# Fleet EV Stations and Infrastructure

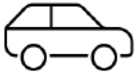

TIM MILBURN

GREEN WAYS 2GO

October 9, 2025


# Evolution of EV Charging

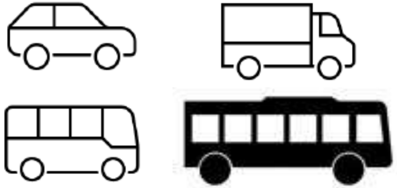
## 2020



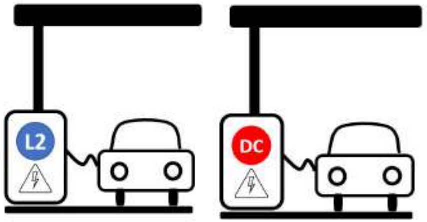
Residential
Public
Workplace

Existing Facility Power

## 2025

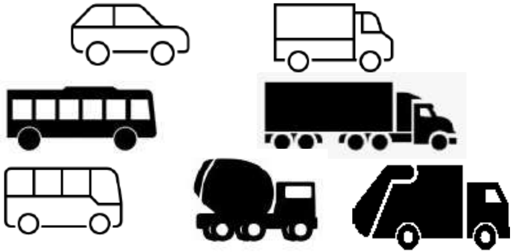


\+ Medium Duty Fleets
School / Transit Buses
Charging as Business




Local Utility Service Upgrades

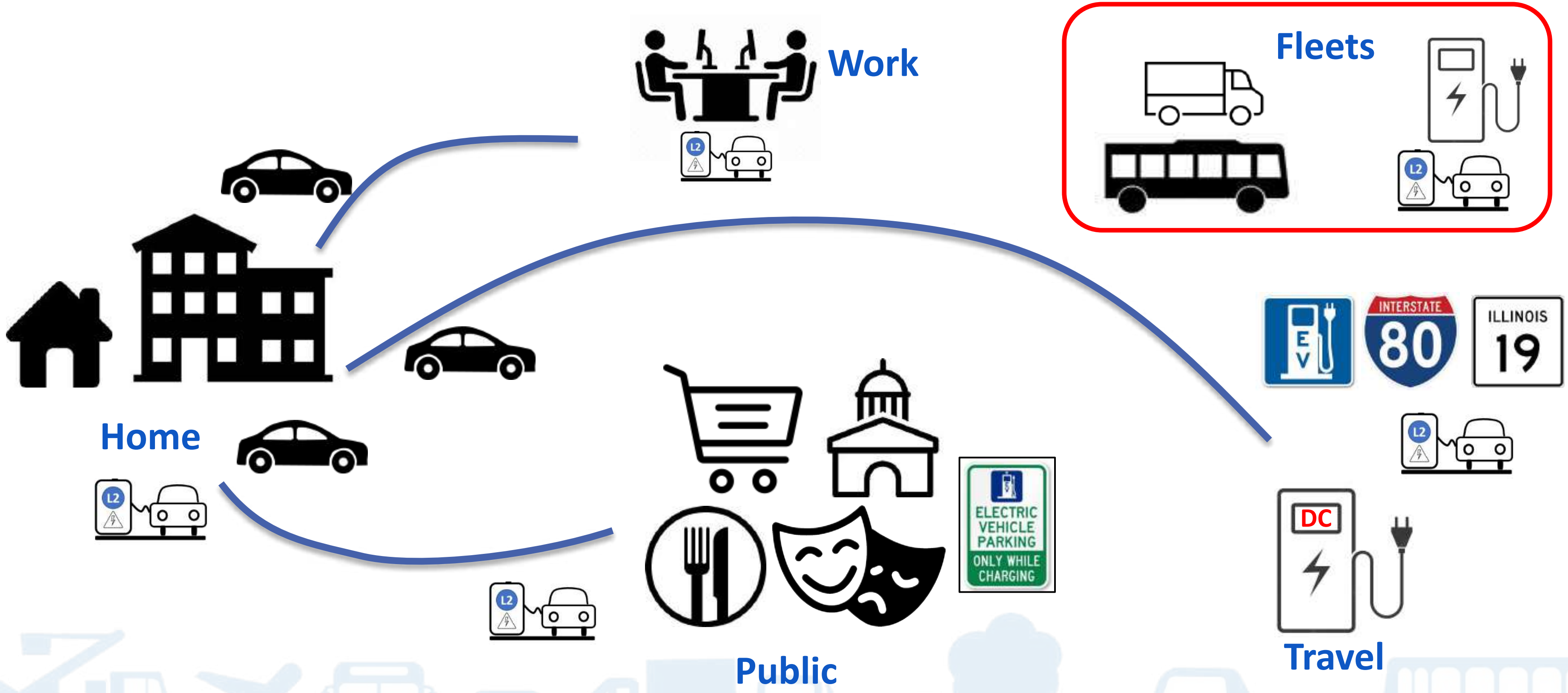
## 2030



\+ Heavy Duty Fleets
Megawatt Charging


Transmission and Distribution Upgrades

# EV Charging Ecosystem



# EV Charging Solutions

EVSE, INFRASTRUCTURE, OPERATIONS

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# EV Charging SOLUTION *Components*

- EV Supply Equipment (EVSE)
    - = EV Charger or EV Charging Station
- EV Charging Infrastructure (EVCI)
- Communication and Networking
- Energy Management
- Metering and Billing
- Value Added Capabilities
    - Reporting
    - Other

# EV Charging Solutions

## EV CHARGING INFRASTRUCTURE (EVCI)

**POWER SUPPLY EQUIPMENT (PSE)**
Panels
Circuit Breakers
Switchgear
Transformers
Interconnecting
Conduit and Wiring
Power Sharing
Other

**BRANCH RUNS/ CONDUIT DISTRIBUTION NETWORK**
Conduit
Wiring
Junction Boxes
Taps

## EV SUPPLY EQUIPMENT (EVSE)

**EVSE**
EV Charging Stations
Ports

**Cord**
Length
Manual
Auto Retraction

**Usage**
Dedicated
Shared

**Access**
Private
Public
Secured
Not Secured

**Video**

**Status Indication**
Visual
Audible

**Connector**
SAE J1772, CCS
J3400, NACS

**Mounting**
Wall
Pedestal
Ceiling

**Power Sharing**
Cloud Networked
Local Networked
Local Hardwired

**Warranties**
Parts & Labor
Term

**Integral Metering**

**Network Communication**
Technology
Fees

## ENERGY MANAGMENT

**SHARE POWER**
@Facility, @Panel
@Circuit

EVSE-Integral
Panel managed

**Distributed Energy Resources**

**Demand Response Management**

V2X

None

## COMMUNICATIONS

**NETWORK**
Wi-Fi
Cellular
Other wireless
Hardwired

**WI-FI SIGNAL COMMUNICATION**
Access Points
Switches/Routers/
Modems/Gateways

**CELL SIGNAL AMPLIFICATION**
Receiving Antennas
Amplifiers
Signal repeaters

EVSE-Integral
Facility Based
Combined

## METERING

Metering integral to EVSE

Metering separate from EVSE

Not Metered

Plug & Charge

## BILLING

Automated Billing

Manual or Semi-manual Billing

Annual Flat Fee

Free

**Data & Reporting**
- Admin
- Energy
- Financial
- Operational
- Etc.

IACT

# EVSEs

## EVSE, INFRASTRUCTURE, OPERATIONS

October 9, 2025

# 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

# EVSE Options: Level 2

1. 16 to 80 Amps, 208/240/277 VAC
2. Stationary (1a) vs. portable (1b)
3. Single (2a) vs. dual port (2b)
4. Simultaneous (3a) vs. shared ports (3b)
5. Mounting Style (Wall (4a), Pedestal(4b), Ceiling(4c)
6. Level 1 or Level 2
7. Cord management (none (5a), retractable integral (5b) or add-on (5c))
8. Cord length (18 to 25’)
9. NEMA plug option (7)
10. Access control (none (8a), smart (8b), mechanical(8c))
11. Automated metering and billing (wide range of solutions)
12. Networking (Cellular (10a), Wi-Fi (10b), Combined(10c))
13. Power sharing (Cellular (11a), Wi-Fi (11b), Ethernet (11c)
14. Reporting (Cellular (12a), Wi-Fi (12b), Combined(12c))

8

1b

1a, 2b, 3ab, 4b, 6c,9b, 11abc, 12abc, 13abc

1b, 2a, 5, 8

1a, 2a, 4c, 6, 8

1a, 2b, 3ab, 4b, 6c, 9b,10, 11abc, 12ab, 13abc

1a, 2s, 3a, 4a, 6a, 8, 9b, 10,11abc, 12abc, 13abc

1a, 2b, 3ab, 4b, 6a,7b,10, 11abc, 12abc, 13abc

1a, 2a, 3a, 4a, 6a, 8, 9a,

1a, 2b, 3ab, 4a, 6a, 9b, 11b, 12bc, 13b

# 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*

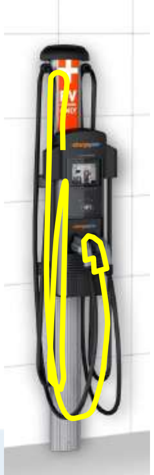

***Tesla EV Connector*** *(Left) and Plug (Right), Recently approved as* ***SAE J3400*** *or* ***North American Charging Standard (NACS)***

