

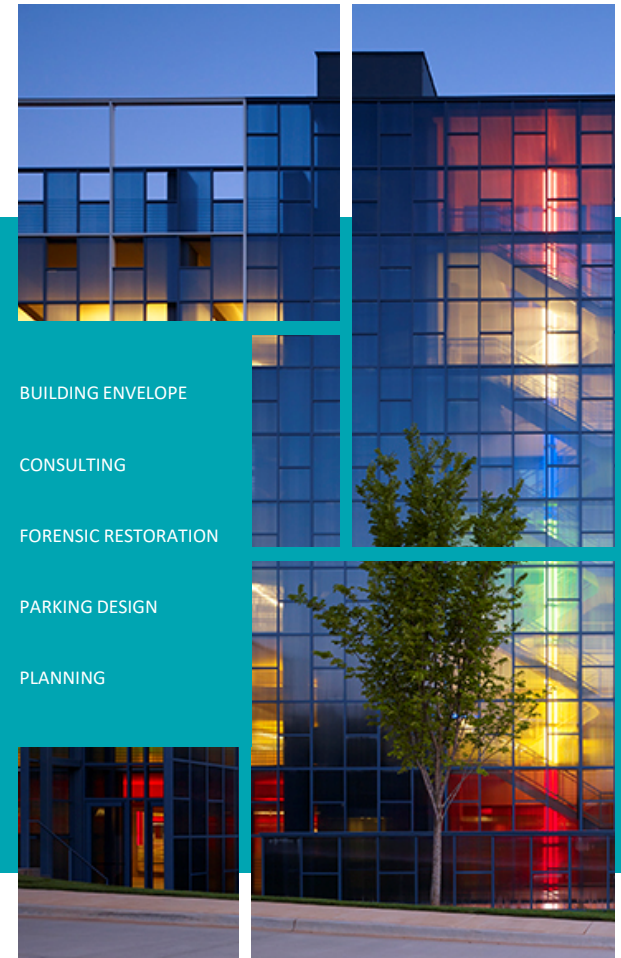


WALKER
CONSULTANTS

ELECTRIC VEHICLE CHARGING:

September 2018

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MINNESOTA CHIEF ENGINEER'S GUILD (MNCEG)

WELCOME &

Mission: Planning, management, and maintenance of public facilities, grounds, equipment and systems.

CONGRATULATIONS!



AGENDA

TERMINOLOGY

HOW MANY EVCS?

EQUIPMENT CHOICES
& ELECTRICAL

FUNCTIONAL DESIGN

SIGNAGE

TERMINOLOGY

HOW MANY EV CS?

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TYPES OF ELECTRIC VEHICLES

- **EV:** Electric Vehicle. Powered, under at least some conditions, by electric battery and motor.
- **PEV:** Plug-in Electric Vehicle (has plug for recharging battery)
 - **BEV:** Battery Electric Vehicle: powered exclusively by electricity from its on-board battery, charged by plugging into the grid.
 - Tesla Model S, Nissan Leaf
 - **PHEV:** Plug-In Hybrid Electric Vehicle. Uses electricity obtained by plugging into the grid to power an electric motor, and similar to a pure hybrid, also utilizes an internal combustion engine.
 - **EREV:** Extended-range electric vehicle. A type of PHEV, operates as battery electric vehicle but switches to internal combustion engine when battery is depleted. Chevy Volt, plug in version of Prius.
- **FCV or FCEV:** fuel-cell electric vehicle converts the chemical energy from a fuel, such as hydrogen, into electricity.



InsideEvs mark larson



Motortrend.com

Definitions per <http://electricdrive.org/ht/d/sp/i/2446/TPL/LandingPageTechIss/pid/2446>

HYBRIDS MAY NOT BE PLUG IN

- **HEV:** Hybrid Electric Vehicle. Uses both an electric motor and an internal combustion engine (ICE) to propel the vehicle. Battery is recharged during driving; vehicle operates from the battery at slower speeds.
 - Toyota Prius, many others
 - **GAEV: Gas Assisted Electric Vehicles** Vehicle that always operates on battery power but a gas motor powers and recharges the battery.



