Fleet Electrification

Useful Ideas

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RAHUL CACHATTERJEA (COMED/EXCELON
KEN CROWLEY (VILLAGE OF OAK PARK)
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May 8, 2025

IACT
ILLINOIS ALLIANCE FOR CLEAN TRANSPORTATION

FLEET ELECTRIFICATION

A. Selecting EVs / EV Chargers
B. Planning and Design
C. Operation, Maintenance & Training
D. Utility Engagement
E. Codes, Standards And Best Practices
F. Looking Forward: New Technologies and Policies

Selecting EVs & EV Chargers

GREEN WAYS 2GO

TIM MILBURN

May 8, 2025

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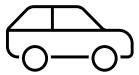
ONE SIZE FITS ALL

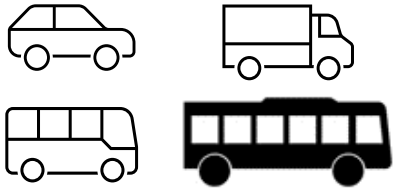
Evolution of EV Charging

2020



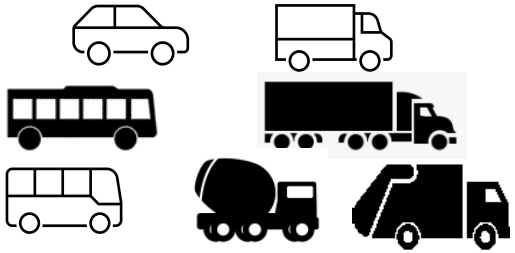
Residential
Public
Workplace

→ 2025

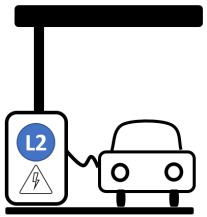


Medium Duty Fleets
School / Transit Buses
Charging as Business

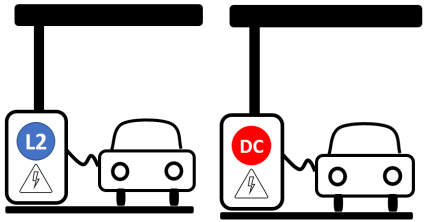
→ 2030



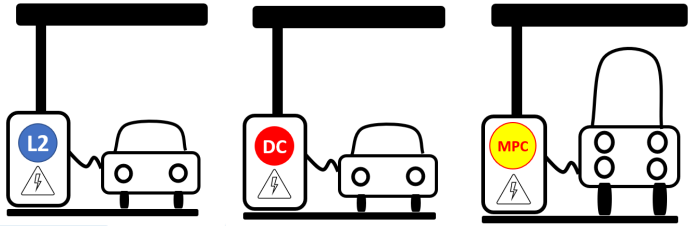
Heavy Duty Fleets
Megawatt Charging



Existing Facility Power



Local Utility Service Upgrades



Transmission and Distribution Upgrades

PEV Terminology: Vehicles

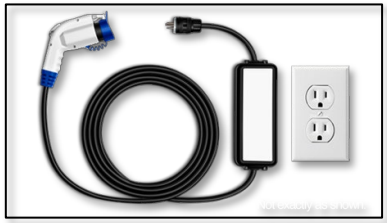
- **Plug-in Electric Vehicles (PEV)**
  - Plug-in Hybrid Electric Vehicle (PHEV) and Extended Range Electric Vehicles (EREV)
    - Run on electricity or internal combustion engine (ICE)
    - PHEV: (*AND*) Can run on both fuels or one fuel
    - EREV: (*OR*) ICE automatically engages when battery runs low
    - Zero tailpipe emissions when running on battery only
    - ICE feature alleviates range anxiety
  - Battery Electric Vehicles (BEV)
    aka All Electric Vehicle (AEV)
    100% electric battery powered
    - Range limited
    - Zero tailpipe emissions
    - Quiet
    - Lower maintenance

EV Charging Station = EV Supply Equipment = EVSE

- EVSE = Equipment that safely delivers electrical energy from an electricity source to charge plug-in electric vehicles
  - Term EVSE used to differentiate from ***On Board Charger*** device that regulates charge ***on the EV***

Level 2 EVSEs

- Types of EVSEs
  - Hardwired
  - Plug in to standard (NEMA) outlets



Level 1 Portable EVSE & 120 V Outlet

Level 2 Portable EVSE & 208 V NEMA 14-50 Outlet

NEMA – National Electric Manufacturers Association

Standard Charging Power Levels
EV Supply Equipment (EVSE = EV Charger)

- **AC Level 1**: (120 VAC)
  - Home/ mobile
  - **3 to 5 RMPH**
- **AC Level 2**: (208/240 /277 VAC)
  - Home/ public/ workplace
  - **10 to 80 RMPH**

AC in, ***AC*** out

- **DC Fast Charging:** (480+ VAC)
  - Public/ workplace / retail
  - Aka Level 3 Charging
  - **60 to 600 RMPH**

AC in, **DC** out



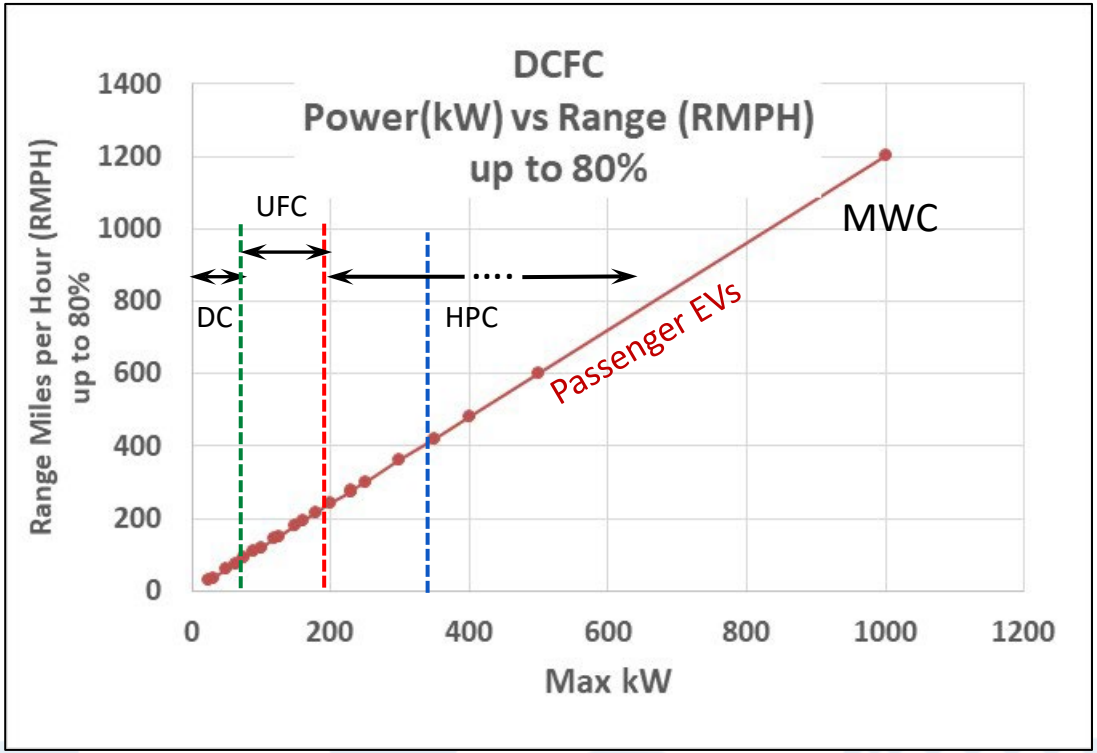


RMPH = Range Miles per Hour added when connected
AC = Alternating Current
DC = Direct Current

