U.S. General Services Administration

ZEV and EVSE Operations Basics

Stephanie Gresalfi, Lisa Wheatley & Leidy Boyce

Agenda

- Benefits of ZEVs
- Components and Features
- Case Study
- Myth Busting
- Operational Hot Topics
- EVSE Basics

Benefits of ZEVs

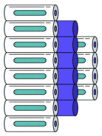
- Increased Fuel Economy
- Support Market Development
- Reduced Operating Costs
- Improved Performance & Technology

FedFleet 2023

BEV vs. PHEV

Battery Electric Vehicle (BEV)	Plug-in Hybrid Electric Vehicle (PHEV)
Operate on 100% electricity	Operate on electricity & gas
Optimal for less than 200 miles / day	Optimal for more than 200 miles / day or less than 30 miles / day
Need access to Level 2 charger or higher	Access to Level 1 or Level 2 charger ideal
Available in Sedan, SUV, Light Truck, Bus and some HD	Available in Sedan, Minivan & SUV ONLY

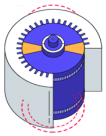
ZEV Basics: Major Components



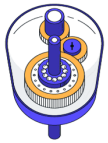
Battery Pack

Cooling System

Inverter

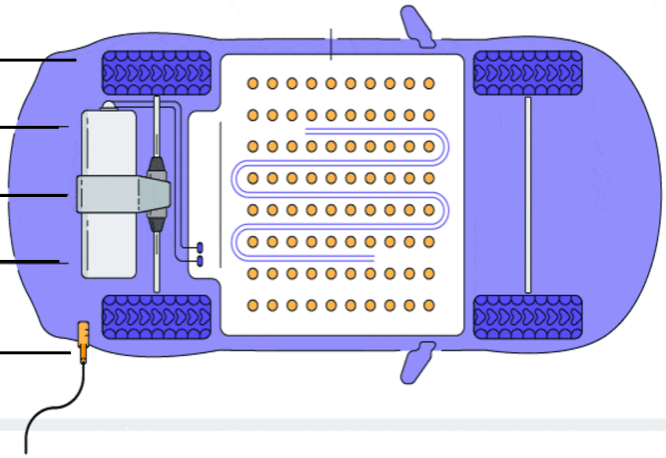


Induction Motor



Drivetrain

Charging System



Features of a ZEV: Regenerative Braking

- Take your foot off the accelerator or press on the brakes, the electric motor is operated in reverse
- This recaptures some of the vehicle's kinetic energy and recharges the battery
- Increases efficiency, but cannot take the place of charging at a station
- Regenerative braking modes vary with each vehicle make and model

Features of a ZEV: One Pedal Driving

Vehicle Action	Pedal Action	Regenerative Braking?
Brake	press the brake pedal to stop quickly	Y
Slow Down	release the accelerator	Y
Speed Up	press the accelerator	N

Dashboard Displays & Other Features

Case Study: Side by Side Comparison

	Ford F-150	Ford F-150 Lightning
Engine	3.3L V6 Flex-fuel (FFV)	Electric Dual eMotor
Horsepower	290 hp @ 6500 rpm	563 (580 w/ ext. range)
Torque	265 lbs-feet	775 lbs-feet
Curb Weight	4,021	6,015
Payload	1,990	2,235 lbs
Towing	5,000 lbs	7,700 lbs
MPG (city/Hwy/Cmb)	19 / 23 / 20	76 / 61 / 68
Range	437-529 (city-highway)	230 (320 w/ ext. range)
Extras		Frunk! Ext. range version power a house for 3 days!

Case Study: Towing

Model Year 2022 F 150 Lightning

➔7,700 lbs. towing

➔Towing can lead to ~50% or more loss in range

➔Drivers CAN back up into the water and it will NOT ruin the battery (same as a gas vehicle - it's not great for the vehicle, but isn't any worse simply due to the battery)

Lesson: Keep requirements in mind, not every ZEV is good for every application, but some may be better than you think!