# Adapters

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

NACS □ CCS Adapter

NACS □ J1772 Adapter



CCS □ NACS Adapter

J1772 □ NACS Adapter

# Transitioning: CCS/J1772 to J3400

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


ChargePoint Level 2 **Omni Port** featuring J3400 or J1772

# DC Fast Chargers: Options

**25 to 1,000 kW**

**One or Two Connectors (Ports)**

1. Single connector
2. Two of same connector type
3. Two different connector types (e.g., CCS and CHAdeMO)

**Simultaneous vs. Single Port Charging**

4. Two connectors with simultaneous charging
5. Two connectors allowing only single use chargin
6. Two (or more) connectors sharing power

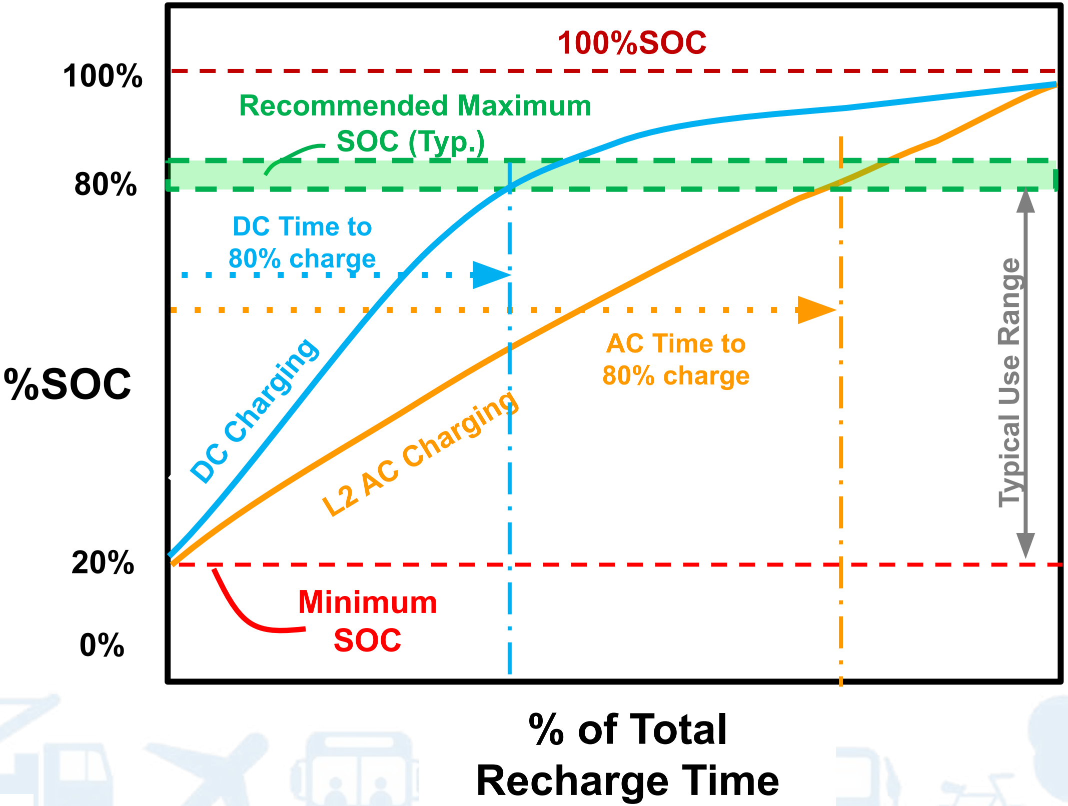
**Power Management**

7. Integral power management (in EVSE)
8. Separate power management






# SOC vs Rate of Charge, AC vs. DC




*Charging to 100% not recommended especially for DCFC on a regular basis*
*shortens battery life*

%SOC = State of Charge relative to fully charged

# *Use Case Drives Decisions*

EVs, EVSEs and Infrastructure

# Use Case Determines EVSE Choices

- Operational
- Vehicle
- Facility
- Investment recovery
  - Metering and billing
- Communications and networking
  - Information management
- Sustainability

**Determines**

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

# Charging Level vs. Charging Speed

- ***Level 1***: 1 to 2 kW
- ***Level 2***: 3.3 to 19 kW


kW= kilowatt

RMPH = Range Miles per Hour

# EV Range Factors and Solution Designs

ONE SIZE FITS ALL

***Top Priority concern:***

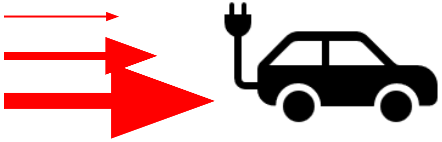
***RANGE MILES PER HOUR (RMPH) connected***

- 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

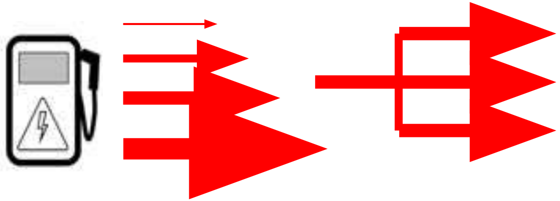
**Vehicle Factors**

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



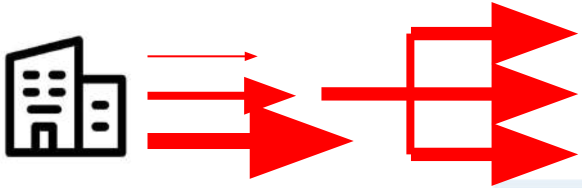
**EV Charger Factors**

1. Power Delivery Rate
2. Power Sharing



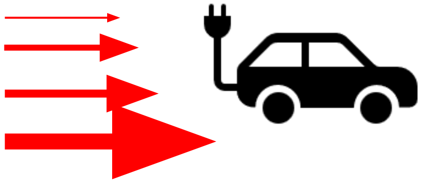
**Facility Infrastructure Factors**

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




# *Acceptance* Rate

| AC kW | DC kW |
| --- | --- |
| 3.3 | 50 |
| 7.7 | 150 |
| 11.2 | 250 |
| 22.2 | 350 |



- ***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

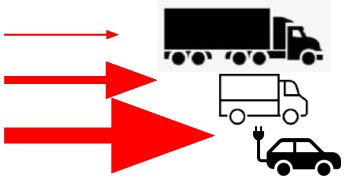
| Model (2024) | Acceptance Rate, kW |
|---|---|
| AC Charging (L2) | |
| Chevy Volt (2017) | 3.8 |
| Nissan Leaf SV (2023) | 7.7 |
| Subaru Solterra (2024) | 7.7 |
| Chevy Bolt (2024) | 7.7 |
| Nissan Ariya (2024) | 7.7 |
| Chevy Blazer EV (2024) | 11.5 |
| Ford Mustang Mach-E (2024) | 11.5 |
| Hyundai 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

0.02 to 0.07
0.1 to 0.3
2 to 5
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 |

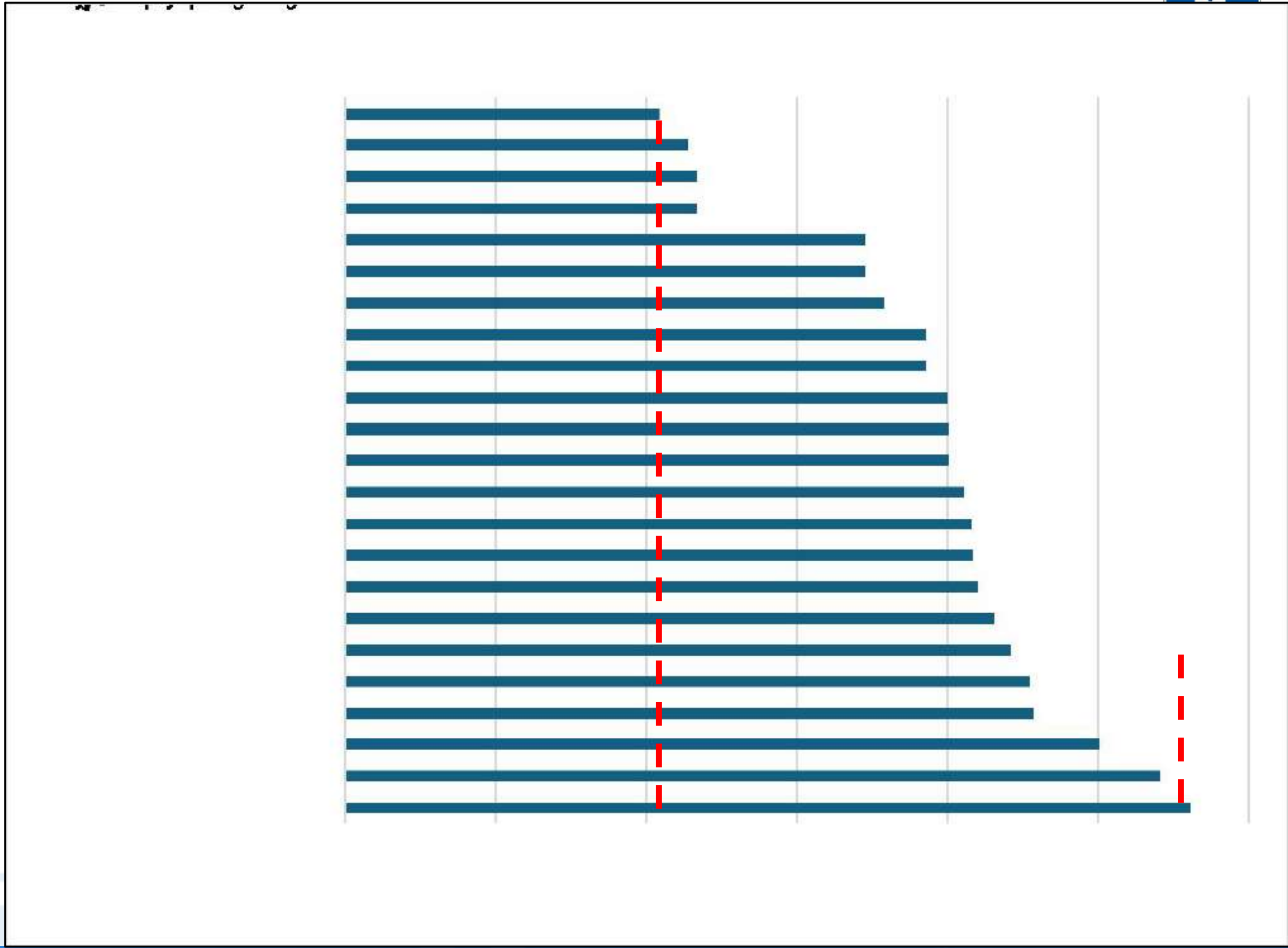
TECHNICAL REFERENCE INFORMATION

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?