Direct Current Charging : *Higher Power is here*

Per Charin*:

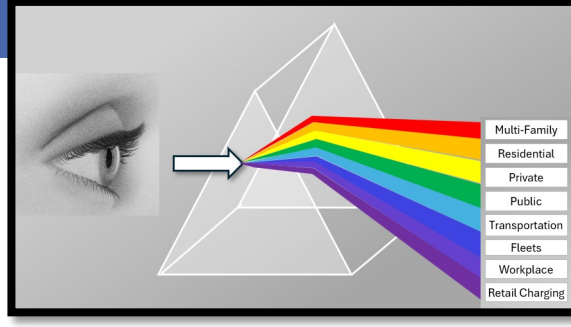
- ***(DC) DC Charging: < 50 kW***
  (FC) Fast Charging : 50 to 99 kW
  (UFC) Ultra Fast Charging: 100 to 149 kW
  (HPC) High Power Charging: ≥ 150 kW
- ***(MWC) Megawatt Charging: 1,000 kW***



kW= kilowatt
RPMH = Range Mile per Hours
For DCFC – basis only up to 80% fill

*Charin- Global Standards organization for EV Charging

Use Case Decision Factors



- **Operational**
  - Daily travel, long distance travel, work travel.
  - Daily/seasonal demand variation – temperature impacts
  - Rate of recharge
  - Special needs (e.g., PTOs, police & fire, IT gear)
  - Reliability - equipment and vehicles
  - Changes in maintenance needs
  - Training
  - Safety
- **Vehicle**
  - Types and quantities of EVs
  - Acceptance and recharge rates
  - Performance: payload, towing load, acceleration, torque
  - Right-sizing
  - Market availability
- **Facility**
  - Logistics, parking
  - Parking space ownership
  - Power capacity, ability to power share, peak demand costs

Use Case Decision Factors

- **Operational**
- **Vehicle**
- **Facility**

- **Investment recovery**
- **Communications and networking**
- **Sustainability**

Determines

- Best EV and EV Charger Fits
- Investment sequences, ROI
- Charging schedules and logistics
- Energy management
- Electricity costing and pricing
- Training needs
- Use of home-based vs. third party charging

RANGE FACTORS

EV Range Factors and Solution Designs

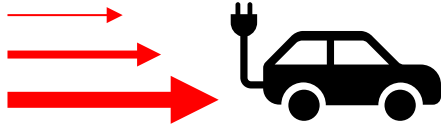
***Top Priority* concern:**
RANGE MILES PER HOUR (RMPH) connected

- Recharging directly affects daily lives and operational predictability
  - Vehicle availability
    - Miles recharged in known time frame
    - Daily miles → year round
  - Charger reliability and availability

EV Range Factors and Solution Designs

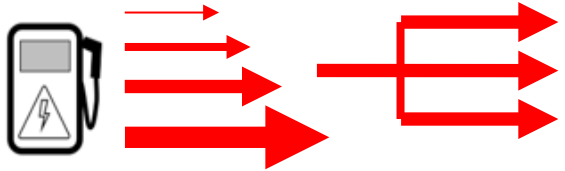
Vehicle Factors

1. EV Acceptance Rate (kW)
2. EV Efficiency (mi/kWh)



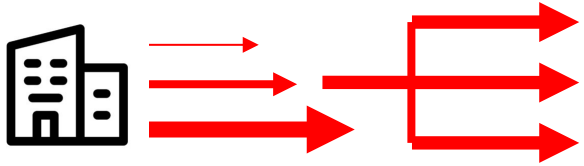
EV Charger Factors

1. Power Delivery Rate
2. Power Sharing

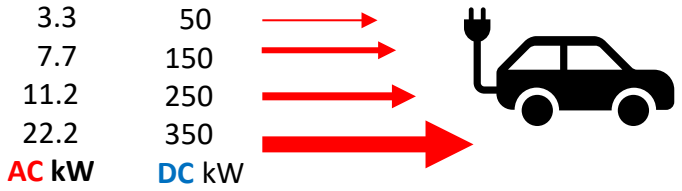


Facility Infrastructure Factors

1. Maximum Power
2. AC vs DC
3. Power Sharing



Acceptance Rate



- ***Not all EVs charge the same!***
  - ***Onboard Vehicle Charging Systems*** *regulates energy/power reaching the battery*

- ***= Acceptance Rate***
  - AC Acceptance Rates vary between 3.3 kW and 22 kW
  - DC Acceptance Rates vary between 50 and 350 kW and are going up to over 1,000 kW (large EVs)

  - *EV Chargers with more power capacity will only charge at the rate the EV allows*
  - ***May influence what EV and what EV charger you buy***

Passenger EV Acceptance Rates, kW

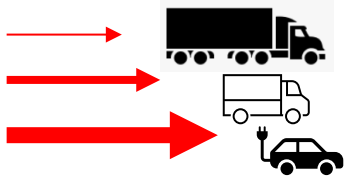
AC Level 2

Model (2024)	Acceptance Rate, kW
AC Charging (L2)	
Chevy Volt (2017)	3.8
Nissan Leaf SV (2023)	7.7
Subaru Solterra (2024)	7.7
Chevy Bolt (2024)	7.7
Nissan Ariya (2024)	7.7
Chevy Blazer EV (2024)	11.5
Ford Mustang Mach-E (2024)	11.5
Hyundai Ioniq 5 (2024)	11.5
Hyundai Ioniq 6, LR (2024)	11.5
Tesla Models Y (2024)	11.5
Tesla Models X (2024)	11.5
Tesla Models 3 Long Range (2024)	11.5
VW ID.4 Pro (2024)	11.5