ZEV MythBusters

All Myths

“Not enough range”

“WEX Cards are not accepted”

“Not enough charging infrastructure”

“They’re only good in more temperate climates”

“EV batteries degrade fast”

“EVs are not fun to drive”

Operational Hot Topics

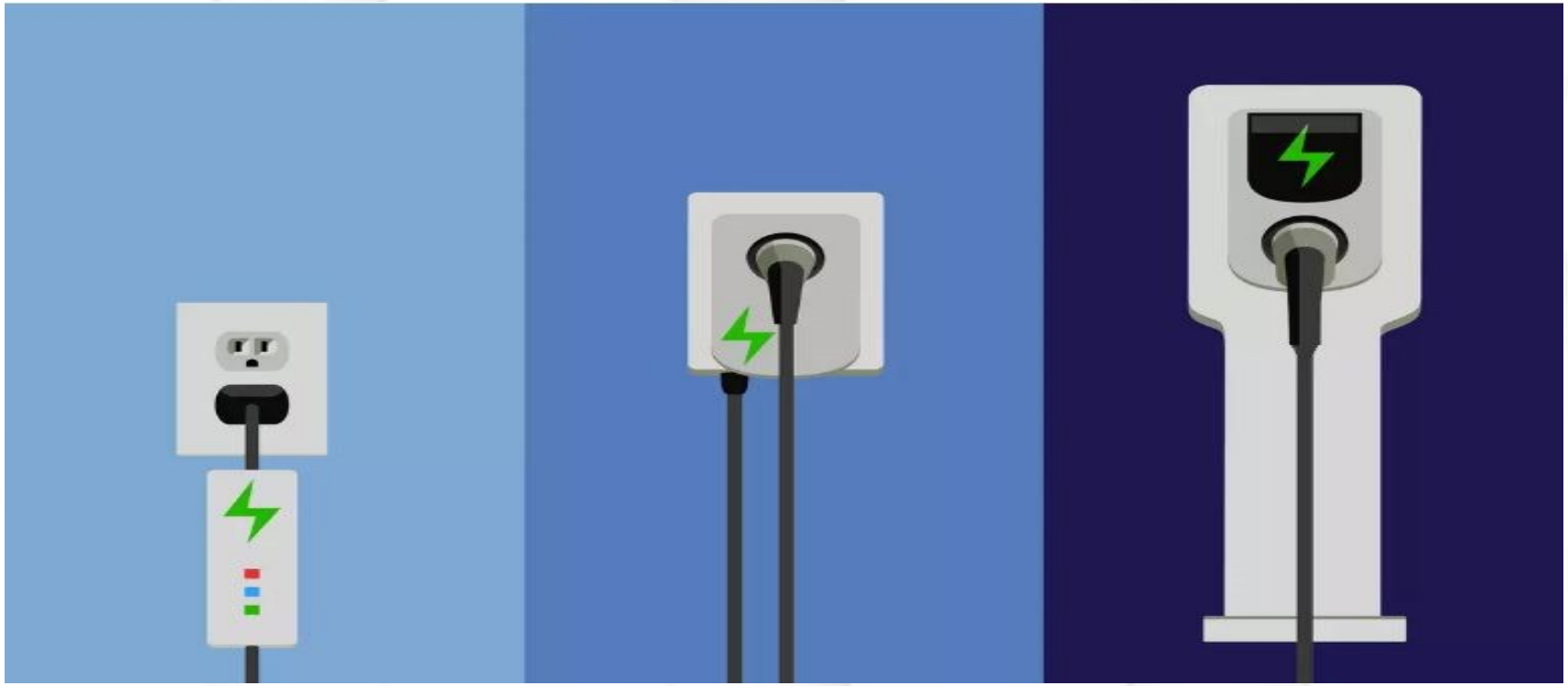
- Picking up your ZEV & deliveries
- Finding Public Charging
- Tesla's
- Charging GOVs at Public Stations

EVSE Basics

Level 1 Charging
(EVSE BPA CLIN001)

Level 2 Charging
(EVSE BPA CLIN002)

DC Fast Charger
(EVSE BPA CLIN003)



Procure stations and learn about GSA's one stop EVSE shop at gsa.gov/electrifythefleet

U.S. General Services Administration

Dispelling EV Charging Times

Leidy Boyce

NREL Research Engineer

Agenda

- EV 101
- Charging Session Energy
- Your EV Choice Matters
- Estimating EV Energy Needs
- EVSE Charging Session Efficiency

EV 101

Battery Capacity: (kWh)
OBC (kW)
Fuel Economy (kWh/100 miles)
EV Driving Range (miles)

OBC: On-Board Charger
EV: Electric Vehicle

Charging Session Energy Overview

- EV On board charger capacity
- Battery State of Charge (SOC)
- EVSE Power Level
- Ambient Temperature
- Overall System Losses