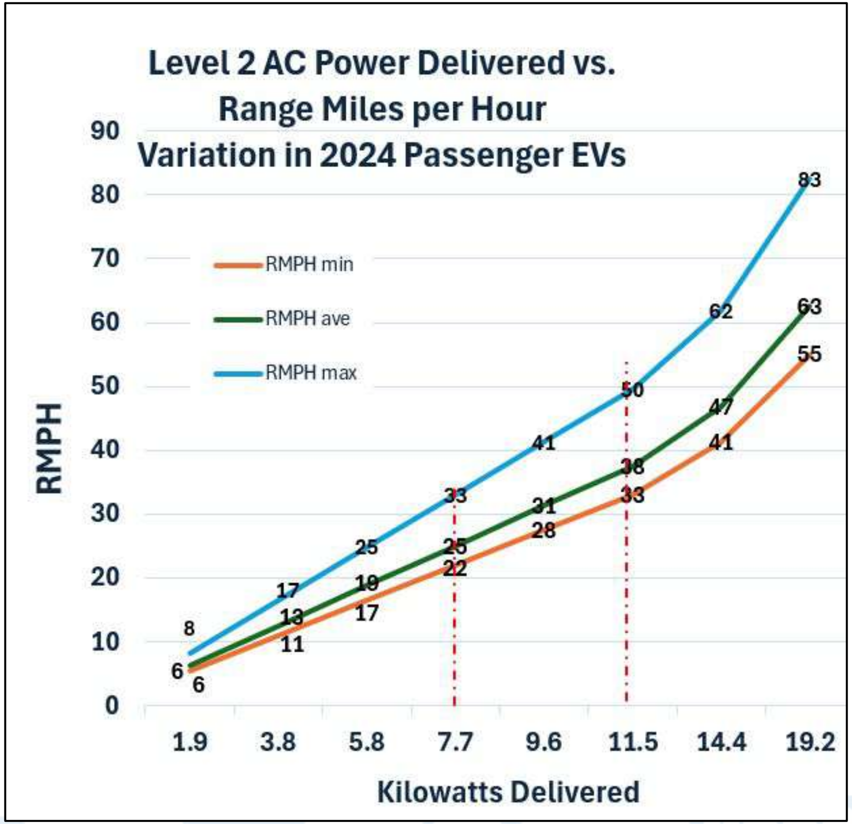
| Model | Mile/kWh |
|---|---|
| 2025 Tesla Model 3 | 5.4 |
| 2024 Tesla Model 3 | 4.56 |
| 2022 Tesla Model 3 | 4.00 |



# Recharge Efficiency Rate and Power Variation

*Recharge rate and miles per kWh depend on the EV model*

*Like Miles per Gallon!*



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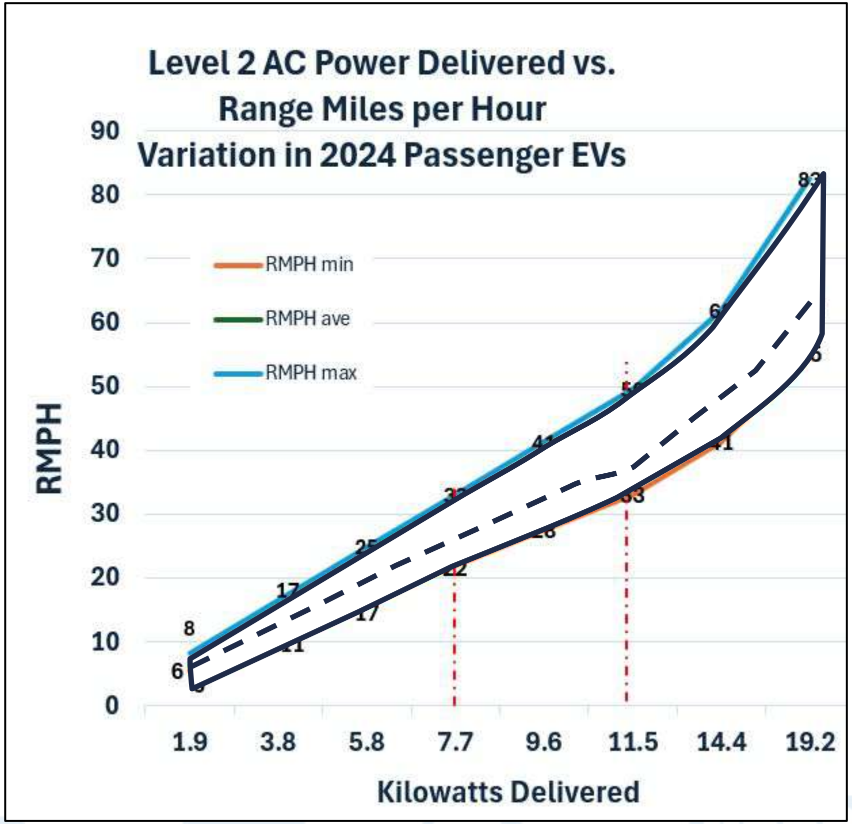
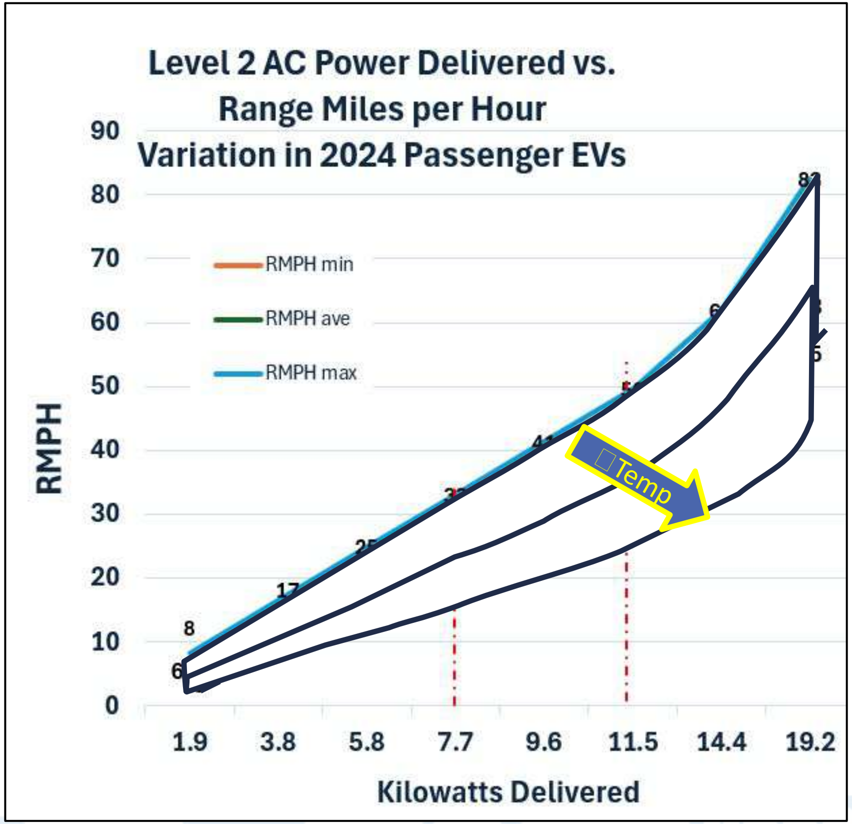