DCFC

Model (2024)	Acceptance Rate, kW
DC Charging	
Chevy Bolt PEV	55
Nissan Leaf e+	125
Nissan Ariya-e-4ORCE	130
VW ID 4	125
Ford Mustang Mach-E	150
Audi –e-tron 15	150
High Powered DCFC	
Rivian R1T	220
Hyundai IONIQ Long Range 2WD	220
Kia EV6 GT	233
Tesla Model 3	250
Porsche Taycan 4S Plus	350
Tesla Model Y Performance	350
Tesla Model S Plaid	350
Tesla Model S Long Range	350
Lucid Air Grand Touring	350

Recharge *Efficiency* Rate, Miles /kWh



- **Not all EVs get same miles with same energy**
- **Newer EVs models more efficient than older ones**
- **Measured in miles/kilowatt Hour (mi/kWh)**

  → ***the new "miles per gallon" metric***

- **Passenger EVs:** **2.00 to 5.00 mi/kWh**
- **Pickups, shuttles, SUVs:** **0.10 to 0.30 mi/kWh**
- **Large trucks/buses:** **0.02 to 0.07 mi/kWh**

Electric car year	OEM	Model	Mile/kWh
2022	Tesla	Model 3	4.00
2021	Hyundai	Ioniq	4.00
2022	Tesla	Model Y	3.85
2022	Lucid	Air	3.85
2021	Hyundai	Kona	3.70
2022	Chevrolet	Bolt	3.57
2022	Lucid	Air	3.45
2022	Tesla	Model S Plaid	3.45
2022	Chevrolet	Bolt	3.45
2021	Kandi	K27	3.33
2021	Nissan	Leaf	3.33
2021	Kia	Niro	3.33
2021	BMW	i3	3.33
2021	Nissan	Leaf	3.23
2022	MINI	Cooper	3.23
2021	Ford	Mustang	2.94
2021	Volkswagen	ID.4	2.86
2021	Polestar	2	2.70
2021	Audi	e-tron	2.33
2021	Volvo	XC40	2.33
2021	Jaguar	I-Pace	2.27
2021	Porsche	Taycan	2.08

TECHNICAL REFERENCE INFORMATION

DC Acceptance Rate Data

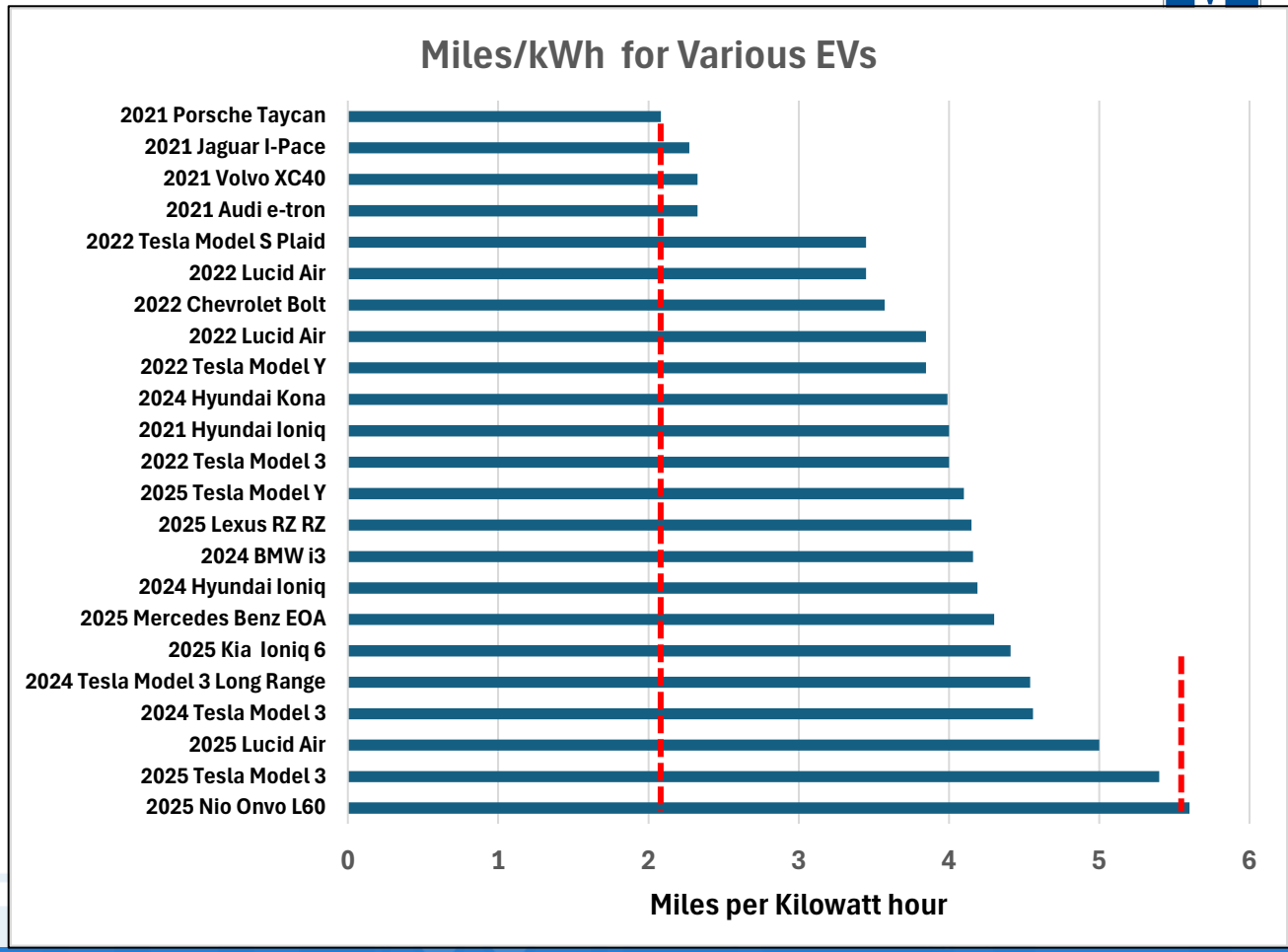
AC EV Acceptance Rate Table

EVs: Miles per kilowatt hour List for AC Charging (eco cost savings.com) LINK

EV Efficiency

- How far can you go on 1 kilowatt hour of energy?