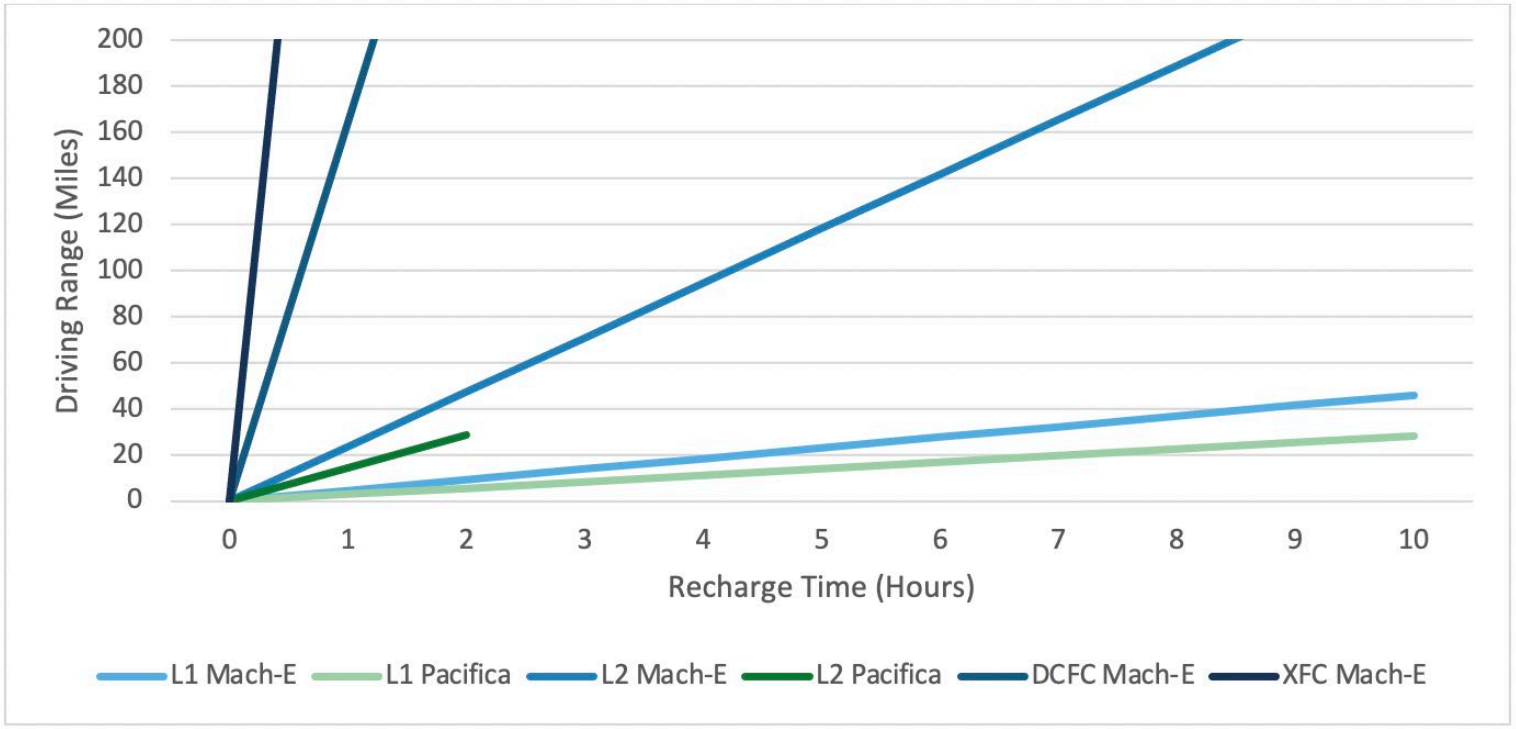
Electric Vehicle Charging Speeds

	Level 1	Level 2	DC Fast Charging
Connector Type[1]	J1772 Connector	J1772 Connector	CCS, CHAdeMO, or Tesla Connector
Typical Power Output	1 kW	7-19 kW	50-350 kW
Est. PHEV Charge Time from Empty[2]	5-6 Hours	1-2 Hours	N/A
Est. BEV Charge Time from Empty[3]	40-50 Hours	4-10 Hours	20 Mins - 1 Hour[4]
Est. Electric Range Per Hour of Charging	2-5 Miles	10-20 Miles	180-240 Miles
Typical Locations	Home	Home, Workplace, Public	Public

Source: https://www.transportation.gov/rural/ev/toolkit/ev-basics/charging-speeds

Driving Range Added by EVSE Level

$$Charge\ Time(hours) = \frac{Energy\ (kWh)}{Charge\ Rate\ (kW)}$$



Charging Time Rule of Thumb

- EVSE Power Rating: 7 kW
- Vehicle Efficiency: 0.28 kWh/mi
- Distance for Hour of Charging = 25 Miles

$$Charge\ Time(hours) = \frac{Energy\ (kWh)}{Charge\ Rate\ (kW)} = \frac{0.28 \times Distance}{7} = \frac{0.28 \times 25}{7} = 1hr$$

$$25\ miles\ of\ driving = 1\ hour\ of\ L2\ Charging$$

Your EV Choice Matters

EV	Connector Type	Charging Station
On Board Charger Capacity (kW) Battery Size (kWh)	Max power (kW)	Level 1, 2 or 3

What are the real charging times?