# Recharge Efficiency Rate and Power Variation

***Recharge rate efficiency depends on the EV model and***

***Temperature effects will apply***



# Direct Current Charging : *Higher Power is here*

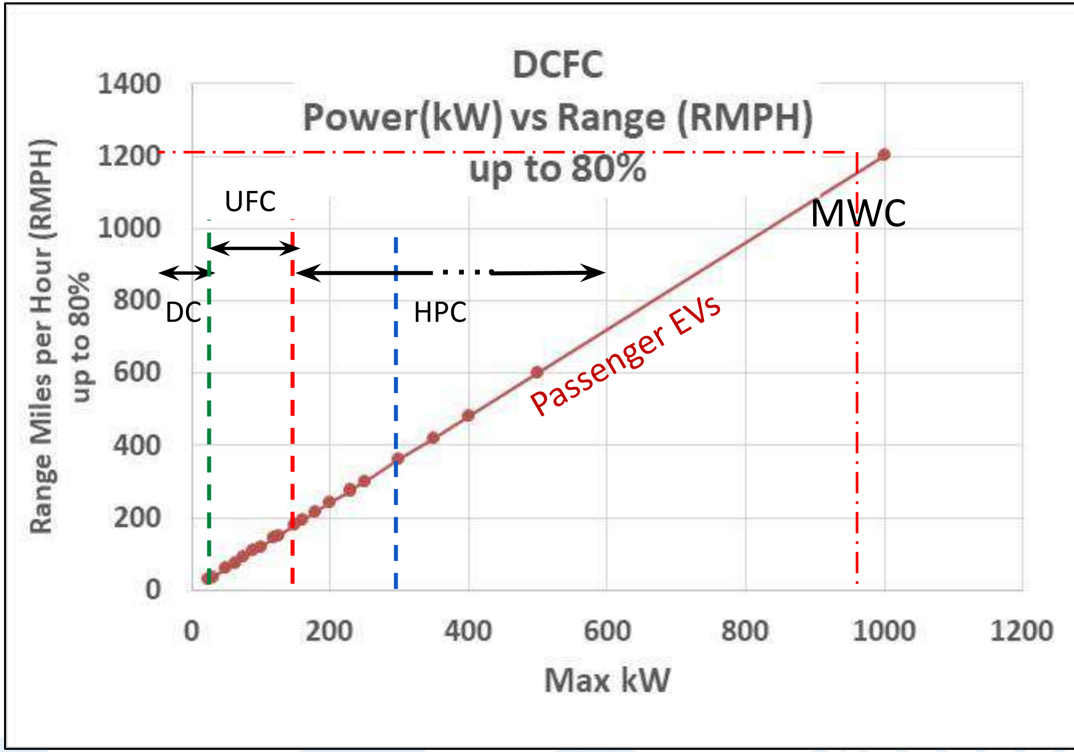
***Per Charin*:***

***(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***

***Other designations exist, but the trend is to move up in power. 350 kW is common***

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




*Charin- Global Standards organization for EV Charging

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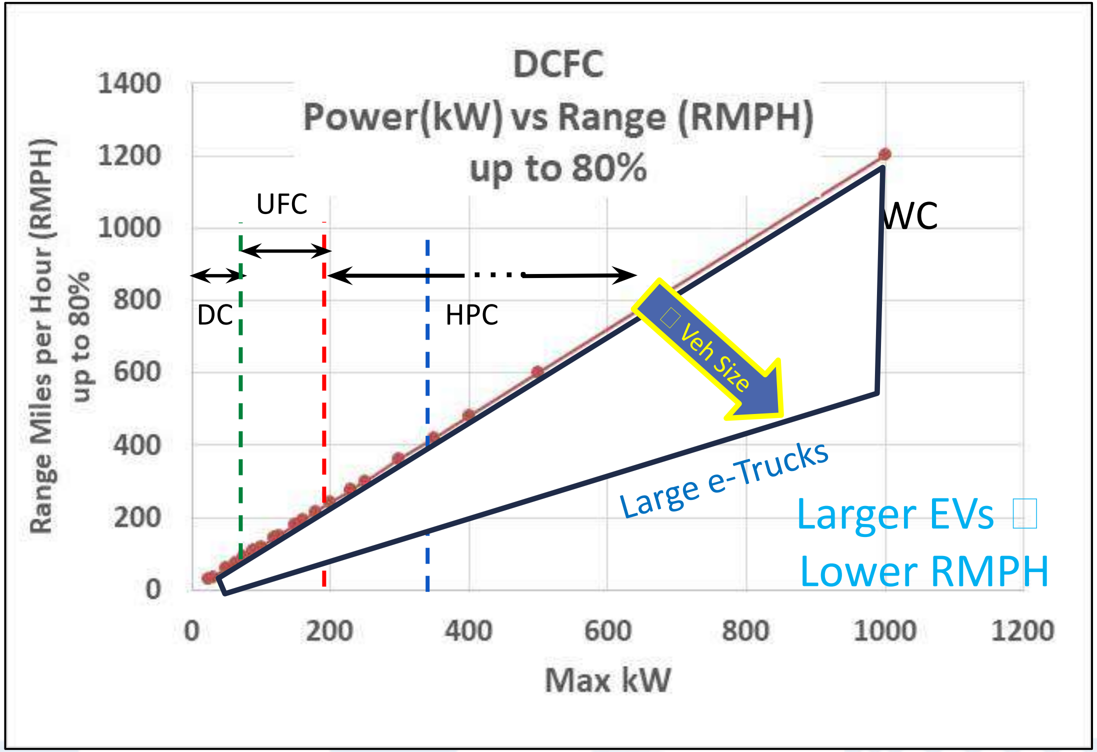


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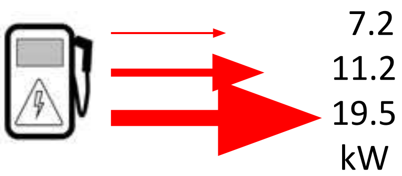
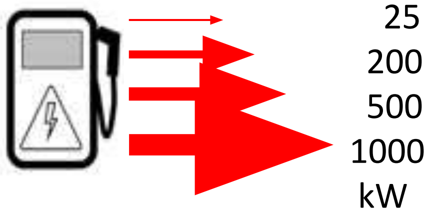
# EVSE Delivery Rate




**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 |

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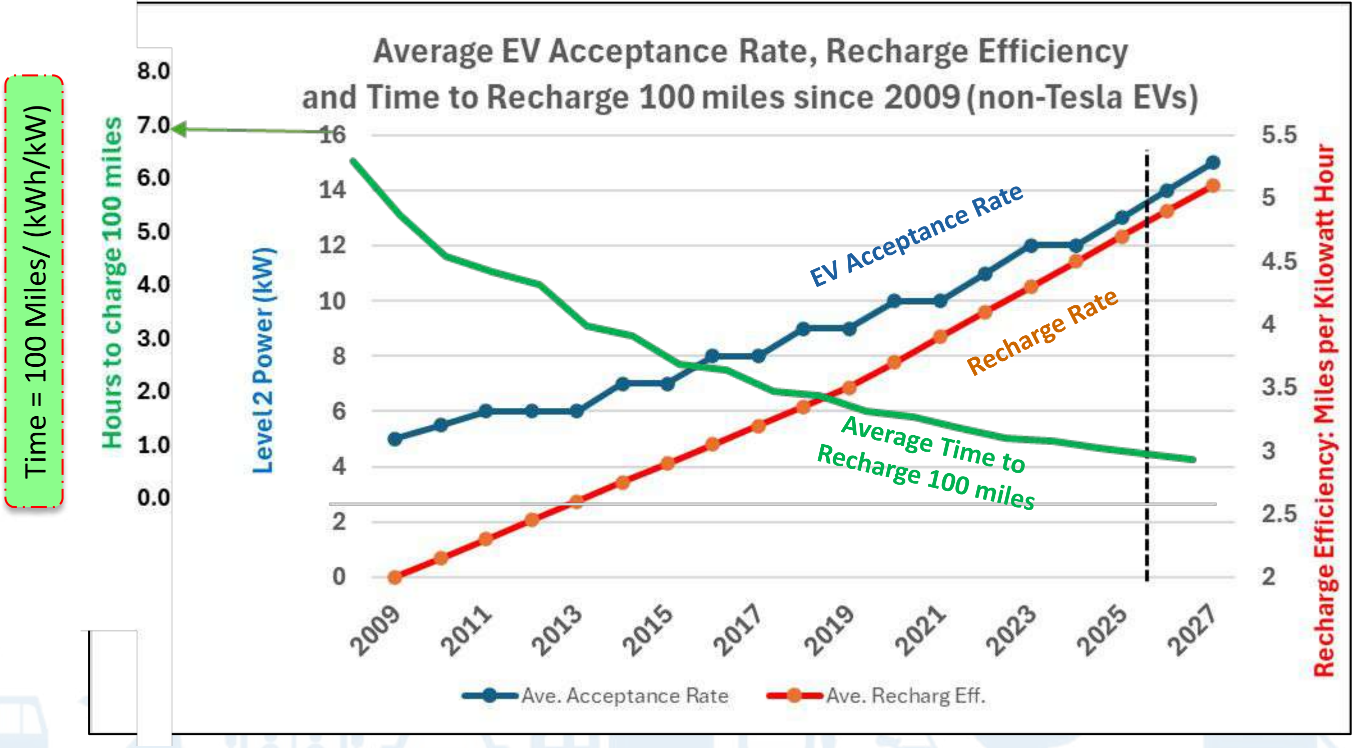
# Combined Performance



# Finding EVSEs for Purchase

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

# *Sizing EV Charging Infrastructure*


# EVSE: Use Case Parameters

- **Duty Cycles**
  - Daily routine
    - Mileage
    - Longest run
    - Seasonal variation
    - Load cycles
    - Hours of operation
    - Total power consumption
  - Range maxima
  - Recharging logistics
    - Refuel speed
    - Refueling ubiquity
    - Acceptance rates and fuel efficiency
    - Seasonal (temperature) impacts

