Level 1

1.35 kW < 1.9 kW

Design Note
The level of battery charge, connector speed, and on-board charger will be tailoring to energy & installation requirements

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
16 A x1.25 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
32A x1.25 x 6 = 240 A

*On-board charger limitation

Pro Tips:

- Typical Level 2 EVSE operates around 7 kW (1.5 kW for Level 1)

$$Session\ (hrs) = \frac{Energy\ (kWh)}{Power\ (kW)}$$

- 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.