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Motortrend.com

Definitions per <http://electricdrive.org/ht/d/sp/i/2446/TPL/LandingPageTechIss/pid/2446>

OTHER RELEVANT DEFINITIONS

- **ICE:** Internal Combustion Engine. Vehicles that burn a liquid (such as gasoline or diesel) or gaseous fuel (such as compressed natural gas) to provide power.
- **ZEV:** Zero Emissions Vehicles emits no exhaust gas from its motor.
 - includes BEVs, PHEVs and FCVs
- **LEV:** Low Emissions Vehicle is one that emits relatively low levels of motor vehicle emissions. The term may be used in a general sense, but in some countries/states it is defined in air quality statutes.
 - In CA (and some other states that have adopted CA regulations), includes ZEV and vehicles that meet the CA Air Resources Board definition.
 - For LEED, the list is compiled by the American Council for an Energy. Efficient Economy and is utilized by the US Green Building. Most hybrids qualify but many other non EV/HEVs do as well.
 - Difficult to enforce!!!

All terms this page: Wikipedia

STANDARD SETTING GROUPS

- **NEC:** National Electric Code
 - Section 625 Electric Vehicle Charging System
- **SAE:** Society of Automotive Engineers.
- **LEED: Leadership in Energy and Environmental Design.** A rating system for sustainable design developed by the US Green Building Council (USGBC) To receive LEED certification, building projects satisfy prerequisites and earn points to achieve different levels of certification. Participation in LEED is voluntary.
- **IgCC: International Green Construction Code** A building code developed by the International Code Council. Local and state governments can adopt IgCc and thereby mandate compliance with the code.
- **ADA:** Americans with Disabilities Act. A civil rights act that prohibits discrimination against persons with disabilities.
 - **DOJ 2010 Standards:** The current guideline for complying with ADA in buildings.
 - **ADAABAAG:** A guideline published by the Access Board for compliance with ADA and the Architectural Barriers Act (which applies to buildings owned or leased by the Federal Government. The DOJ 2010 standards incorporates ADAABAAG, with a few additional requirements.



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Motortrend.com






STANDARD SETTING - CHARGING EQUIPMENT / SIGNAGE

EVCS: Electric Vehicle Charging Station. Self-contained unit that combines all required equipment for charging electric vehicle batteries, including the cords and couplers, with additional safety features beyond simply a cord and wall outlet. Some units provide a means of payment for the electricity used in recharging.

MUTCD: Manual on Universal Traffic Control Devices. Is A document issued by the Federal Highway Administration to specify the standards by which traffic signs, road surface markings and signals are designed, installed and used.

MINNESOTA STANDARD SETTING GROUPS

- **Minnesota B3**
- The B3 Guidelines are required on all projects that receive general obligation bond funding from the State of Minnesota.
- No EVCS standards

Design of New Buildings and Renovations	
	Use B3 Guidelines on new buildings or renovations to meet sustainability goals for site, water, energy, indoor environment, materials and waste.
	Use the SB 2030 Energy Standard to meet energy use goals only. If the B3 Guidelines are used, the SB 2030 Energy Standard is automatically included in the process.
Operation of Existing Buildings	
	Use B3 Benchmarking to track and compare energy use on existing buildings. The B3 Guidelines and SB 2030 Energy Standard direct the user to the B3 Benchmarking tool.
	Use B3 Energy Efficient Operations to minimize energy use during building operations. This program can be applied to any existing building.
	Use B3 Post Occupancy Evaluation (POE) to determine occupants' perceptions of the buildings' indoor environmental quality. The POE survey is required for B3 buildings.

TYPES OF CHARGERS

- **Level 1**

- Typically residential, plugs into std 120 outlet
- 120v, 15 amp
- ± 20 hours full charge

- **Level 2**

- Residential/Commercial
- Has coupler that plugs into vehicle; coupler carries data as well as electricity
- 240v, 40 amp
- ± 7 hours full charge
- 12 – 26 miles per charge hour

- **Level 3**

- Highway/Fleet
- 480v, 85 amp, 50 – 150 miles ± 30 minutes
- No industry std for coupler yet



WHAT IS THE COUPLER?

- Device that is connected to the vehicle charging port. The coupler carries data as well as electricity to provide safety and coordination of the charging.
- Took long time for industry to set standard, competing options were developed in the meantime.
- US standard is Society of Automotive Engineers (SAE) J 1772 (latest revision 1/2015)
 - Covers Type 1 and Type 2 charging
 - No standard yet for fast charging (Type 3)
- CHAdeMO: Invented by Japanese, standard for Quick Charge (Type 3) stations operating in Europe, Asia, and South America.
 - Nissan Leaf
- Tesla: Proprietary, “supercharger”, vehicle needs adapter to use SAE coupler on an EVCS.
 - Tesla’s EVCS works ONLY for Teslas.
- China has its own standard too



By Michael Hicks / Flickr "mulad", CC BY 2.0,

TERMINOLOGY

HOW MANY EV CS?