IACT

# EV Charging Solutions
# Use Case Defined by Stakeholders

- **Facility**
  - Type of building, structure, parking lot or parking garage
  - Public vs private
  - Deeded vs. assigned vs. open parking spaces
  - Types of vehicles to be charged (cars, trucks, buses)
  - Operational cycles of EVs
  - Codes that apply to facility/zone/occupancy type (residential, commercial, etc.)
- **EVSE owner's/ operator's** expectations
  - Charging as a service, for cost recovery, to generate revenues/profits
  - Types of information needed to operate (energy, power, schedules, rates)
- **Users (Drivers)**
  - Types of users that use the EV Charging Station (customers, homeowners, visitors, employees, students, fleet)
  - User expectations (charge time length, recharge speed, number of miles to recharge, hours of operation, safety)
  - User activities while waiting (shopping, dining, entertainment, recreation, business)

- **EVSE** Specifications
  - Shared vs. dedicated
  - Power ratings, features, charging level(s),
- **Communication**
  - Networking, payment systems, ties to grid, reporting
- **Energy management**
  - Power sharing, distributed energy, Vehicle to grid, demand response management
- **EVSE Reliability / Aftermarket**
- **Accessibility** requirements (ADA)
- **Equity** requirements

# Supply and Demand

*Power supply must be ≥ power demand*


- Power demand
  *= # of EVs x charging rate* (kilowatts, kW)
- Facilities should plan supply based on assumptions in growth in demand (future proofing, redundancy)
- Facilities need to also consider
  - Value of EV Charging Infrastructure to facility
  - Investment recovery method, timing

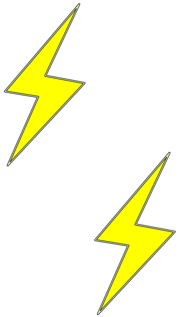
# Basis: Supply and Demand Profiles


When planning for EV charging infrastructure investments

- Main question is:
  - ***How much electricity*** **is needed now and will be needed to recharge EVs?**
  - ***Power supply must equal or exceed the demand of users***

First steps:

1. Estimate **Demand Profile** : Understanding the Facility and Market
   - Users and their recharging behavior and needs
   - Value of enabling EV charging at the facility
   - Interest of users wanting EVs
2. Determine **Supply Profile**
   - Quantify the amount of existing power at the host facility
   - Determine whether demand can be met with existing capacity
     - If so, what investments will be needed when?
     - If not, how much new power will be needed and when and what are these investments?



# Typical Process for a Facility

1. **Planning: Site Assessments**
    - Establish a **DEMAND profile:** EV count, sizes, battery capacities, use case…
        - Converts to EVSE power profile – number of EVSE ports, power levels
    - Establish a **SUPPLY profile:** Capture existing capabilities, set near-and longer-term electric charging infrastructure power requirements
    - Review **"What-If" scenarios**
    - Leverage incentives
2. **Decide on go-forward plans**
    - Now vs. later – staging EVCI investments
    - EVSE locations and quantities
    - ADA needs
    - Define **EV charging solutions** – dedicated / shared, metering, billing, cost splits, communication
3. **Select contractor(s)**
    - **Installer**
    - **Advisor**
4. **Design**
5. **Install and commission**

# EV Charging Infrastructure = EVCI

**EV CHARGING INFRASTUCTURE (EVCI)**

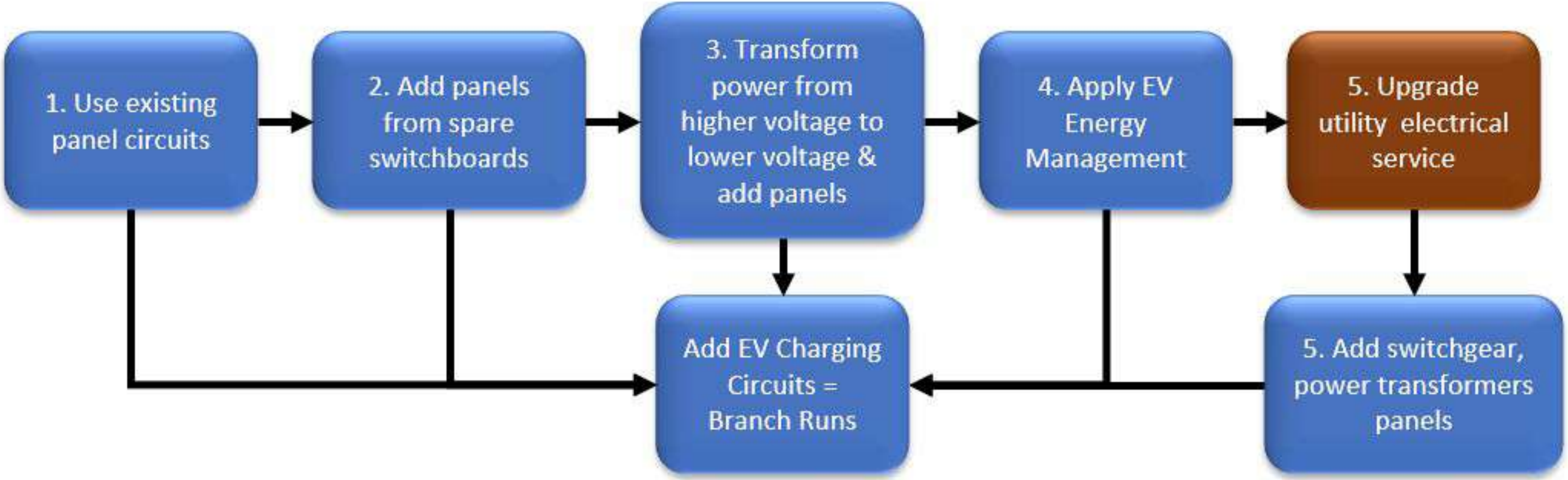
**POWER SUPPLY EQUIPMENT (PSE)**

Panels
Circuit Breakers
Switchgear
Switches/ Fuses
Transformers
Conduit and Wiring

**POWER  DISTRIBUTION EQUIPMENT (PDE)**

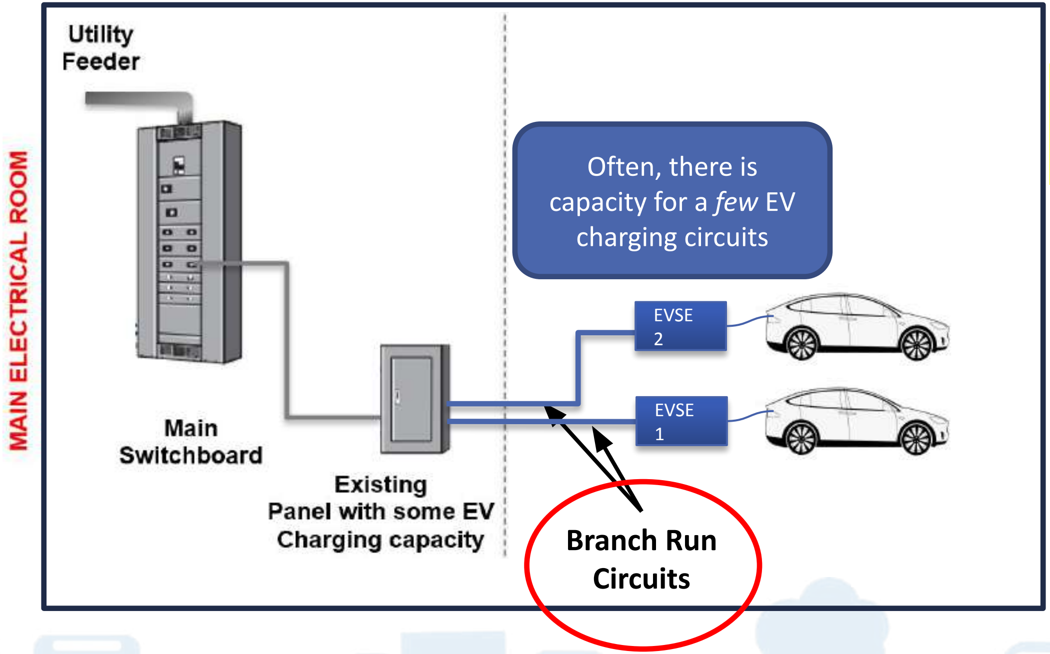
Branch Runs
Conduit Distribution Networks
Conduit & Wiring
Junction Boxes