Level 2 EVSE: Think Kilowatts

$$P = V^* I$$

$$P = 240\ V\ X\ 32\ A \div 1000 = 7.68 \sim 7.7\ kW$$

$$Charge\ Time(hours) = \frac{Energy\ (kWh)}{Charge\ Rate\ (kW) * EF}$$

$$Charge\ Time(hours) = \frac{Energy\ (kWh)}{7.7\ (kW) * EF}$$

EF: Efficiency Factor
V: Voltage (V)
I: Current (ampere A)

OBC Specifications Are Important

Battery Size 40 kWh or 60kWh
Fitted with a 6.6 kW on-board

$$Charge\ Time(hours) = \frac{Energy\ (kWh)}{7.7\ (kW) * EF}$$

$$Charge\ Time(hours) = \frac{40\ (kWh)}{6.6\ (kW) * 0.8} = 7.5 \text{ hrs.}$$

EVSE Power Level	7.7 kW
Nissan OBC	6.6 kW
Battery Size	40 kWh
Time to fully Charge (0-100%)	7.5 hrs.

OBC: On Board Charger

Estimating EV Energy Needs

2021 Nissan Leaf (40 kW-hr battery pack)

Personalize | Find a Car | Compare

Fuel Economy

About All-Electric Cars

EPA MPG

- MPGe: Miles per Gallon Equivalent
- 1 Gallon of Gasoline = 33.7 kWH

Electricity: 111 Combine City/HWY

MPGe: 123 City, 99HWY

30 kWh / 100 miles

$$Charge\ Time(hours) = \frac{Energy\ (kWh)}{Charge\ Rate\ (kW) * EF} = \frac{0.3\ kWh/miles \times Distance}{Charge\ Rate\ (kW) x 0.8}$$

https://www.fueleconomy.gov/feg/noframes/43664.shtml

Honing Charging Times

$$Charge\ Time(hours) = \frac{Energy\ (kWh)}{Charge\ Rate\ (kW) * EF} = \frac{0.3\frac{kWh}{miles} \times Distance(miles)}{Charge\ Rate\ (kW) * 0.8}$$

At Table Displaying How Many Miles are Added with Different Charger Power Output kW

Miles Added	2.4	3.7	6.6	7.7	11	22	50
10	1.56	1.01	0.57	0.49	0.34	0.17	0.08
20	3.13	2.03	1.14	0.97	0.68	0.34	0.15
30	4.69	3.04	1.70	1.46	1.02	0.51	0.23
40	6.25	4.05	2.27	1.95	1.36	0.68	0.30
50	7.81	5.07	2.84	2.44	1.70	0.85	0.38
60	9.38	6.08	3.41	2.92	2.05	1.02	0.45
70	10.94	7.09	3.98	3.41	2.39	1.19	0.53
80	12.50	8.11	4.55	3.90	2.73	1.36	0.60