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INCREASING PROJECTIONS OF EV SALES

- Coincidental to development of AVs, it is currently expected that cost of batteries will continue to decline while battery range will increase enough to finally make electric vehicles cost-effective for the average consumer (without fed/state subsidies) sometime between 2020 and 2025.
- OPEC, Exxon Mobil and BP all have recently doubled projections of impact of EVs on oil markets.¹
 - Some say this is one reason for Saudi prince attempting to modernize quickly.
- Morgan Stanley projects that EVs will reach 50% of new car sales by 2040¹; some others say that milestone will be achieved by 2035 if not 2030.
- China is thought to mandate electric vehicle use in the coming years.

¹<https://www.greentechmedia.com/articles/read/everyone-is-revising-electric-vehicle-forecasts-upward#gs.neSIEzw>

IMPACT OF EVS ON PARKING DESIGN

- The biggest impact of accommodating EVs is not the installation of the EV Charging Stations (EVCS) but the requirements for power. The energy demands of an EV are roughly equivalent to adding a new small house onto the neighborhood grid.
- The good news is that power management systems are now being developed that will spread out the charging of employee, resident and other vehicles that stay longer, so that they all are not “topped off” simultaneously.

LATEST DATA ON PEVS AND PROJECTIONS

Projected PEV Sales and Percentage of Light Vehicles on Road

	Today Through 12/2017 (1)	Near Term (by 2025) (2)	Long Term (by 2040) (2)
Annual PEV sales	194,479	2,000,000	
On the Road	717,852	8,000,000	
Percentage of Light Vehicles Sold Annually	1.1% or 11 per 1000	Est 10 to 11%	Est 60%
Percentage of Vehicles on Road	0.28% or <3/1000	Est 2.6%	Est 36%

1) PEV Sales: <http://electricdrive.org/index.php?ht=d/sp/i/20952/pid/20952>

2) PEV Sales Bloomberg Electric Vehicle Outlook 2017

Vehicles on Road: US DOT Bureau of Transportation Statistics through 2015

1% population growth after 2017 per US Census Bureau.

Scrapage rate: 4.5% cars on road, per IHS Markit Reports

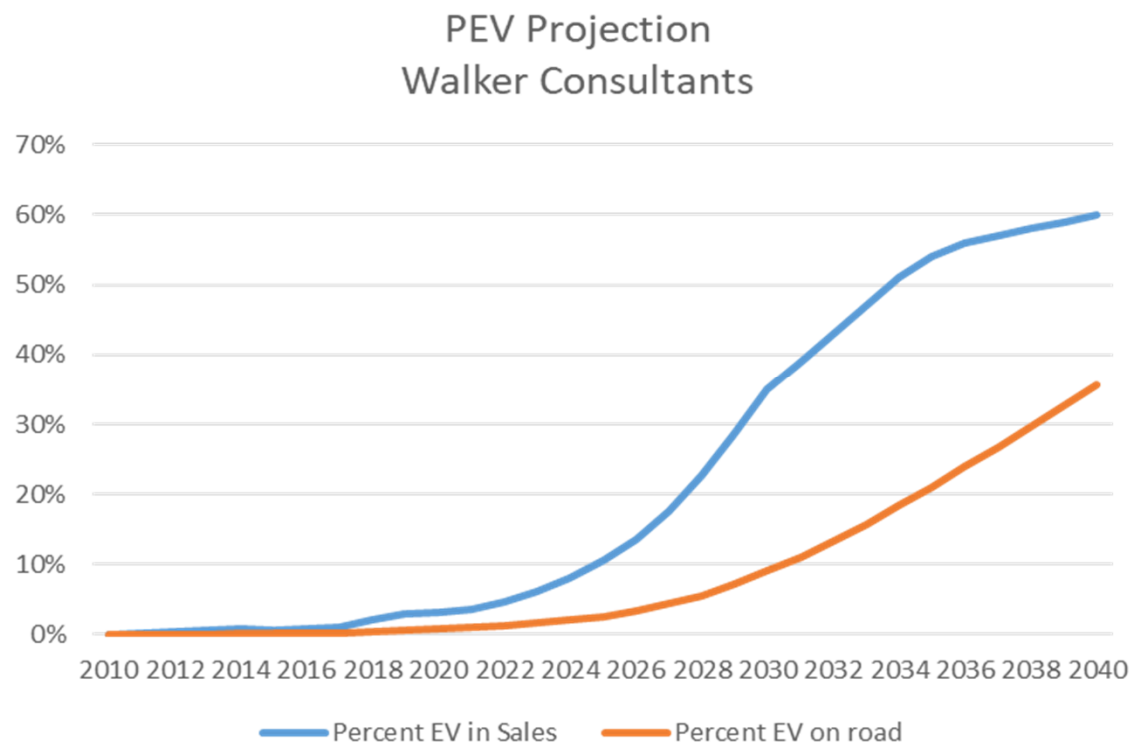
Overall sales: *Automotive News* through 2017