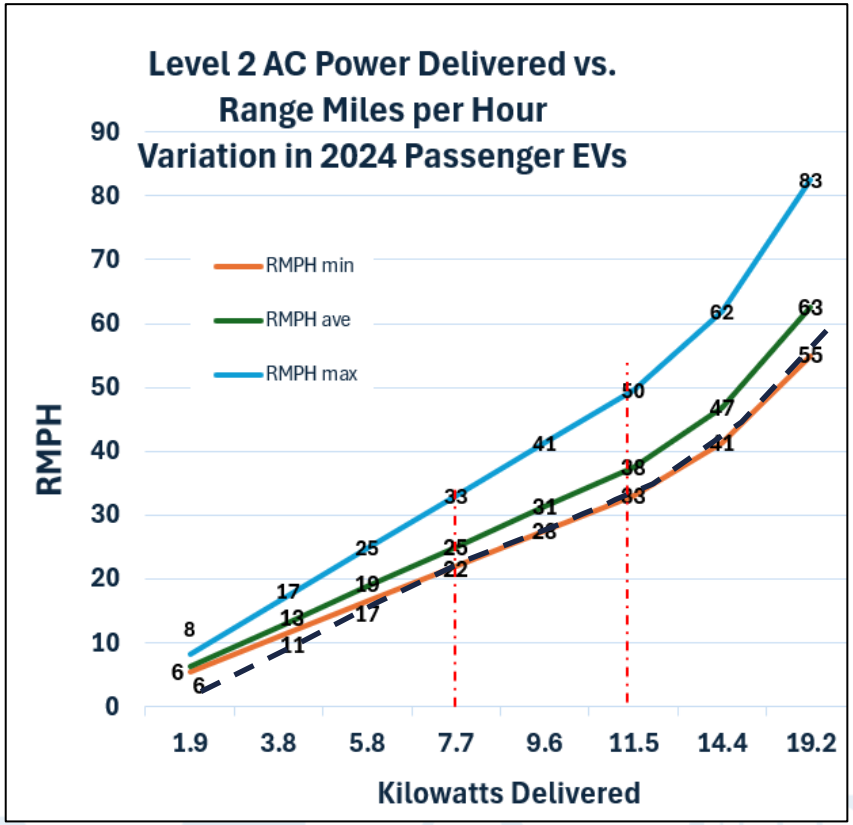
Model	Mile/kWh
2025 Tesla Model 3	5.4
2024 Tesla Model 3	4.56
2022 Tesla Model 3	4.00



Recharge Efficiency Rate and Power Variation

Recharge rate efficiency depends on the EV model

Like Miles per Gallon!



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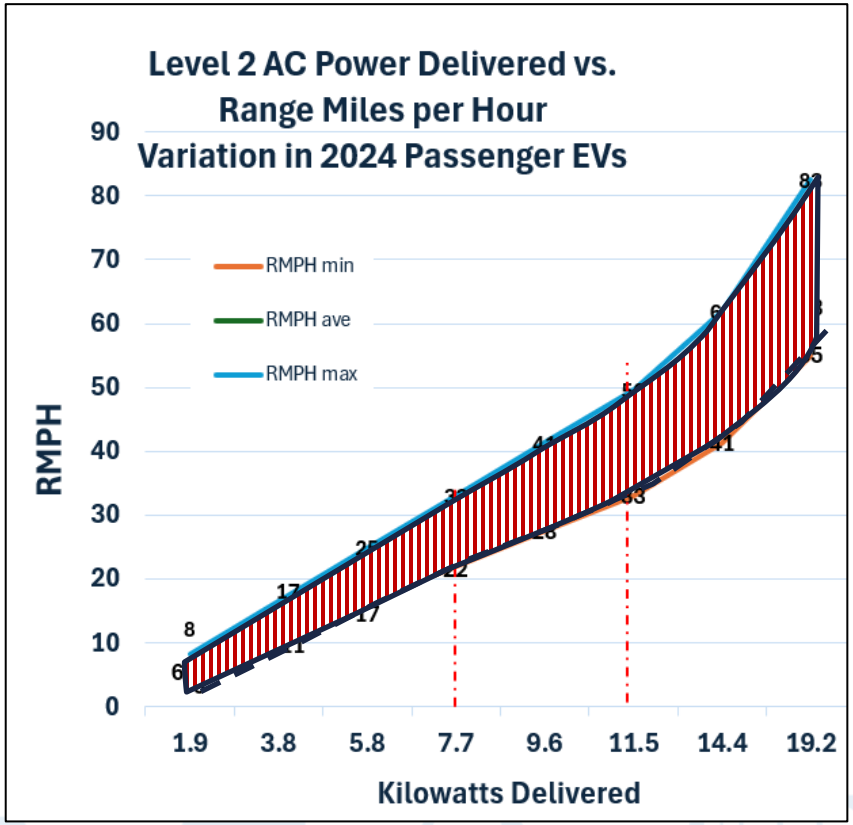
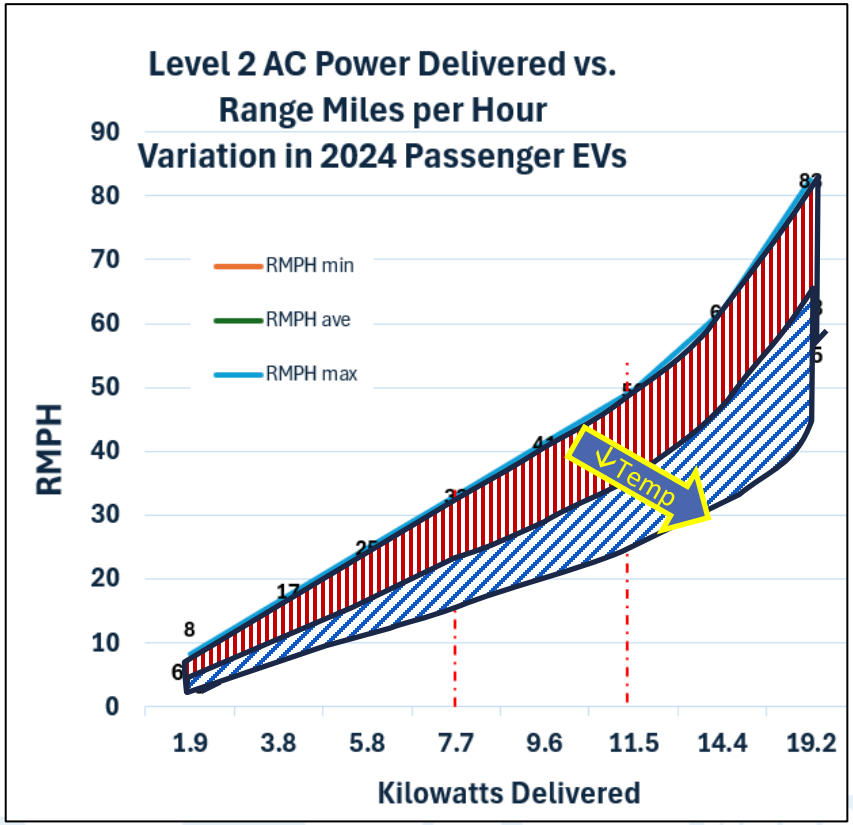


Recharge Efficiency Rate and Power Variation

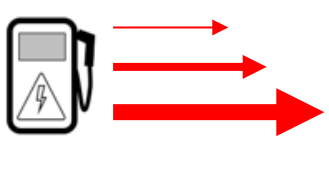
Recharge rate efficiency depends on the EV model

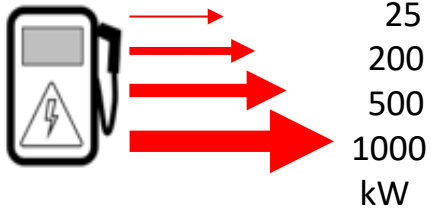
Like Miles per Gallon!