# Planning Sequence for Retrofitting w/ Shared EV Charging Infrastructure (EVCI)



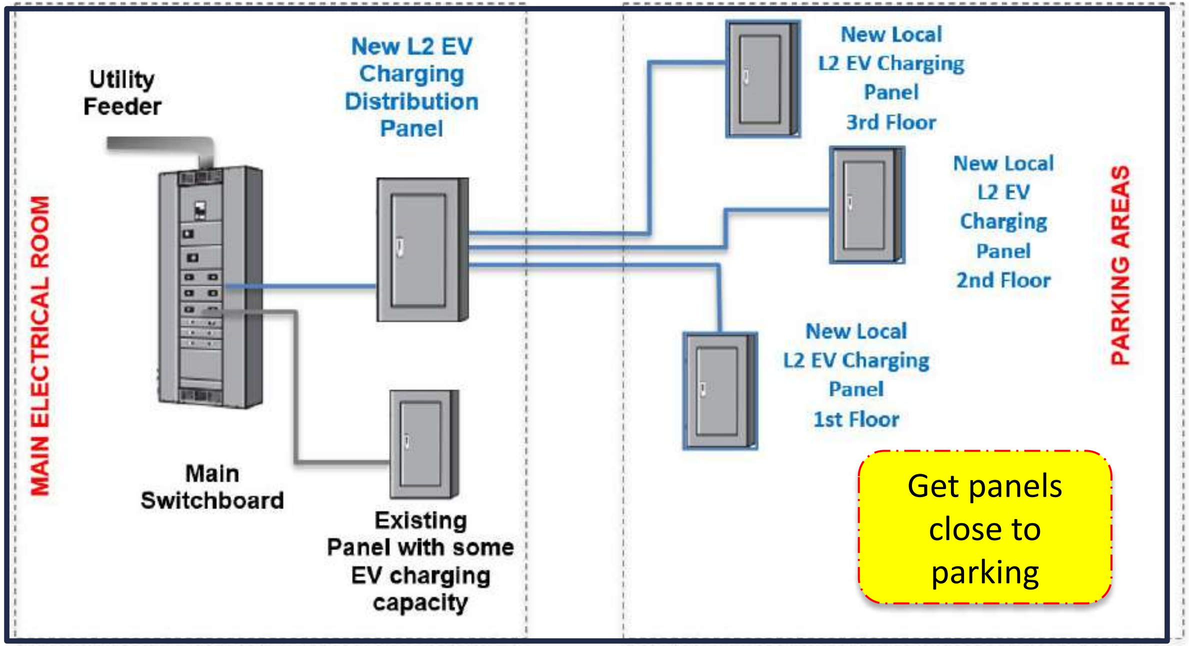
# Supply Scenario : Use Existing Panels

Distribute power branching from existing panel(s) to EV charging stations

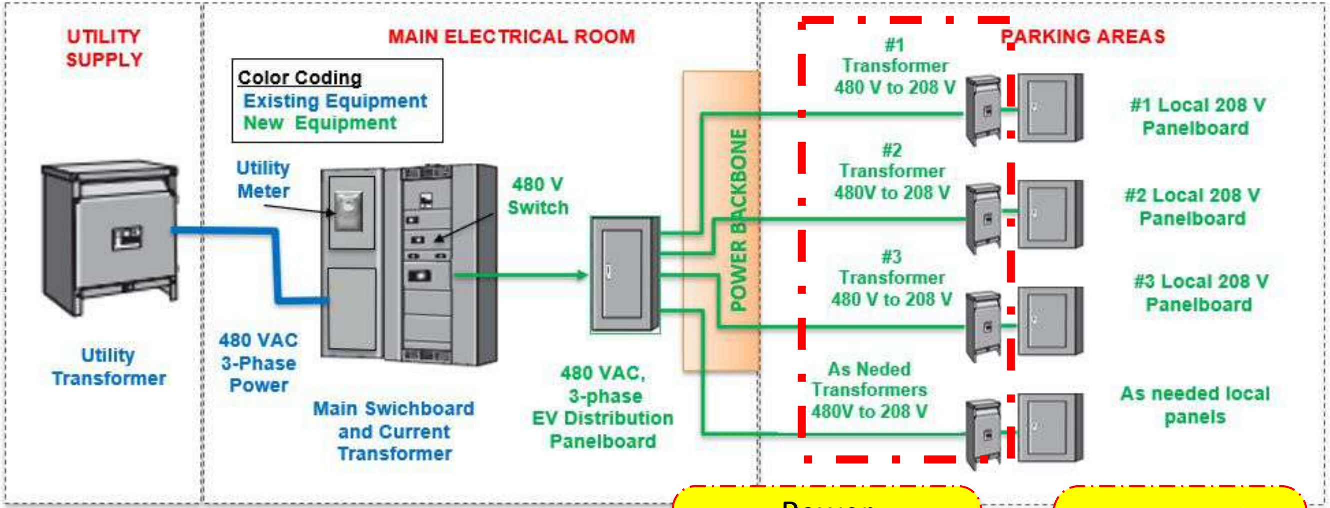



EVSE
= EV Supply Equipment
= EV Charging Station

# Supply Scenario: Adding Dedicated EV Charging Panels



# Supply Scenario : Adding Transformers and Panels

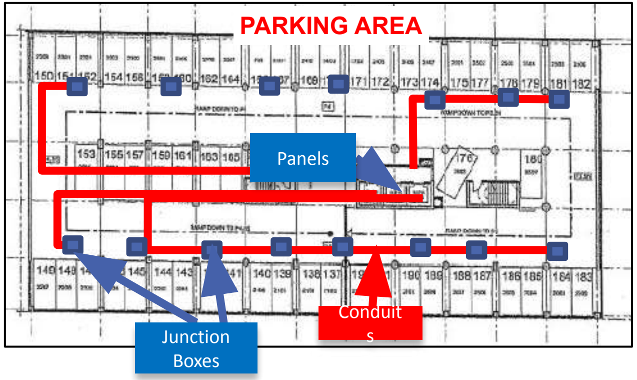



Power Transformation Required

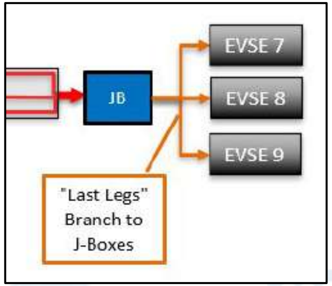
Get panels close to parking

# Power Distribution: Conduit Networks

- **Pre-run *conduit and wiring*** close to some or all parking spaces
- When EVSE installed, run "last leg" of circuit
  - Fair distribution of power
  - Lower cost/EV Space - at high % EV parking
  - Easy to power share
- Facility pays for upfront, typically
- Cost recovery through growth in use
- Can be staged




Get wires closer to parking and the same distance / cost for all to connect



# EVCI Power Max

***Maximum current / power***

- Defined by EV Charging Infrastructure
  - Amount of power available from utility
  - Amount of power available at each power node in each facility
  - Amount of power allowable in breaker
- Maximum amount allowed by conduits and wiring feeding EVSEs
  - Once installed, this ***caps the maximum amperage / power available***

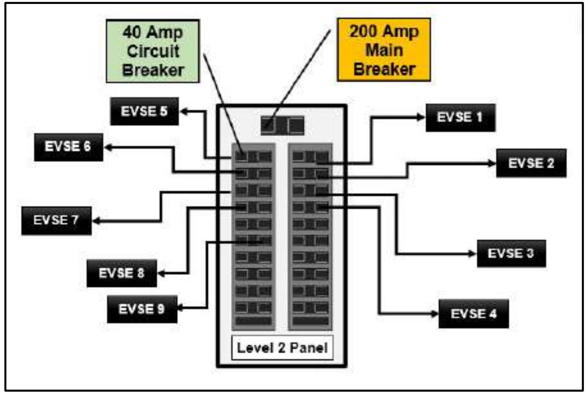
# EVCI Power Sharing

***Share current between panels, circuits, ports***

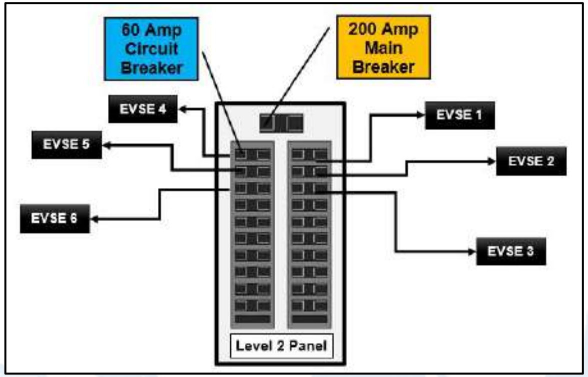
- RMPH proportional to amperage
- More sharing, slower recharge rate
- Level of sharing and sharing scheme tied to use case
  - Users expect to be recharged for their use case within reasonable time
  - This need inform whether to power share and if so, what level of sharing

# EV Charging Energy Management

- <u>No</u> power sharing
  - Typ. 200 A panel capacity
    - 9 EVSE circuits (32 Amp)

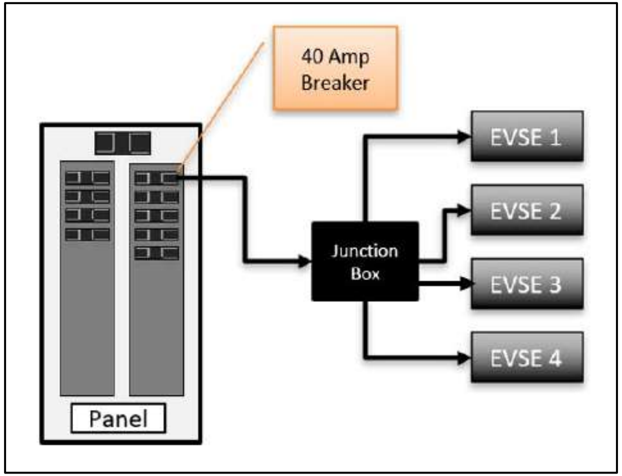



    - 6 EVSE circuits (48 Amp)