As required for vehicles on the road and scrapage rates

energy.gov/eere/vehicles

LATEST DATA ON PEVS AND PROJECTIONS

- PEVs broke through 1% of passenger vehicle sales in 2017 for first time.
- PEV sales increased 24% from 2016.
- But....HEVs (no plugs) still outsell PEVs more than 2 to 1.

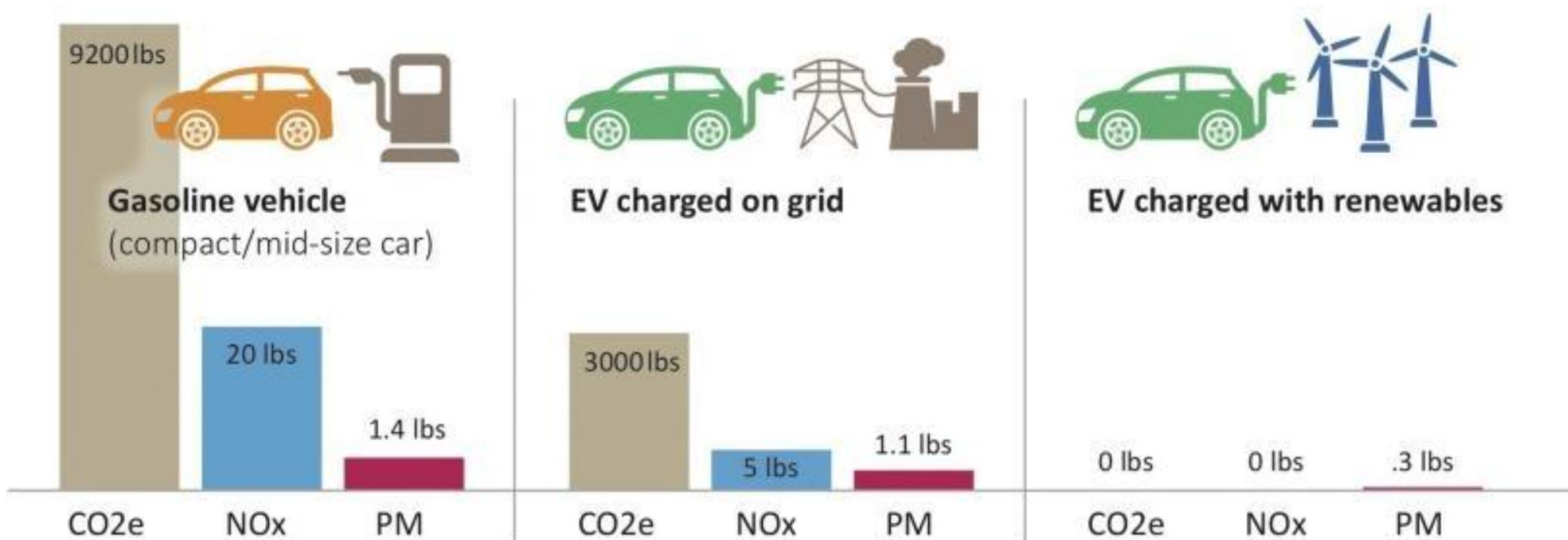


energy.gov/eere/vehicles

MINNESOTA POLLUTION CONTROL AGENCY PROJECTIONS

Minnesota's first Electric vehicle corridor. MPLS to Duluth including Forest Lake, Pine City, Sturgeon Lake, and Duluth all host stations

Annual vehicle emissions by fuel type (12,000 miles)



HOW MANY ELECTRIC VEHICLE CHARGERS?