Temperature effects will apply



EVSE Delivery Rate





Level 2

- Power range from 6 to 22 kW
- Volts: 208/240/277
- Amps: 16 to 80

DCFCs

- kW range from 25 to 1,000+
- Supply voltage from 480 to 1,600 AC
- Amp range depends on Voltage

- Excerpted from EPRI Vetted EVSE Product list Aug 2024

Level 2 EVSE

Brand	Max Power (kW)	Max Amperage
ABB	19.2	80
ABB	9.6	40
Autel	19.2	80
Autel	12	50
Autel	8.3	35
Blink	12	50
Blink	7.2	30
Blink	7.2	30
Blink	11.52	48
Blink	9.6	40
Blink	11.52	48
Blink	19.2	80
Blink	19.2	80
Blink	8.3	35
ChargePoint	9.6	40
ChargePoint	12	50

DCFC

Name	Max Power (kW)	Max Amperage
ABB	24	29
BTCPower	25	30
Blink	30	36
Zerova	30	36
Autel	40	48
FLO	50	60
ChargeTronix	60	72
ChargePoint	62.5	75
Enel X Way	75	90
Autel	80	96
ChargePoint	80	96
ABB	90	108
XCharge	95	114
Autel	100	120
Delta	100	120
Autel	120	145
Blink	120	145
BorgWarner	125	151
Autel	140	169
ABB	150	181

Direct Current Charging : *Higher Power is here*

Per Charin*:

- ***(DC) DC Charging: < 50 kW***
  (FC) Fast Charging : 50 to 99 kW
  (UFC) Ultra Fast Charging: 100 to 149 kW
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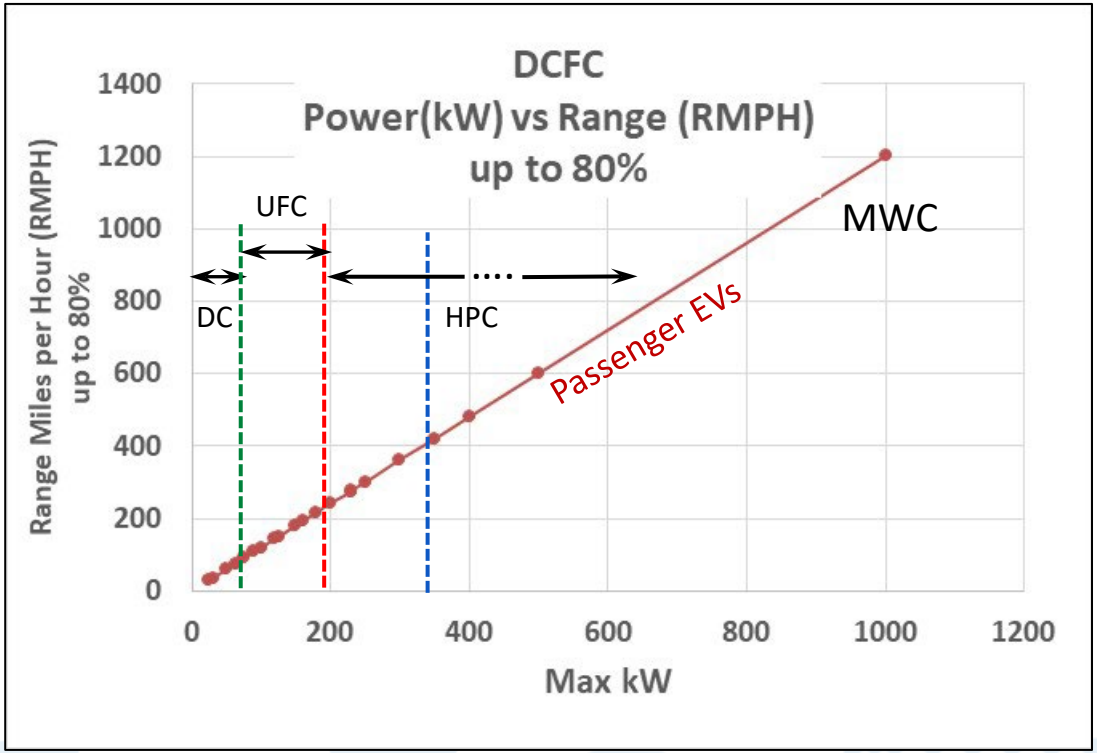

kW= kilowatt
RPMH = Range Mile per Hours
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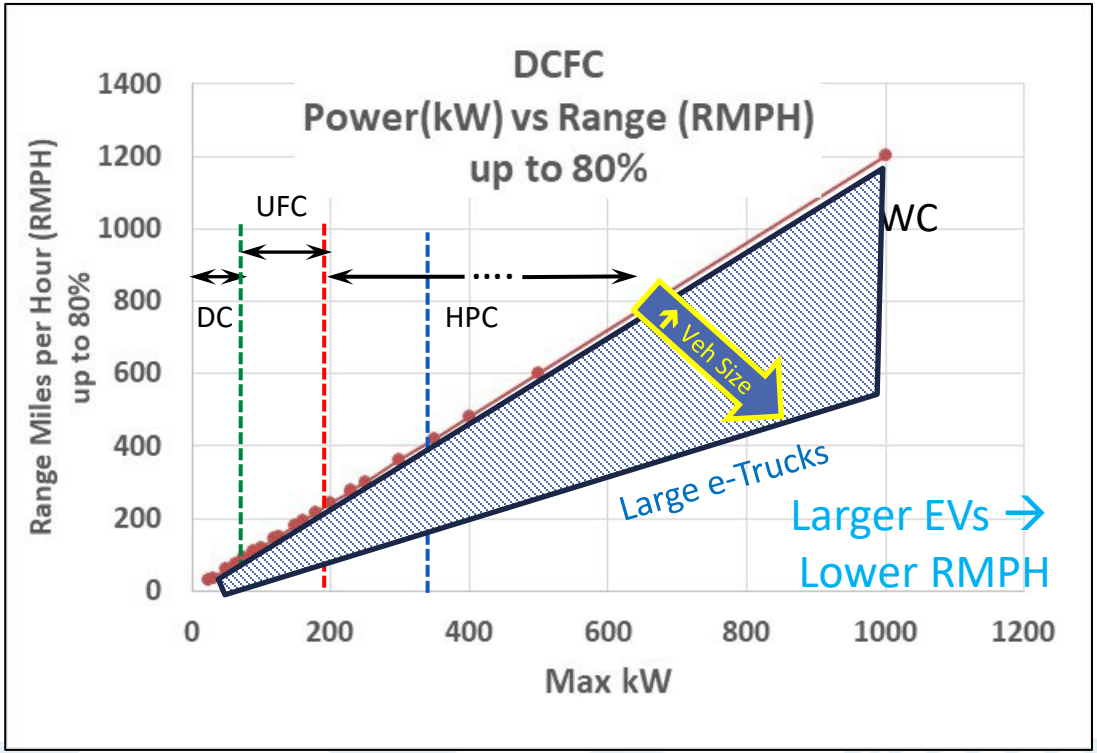