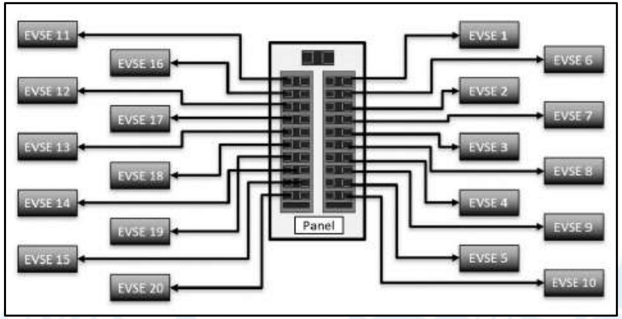


# Supply : EV Charging Energy Management

- **SHARING POWER**
  - Typical 200 Amp (3 phase)
- Share power in a **circuit**
  - Simultaneous charging circuits
    - 4X for 32 Amps (36 total)
    - 6X for 48 Amps (36 total)
    - 10 x for 80 Amps (40 total)
  - More EVSEs can be connected and share circuits

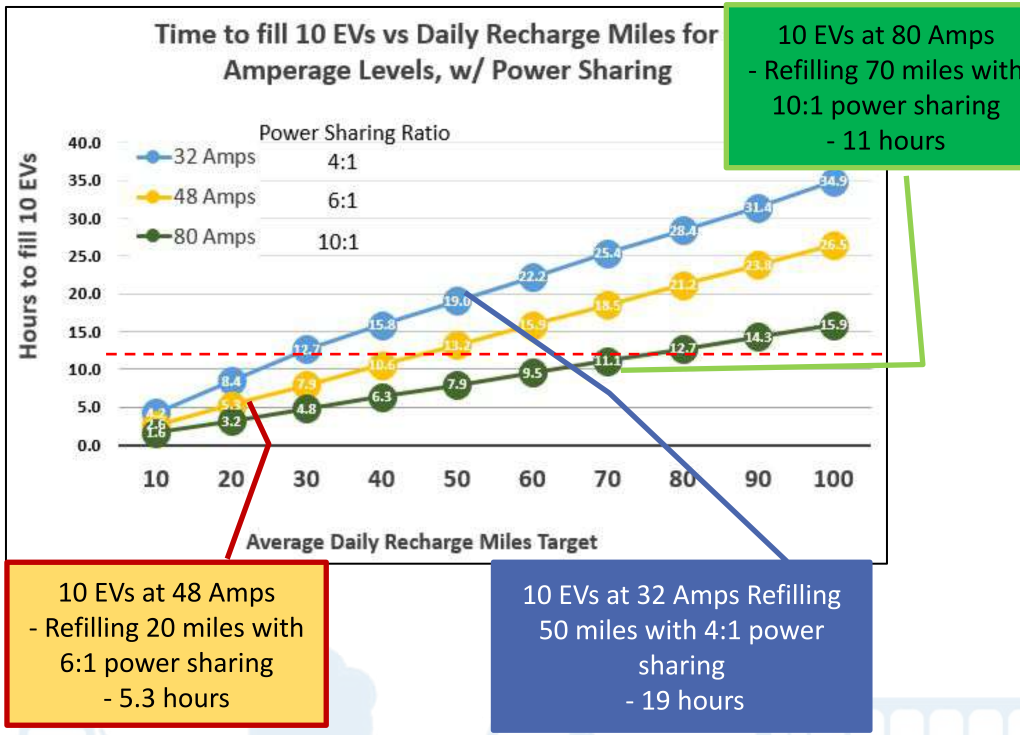



- Share power in a **panel**
  - Simultaneous charging circuits
    - Up to 3X
  - More EVSEs can be connected and share circuits



# Use Case Determines Power Sharing

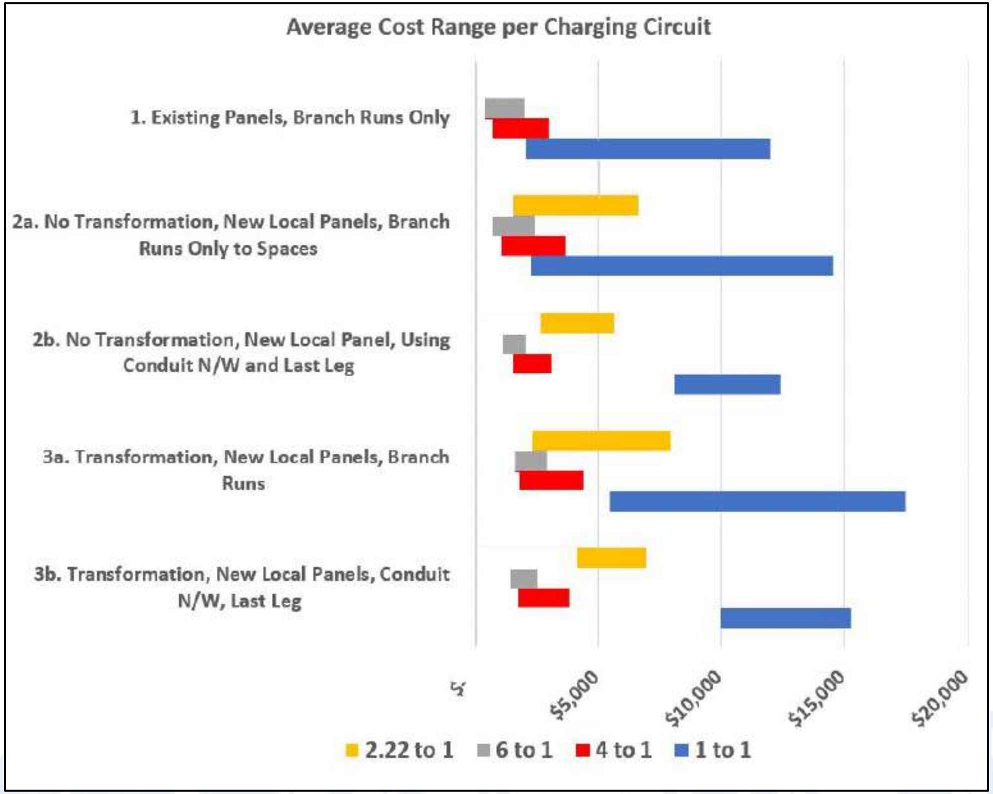
- 10 EVs sharing facility power
- Vary amperage
  - More design amps
    - More expensive
    - More simultaneous charging
    - Few EVs with 80-amp capacity
  - More amps: less time
  - More miles: more time
- *Balance use case (hr./day) with costs and acceptance rates (A) □ design amps*



# Investment Cost Ranges

**Key Variables**

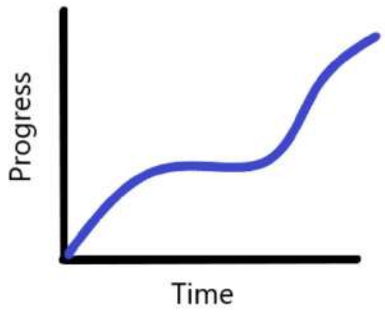
- Power sharing ratio
- Extent of new EVCI
  - Power Supply Equipment
  - Distribution method
- Stakeholder participation
- Cost splits
- Future proofing



# *Demand Profiling*

# Determining Demand Profiles

- Learning Curve: educate and communicate with owners, management boards, visitors, building staff, property managers, valet services, etc.
- Make sure the cost recovery ideas defined early
- Stakeholder surveys help define Use Case
- Interest tends to grow once ability to charge is provided/ communicated
- Establish value is added
- Shared vs. dedicated – may play a role
- Keeping up with the Joneses – some MDUs are Sustainability policies may drive




# ***Load Profiling***

# Battery Sizes: kWh

- *Passenger EVs Battery sizes range from 16 kWh to 150 kWh  (kilowatt hours)*
  - *16 kWh  35 to 45 miles*
  - *95 kWh   220 to 300 miles*
  - *150 kWh   350 to 420 miles*

- *The size of the battery determines how often an EV needs to charge*
- *Most EVs today: 150-to-300-mile range*
- *PHEVs up to 60 miles*

# Range for Class 8 Trucks

| Model | Range miles (mi) | Charging Time minutes (mn) | Battery Capacity kilowatt hour (kWh) |
|---|---|---|---|
| Kenworth T680E | 150 mi | 125mn (80%) | 396 kWh |
| Peterbilt 579EV | 150 mi | 120mn (90%) | 400 kWh |
| Freightliner eCascadia | 150-230 mi | 90mn (80%) | 291 - 438 kWh |
| Volvo VNR Electric | 275 mi | 90mn (80%) | 565 kWh |
| Nikola Tre BEV | 330 mi | 160mn (80%) | 733 kWh |
| Tesla Semi | 500 mi | 30mn (70%) | 500 - 1,000 kWh |

All figures are courtesy of the manufacturers

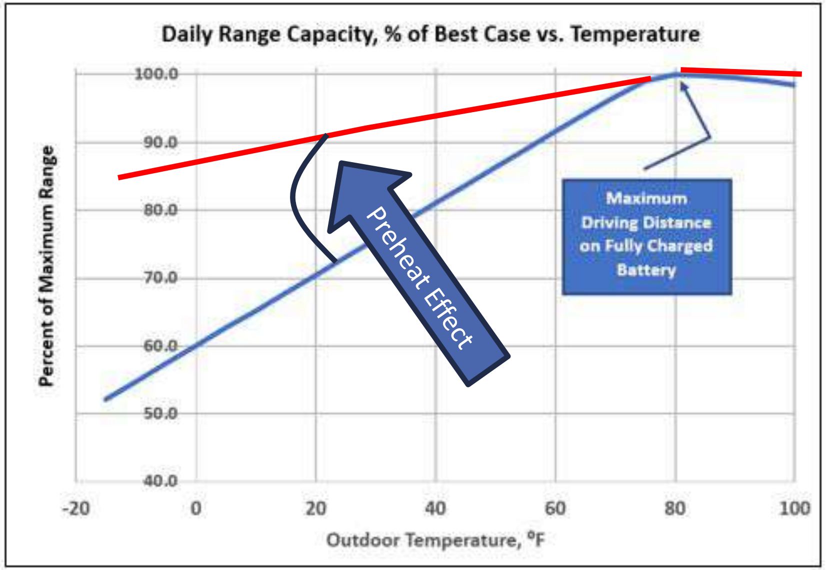
# Vehicle and Load Range Factors

1. Vehicle load – physical weight, including towed and carried loads
2. Road terrain
3. Driver behavior
   – Acceleration habits
   – Use of regenerative braking
   – Use of HVAC

*All these factors effect mileage on ICEVs too*

# Temperature Effects on Range

1. Ambient temperature of battery directly affects range*
2. Battery Thermal Management Systems (BTMS) improves efficiency**.