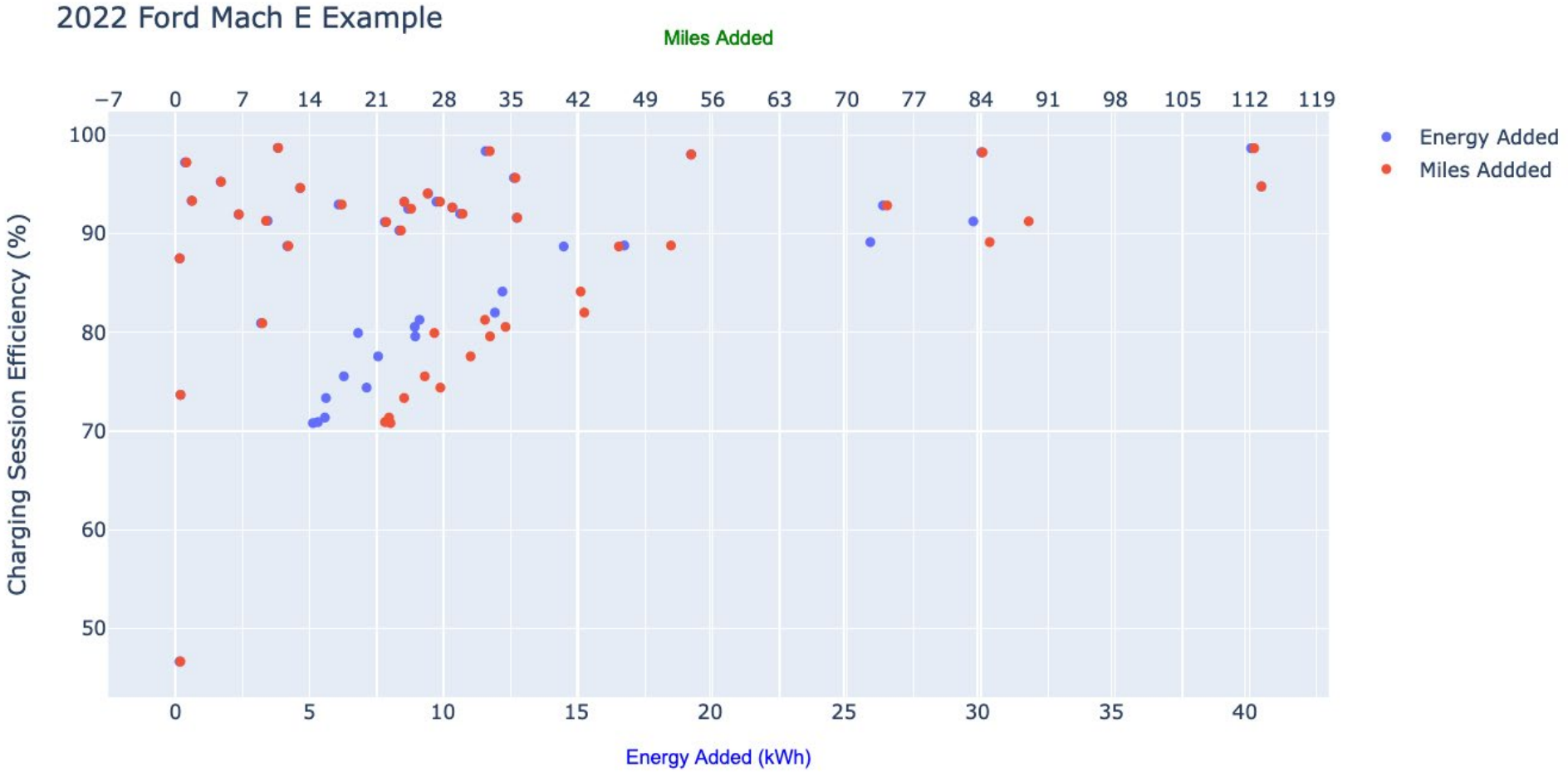
Charging Session Efficiency

Start Charge %	32
End Charge %	74
Delta Charge %	42%
Battery Size	70 kWh
Duration	04:49:00
Max Power from Level 2 EVSE	6.29
Energy Added kWh	30.14

$$\textit{Efficiency} = \frac{\textit{total energy taken up by the vehicle battery}}{\textit{total energy added from the charging event}} \textit{ x 100}$$

*Efficiency = (70*0.42) ÷ (30.14) x 100 = 97.5%*

Charging Session Efficiency



Charging Efficiency Challenges

- EV-specific acceptance rates
- Evs don’t charge at an EVSE port’s rated power level
- Battery Temperature Battery SOC dependent
- Actual rate of charging to be on average just 35% - 71% of the ports rated power level
- EVSE ports provide electricity at a variable rate

Takeaways

- Use the 80/20 rule for EV charging.
- Start shifting away from plug-in at the end of every trip.
- Develop EV charging policy based on EV energy needs.

References

1. Brennan Borlaug, Fan Yang, Ewan Pritchard, Eric Wood, Jeff Gonder. Public electric vehicle charging station utilization in the United States. Transportation Research Part D: Transport and Environment. Volume 114, 2023,103564, ISSN 1361-9209. https://doi.org/10.1016/j.trd.2022.103564.

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2. Emmanouil D. Kostopoulos, George C. Spyropoulos, John K. Kaldellis. Real-world study for the optimal charging of electric vehicles. Energy Reports. Volume 6, 2020. Pages 418-426,ISSN 2352-4847. https://doi.org/10.1016/j.egyr.2019.12.008.

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THANKS

Leidy Boyce
Leidy.boyce@nrel.gov

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Contact Us

gsafleetafvteam@gsa.gov
federal.fleets@nrel.gov