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For DCFC – basis only up to 80% fill

*Charin- Global Standards organization for EV Charging

EV / EVSE Standard Connectors: North America

SAE J1772 *Standard Level 1 & 2 Charging Connection (Left) and Plug (Right) US EVs*

CHAdeMO *DCFC Standard EV Connection (Left) and Plug (Right) Japanese EVs*

SAE Combined Charging System (CCS1) *(Left) Standard Level 1 and 2 AC EV and DC Fast Charging connection and Plug (Right) - US EVs*

NACS vs J3400
Same mechanical connection
NACS ; 250 V Max
J3400 1000 V Max

Tesla EV Connector *(Left) and Plug (Right), Recently approved as* ***SAE J3400*** *or* ***North American Charging Standard (NACS)***

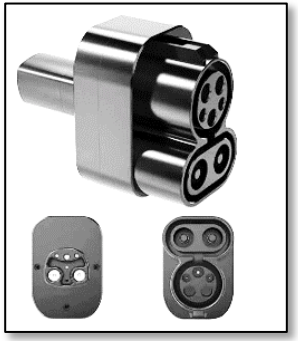
Changing Charging Standards

- Through 2024, all US EVs use standard AC & DC connectors except Tesla:
  - **AC**: SAE J1772
  - **DC**: Combo Charging Standard (CCS1 – US EVs)
  - **DC**: CHAdeMO (Japanese EV Standard)
- Tesla uses <u>one</u> connection for AC and DC
  - North American Charging Standard (NACS)
  - NACS is now SAE J3400 Standard

- Starting in 2025 – **<u>Migration</u>** to NACS/ SAE J3400
  - All Major EV OEMs
  - Major EVSE vendors
  - Japanese vendors – phasing out CHAdeMO in new US EV products
  - Goal: allow network of Tesla and US DCFCs to charge any EV (in time)
- Adapters are available to charge between standards

SAE = Society of Automotive Engineers

Adapters



NACS → CCS Adapter

EVSE cords and connectors can be swapped out in the future (in Yellow). Not all models.

CCS → NACS Adapter

NACS → J1772 Adapter

J1772 → NACS Adapter

Transitioning: CCS/J1772 to J3400

Tesla Supercharger featuring ***Magic Dock*** *J3400 or CCS1*

ChargePoint ***Omni Port*** *featuring J3400 or J1772*

Finding EVSEs for Purchase

- ERPI Vetted EVSE list
- Energy Star List
- Sourcewell List

Passenger EV Availability

Plug-in EVs (PEVs, aka "EVs")

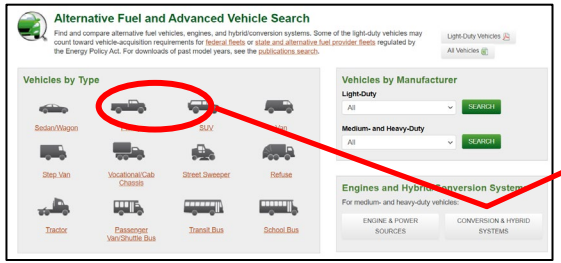
- **Battery EV (**BEV), aka All Electric Vehicles
  - 33 OEMs / 295 models (2025) EV Data per Plugstar
  - 150 to 350-mile range for most
  - 410-mile Rivian Silverado, Tesla
  - 512-mile Lucid
  - 60 models have DC Acceptance Rate at >300 kW (7 OEMs)

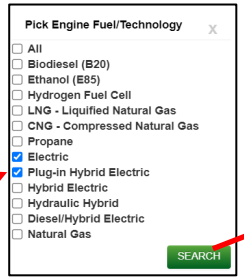
- **Plug-in Hybrid EV** (PHEV), aka Extended Range EVs
  - 15 OEMs / 85 models (2025)
  - 22 to 52-mile EV range min
  - Up to 559-mile total range (Prius)

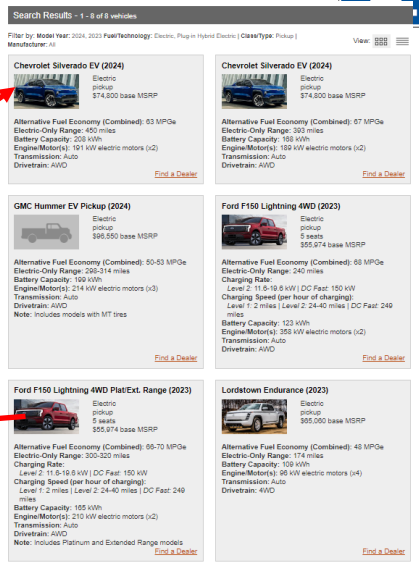
- **Availability varies by region and model**

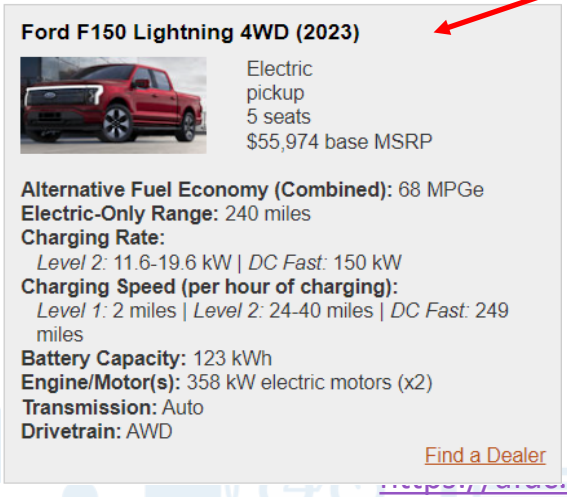
Shopping for EVs:

AFDC Advanced Vehicle Search









https://afdc.energy.gov/vehicles/search/

Fleet EV Availability by Vehicle Type

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Alternative Fuels Data Center