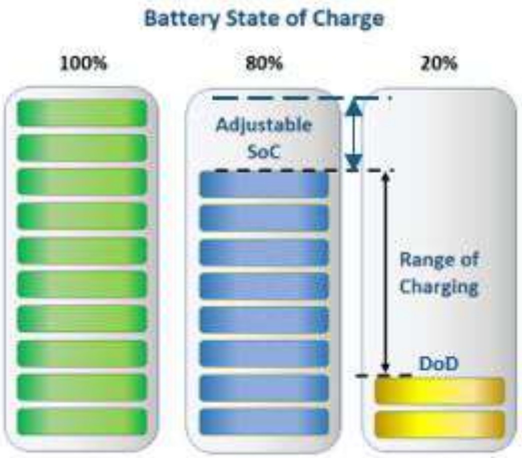



*Cold Temps slow down the chemical reactions within the battery
Hot temps increase internal resistance reactions occur faster, less efficient.
** BTMSs use facility energy or EV energy to heat/cool battery to temp where the chemical reactions are most efficient.

# Battery Range and Life Factors: Driver Roles

- Miles per charge decreases with time
  - Rate depends on number of charge cycles, EV age, total miles driven, and driver habits

- Charging habits impact degradation
  - Fill State of Charge (SOC, < ~80% recommended)
  - Rate of charge (e.g., L2 vs DCFC)
    - DCFC, higher power and frequent high SOC may shorten life, depending on SOC and battery control
  - Use of battery pre-conditioning (pre-heat/pre-cool)
  - Depth of Discharge (DOD) – charge level when refilling starts
    - Full discharge shortens life.
    - Most EVs factory set at ~20%

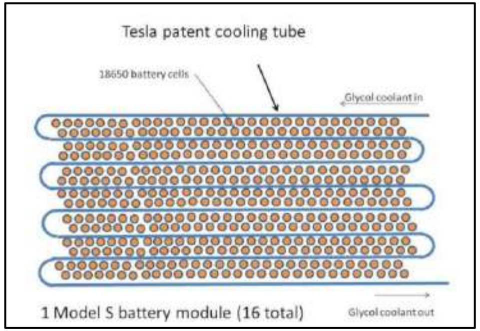


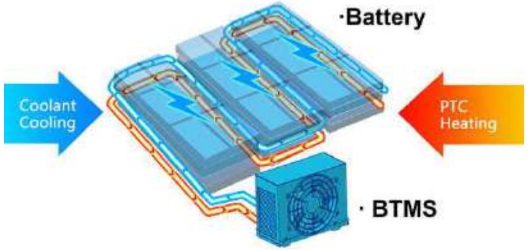
# Battery Life Factors: Battery Thermal Management Systems

- Battery Temperature
  - Ambient temperature affect
  - Indoor vs outdoor parking
  - Battery Thermal Management Systems (BTMS)
    - Cool battery when hot out
    - Heat battery when cold out

*Batteries being developed targeting million miles of life*

Tesla Glycol Cooling System



*Introduction to Transportation Electrification*

# AFTERMARKET AND TROUBLESHOOTING

# Aftermarket and Troubleshooting

- EVSE hardware warranties
- EVSE software issues
- Communication / networking hardware warranties
- Communication / networking software issues
- Connectivity issues
- EVCI hardware warranties

***Make sure you know who will address which warranty issues!***

EVSE = EV Supply Equipment
EVCI = EV Charging Infrastructure

# EVSE Aftermarket

- EVSE <u>hardware</u> warranties (typ. 1 to 3 years)
  - Parts replacements w/ purchase
  - Full EVSE replacements for some failures
  - Parts and labor ($)
  - Ask about local support & response time when purchasing
  - Extended programs (e.g., 5 to 10 years)
    - Incentive programs may require, especially with DCFC
  - Depends on charging level and cost
    - DCFCs – more complex machines, repairs likely. Extended warranties recommended
    - Spare parts programs for larger EVSEs
- EVSE <u>software</u>: technical support ranges from none to 24/7/365
  - Requires networked connection
  - Problems solved remotely
  - Look for auto updates and repairs
  - Warranty tied to annual network licenses, not hardware warranty
  - If remote resolution not possible, may need to engage EVSE vendor for local support

EVSE = EV Supply Equipment
EVCI = EV Charging Infrastructure

# Communication Aftermarket

- Communication / networking
  - If cellular – communication issues likely resolved by telecom company
  - If Wi-Fi – someone must troubleshoot, determine cause and extent of solution, responsible parties – who repairs, if not internal IT group
  - 1-year materials and workmanship for purchased communication hardware
  - Purchased items – responsibility of installation contractor, who will pass onto vendors
  - Installation work – contractor responsible

# Connectivity Issues

- Hardwired connectivity between EVSEs and infrastructure
  - Electrical and communication connections
  - Turnkey installer responsibility
- Wireless connectivity between EVSEs, network and remote servers
  - Turnkey installer responsibility
  - If site owner acts as general contractor, they will need to resolve
  - Issues may involve hardware and/or software for EVSE and/or network
  - Depends on network
    - Cellular
      - Hardware issues resolved by EVSE vendor
      - Network issues typically resolved by telecom company
    - Wi-Fi
      - Hardware issues resolved by EVSE and Wi-Fi equipment vendors
      - More complex or proprietary installations may need third party support
      - May use internal IT support
  - Signal strength issues
    - Cellular: Signal boosting in weak areas
    - Wi-Fi: Increase Access Point density

EVSE = EV Supply Equipment

# EVCI Aftermarket

- Infrastructure warranties and guarantees (1 year typ.)
  - Materials and workmanship for all EVCI hardware
  - Purchased items – responsibility of installation contractor, who will pass onto vendors
  - Installation work – installation contractor responsible

# *Tools*

FINDING STATIONS, PLANNING, MODELING, MAPPING, DATA, POLICIES, INCENTIVES

# Finding Stations

- AFDC **LINK**
- PlugShare LINK
- Tesla LINK
- Electrify America LINK
- ChargePoint LINK

# Planning Trips

- Google Maps LINK  (built into many EVs)
- ChargeHub LINK
- PlugShare LINK
- evNavigation LINK
- EV Trip Planner LINK

# AFDC Tools: Calculators

EVI-X Toolbox
Analyze EV charging infrastructure scenarios with the EVI-X Modeling Suite.

AFLEET Tool
Calculate a fleet's petroleum use, cost of ownership, and emissions.

Vehicle Cost Calculator
Compare cost of ownership and emissions for most vehicle models. mobile

VICE Model
Evaluate the financial case for natural gas vehicles and battery electric buses.

# AFDC Tools: Calculators

JOBS Model
Estimate economic impacts of deploying alternative fuel and charging infrastructure.

Charging Hub Economic & Costing Tool
Estimate levelized charging costs ($/kwh) for various EV charging scenarios.

HEVISAM
Estimate levelized charging costs ($/kWh) for electric truck fleets.

# AFDC Tools: Data Searches

Vehicle Search
Compare all classes of alternative fuel vehicles, electric vehicles, and hybrids.

Laws and Incentives Search
Search for laws and incentives related to alternative fuels and advanced vehicles.

U-Finder
Search for local utility partners and incentives for EV infrastructure installation.

Battery Policies and Incentives
Find policies and incentives for batteries developed for EVs and energy storage.

# AFDC Tools: Data Searches

[Fuel Properties Comparison]
Compare alternative fuel properties and characteristics.

[Find a Car]
Compare fuel efficiency, costs, carbon footprints, and emissions. [mobile]

[State Information]
Find state information about alternative fuels and advanced vehicles.

[Electricity Sources and Emissions]
Learn how your state's energy mix affects electric vehicle emissions.

# AFDC Tools: Interactive Maps

Alternative Fueling Station Locator
Locate alternative fueling stations and get maps and driving directions. Mobile

Alternative Fuel Corridors
Find maps and station data to help with nominating alternative fuel corridors.

TransAtlas
Explore light-duty vehicle registration counts over time by state and fuel type.

Coalition Locations
Find Clean Cities and Communities coalitions and director contact information.

Geospatial Energy Mapper
Explore data and use analysis tools to plan energy infrastructure geographically.

ATRAVEL Tool
Estimate costs, travel time, and emissions

# *Thank You*


TIM MILBURN

GREEN WAYS 2GO

October 9, 2025

# *Fleet Electrification Case Study*

**KEN CROWLEY:** **SUPERINTENDENT OF FLEET SERVICES**

**VILLAGE OF OAK PARK**