	# of 2025 Models per AFDC			
EV Type	BEV	PHEV/ EREV	TOTAL	Class
Sedan/Wagon	41	5	46	PV
SUV	55	20	75	1 & 2
Passenger Van/Shuttle Bus	41	5	46	2 & 3
Van	12	1	13	1 & 2
Transit Bus	28	0	28	5 & 6
Refuse	6	0	6	7
Street Sweeper	3	3	6	7
Pickup	10	0	10	1&2
Vocational/Cab Chassis	28	0	28	3 to 6
School Bus	16	0	16	4 to 6
Step Van	5	0	5	5 & 6
Tractor	13	0	13	7 & 8
Totals	258	34	292	

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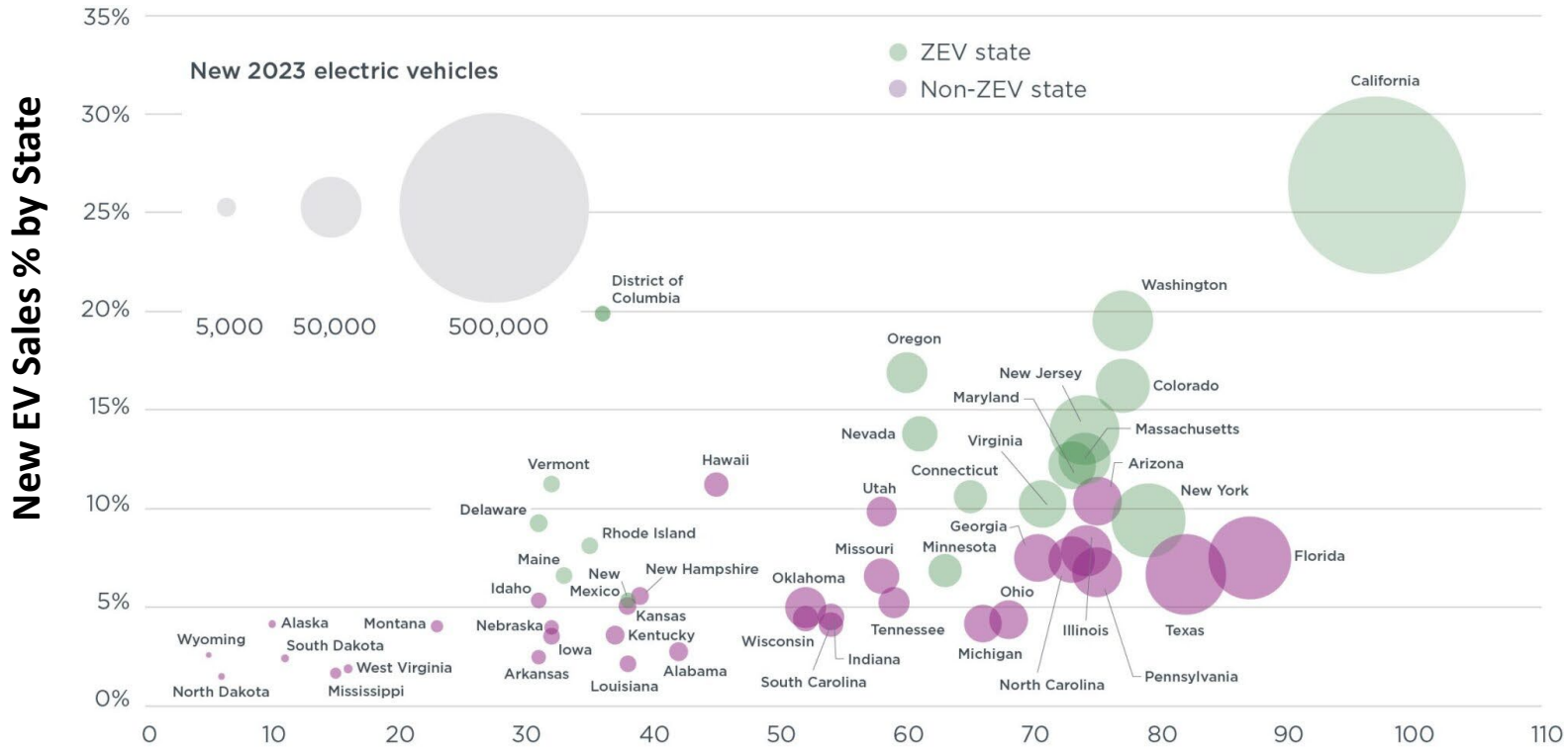
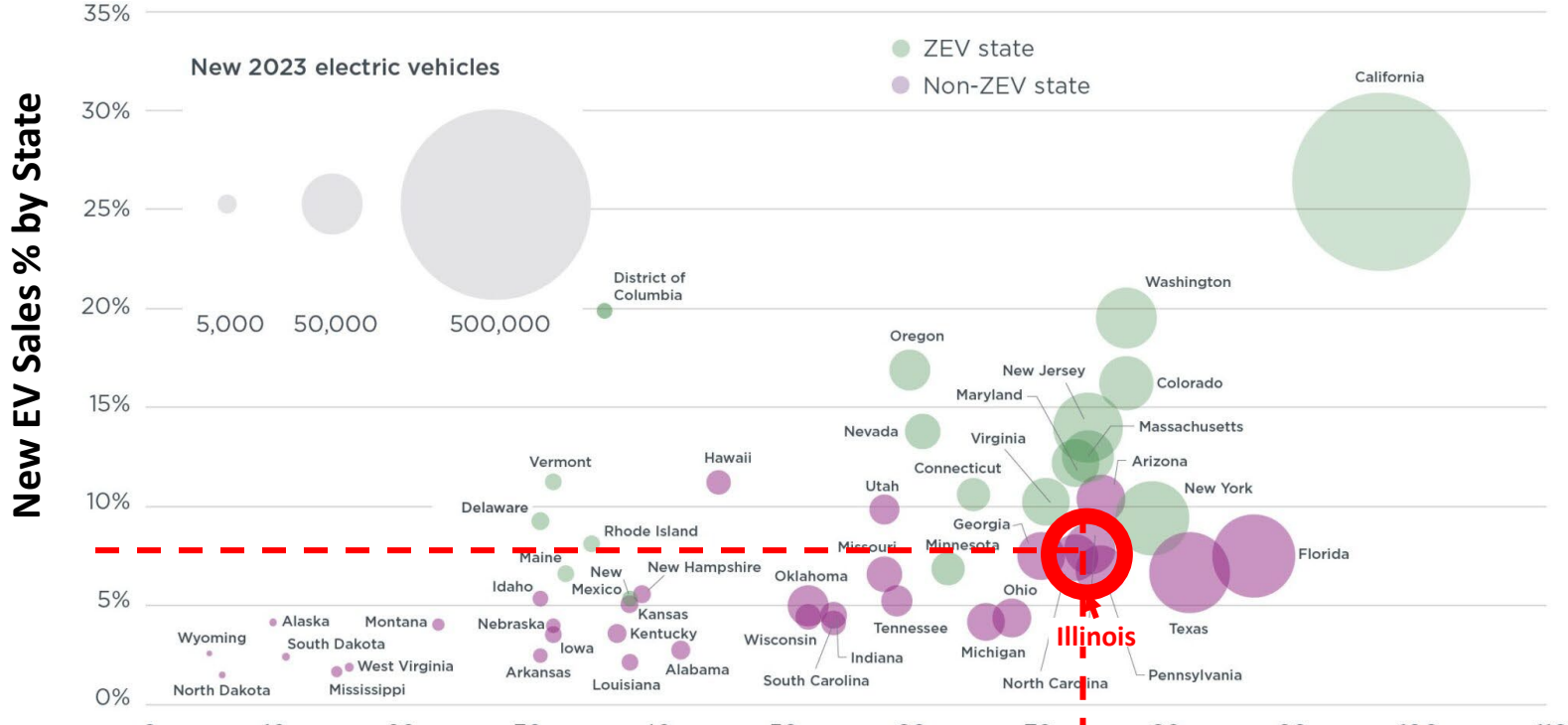
EV Model Availability by State



EV Model Availability by State



Finding EVs and Specs

Passenger EVs

- AFDC Alternative Fuel Vehicle Search – search by type, fuel, more
- AFDC EV Model Availability
- PlugStar Shopping Assistant – US Cars
- Consumer Reports, "Hot New Electric Cars"
- Car & Driver – New EV Models
- Car & Driver: New Car Reviews, Buying Advice and News
- Cars.Com - American Made EVs
- Electric Vehicle Database Website – global EV listings
- EV Technical Specs and Comparisons
- Compare EV choices Side-by Side: Fueleconomy.gov

Used Passenger EVs

- Autotrader Used EVs for Sale
- Edmunds Find Used EVs
- Carmax Used EVs

26 Pickup EV Models (Global)

	Class	Type of EV		Available?	AC	DC	kWh	miles	HP	Torque (ft-lb)	Min	Max	Photo
Atlis XT- Pickup	2	Pickup		TBD	N/A	1.5 MW at 1,600 V	125 / 250	300 / 500	600	12,000	$ 45,000	$ 69,000	
Bollinger B1	2	Pickup		Production Stopped			102 kWh	200				$ 110,000	
Caterpillar Pickup EV	2	Pickup		TBA									
Ford F-150 Lightning	2	Pickup		Yes	11.5	350		400	600		$ 62,000	$ 85,000	
Ford Ranger PHEV	2	Pickup - LD		2025?	TBA	TBA	TBA	28					
GMC Hummer Pickup EV	3	Pickup	10000	Yes	11.5	350	212/ 247	298/451	530/830	7400/11500	$ 95,000	$ 105,000	
GMC Sierra Denali EV	2	Pickup		Yes	11.5	350							
JAC T9 Hunter EV	2	Pickup		Yes- Asia only	11.5		77		225				
Jeep Gladiator PHEV	2	Pickup		2026			14	21	375	470	$ 58,000	$ 75,000	
Kia Tasman	1	Pickup - LD		2027									
Lordstown Endurance	2	Pickup		N/A				200	400				
Maxus eTerron9	2	Pickup		In Europe, US TBA			115	102	436				
Mistubishi Titon PHEV	1	Pickup		In Asia									
Nikola Badger – Pickup	2	Pickup											
Radar RD6	2	Pickup											
Ram 1500	2	Pickup		2025								$ 55,000	
Rivian R1T	2	Pickup		Yes			199 to 220	269 to 420	499 to		$ 71,000	$ 102,000	
Tesla Cybertruck	2	Pickup											
Tesla Pickup	2	Pickup		2026				500	600			$ 138,000	
Toyota Hilux	2	Pickup		TBA									
Toyota Tacoma EV	2	Pickup		2027									
VinFast	2	Pickup		2027				230					
VW Scout Amarok	2	Pickup		2026									
VW Scout Terra	2	Pickup		2027									
Workhorse C1000	3	Pickup		Yea									

SUVs & Pickups

- 75 SUVs (55/30)
- 10 Pickups (8/0)

Cadillac Escalade IQ0- BEV

Rivian RT1- Pickup BEV

Chevy Silverado BEV

Ford F150 Lighting BEV

Tesla Cybertruck BEV

GMC Sierra BEV

Dodge Ram 1500 BEV

GMC Hummer BEV

Bollinger B2 BEV

Medium Duty e-Trucks Class 3 to Class 6

Tata Prima Electric

Mack MD Electric

Motiv Argo Electric

International eMV

Workhorse Electric

Heavy Duty e-Trucks

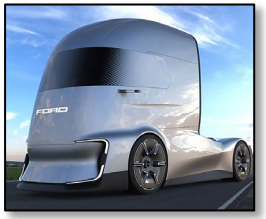
Freightliner eCascadia

Tesla Semi

Volvo

Peterbilt 579EV

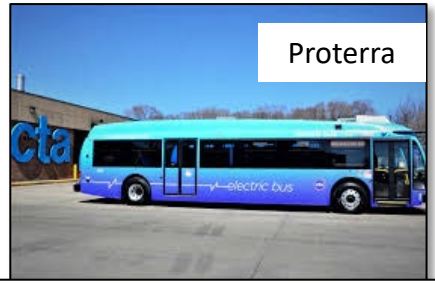
Kenworth



Ford Semi EV

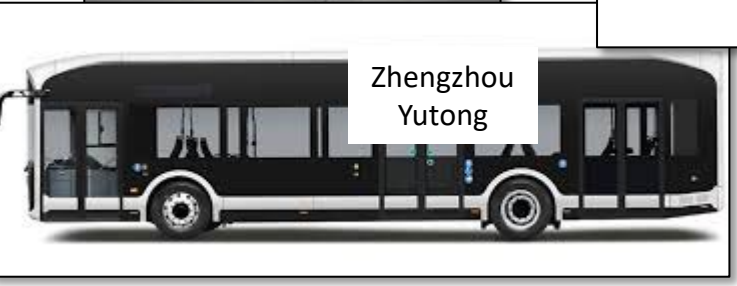
Nikola BEV

- 28 Transit Buses (28/0)
- 15 School Buses (15/0)



Proterra

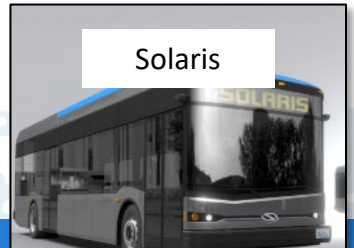
Volvo


Zhengzhou Yutong

Thomas

Tata


Temsa



Solaris

BYD

IACT
ILLINOIS ALLIANCE FOR CLEAN TRANSPORTATION

Thank You

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