- **Recommendation:**
 - **Install to demand now (unless you want to meet LEED.)**
 - Add more units as demand requires.
 - Provide power for future need through at least 2030
 - Use Power Management system after demand >5%.
- EVCS Stalls needed today:
 - On road, today: 0.28% or 2.8/1000 parking stalls
 - 2025: 2.6%, or 26/1000
 - 2030: 10% or 100/1000
 - 2040: 36% or 360/1000
- Due to random presence, at least double of units, so **do 1% (with min 1) today.**

HOW MANY ELECTRIC VEHICLE CHARGERS?

Total Parking Stalls	Residential		Workplace/Visitor	
	Power for EVCS (stalls)	Min EVCS (stalls)	Power for EVCS (stalls)	Min EVCS (stalls)
1 to 25	8	1	4	1
26 to 50	10	1	5	1
51 to 75	16	2	8	1
76 to 100	20	3	10	2
101 to 150	20%	4	10%	2
151 to 200	18%	5	9%	3
210 to 300	16%	6	8%	3
301 to 400	14%	7	7%	4
401 to 500	12%	8	6%	4
501 and over	10%	2%	5%	1%

WHAT MIGHT AUTONOMOUS CARS DO TO PEVS?

- Subscription services (uber/lyft) are likely to use smaller, purpose-built electric vehicles.
 - But those vehicles won't be parked at most parking destinations.
- Cars owned and used for personal daily transportation could decline; Walker estimates parking demand reduced up to 40% nationally BY 2050.
- As demand for parking stalls goes down, lowering total required EVCS parking stalls in US, even as % of electric vehicles sold/ on the road goes up.
- If an individual facility remains full, EV stalls will be required at the percentage on the road.

TERMINOLOGY

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SIGNAGE

CONSIDERATION FOR CHARGER SELECTION

- Best for both Vehicle Owner and Community to charge, at home, overnight
 - for electric grid
 - cost to consumer
- Most short-term visitors only need “topping off”
- Employees: have full work shift to charge if needed

All of the above: only need **Type 2** charging

Exceptions to Type 2:
fleet/shared car/ highway
rest stops, short- stay
tourist destinations

OTHER CONSIDERATIONS - OWNERS GOALS

- Sustainability - Corporate or Personal
 - Whether or not going for LEED points
- Public Service - City/State
 - Helps overcome range anxiety, encourages people to buy PEV
- Client Capture – Office, Retail, **Residential**
- Government Requirements – also to stimulate market for EVs



LEED

ATTRACT TENANTS

Today's tenants understand and are looking for the benefits that LEED-certified spaces have to offer. The new Class A office space is green; lease-up rates for green buildings typically range from average to 20% above average.

OWNER CONSIDERATIONS

- Length of stay vs. length of charge
 - Stay in stall after charging done? Inefficiency?
 - Valet /Monitored? Fewer charges, lower power load.
 - Need to compare cost benefit of valet vs power management system.
- Locations –
 - Should be closest, after ADA
 - Some argue opposite because if you need charge, you'll find and park there. However LEED and others insist on best location
- Nested, part of Preferred Parking?
 - Theoretically, preferred parking encourages EVs
- Employee & Car Sharing – Corporate vehicle, incentives
- Current & Future EV Charger Stations



Guelphholdings.com

CHARGER SELECTION AND FEATURES

- Single & Double Stations
 - One vendor has quad
- Pole Pedestal or Wall Mount
- Smart Features
 - Remote diagnostics, Smart card reader, Metering,
 - Station Management, Billing Systems, Apps
- Power management



Eaton

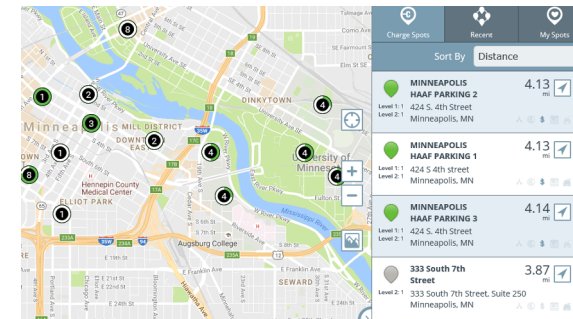


chargepoint

ACCESS AND PAYMENT CONTROL

- Open Access
 - *Home/commercial*
- Controlled Access (Smart Feature)
 - Pin Pad
 - *Clipper Creek*
- RFID Reader
 - Proprietary: *GE*
- Charge Point Network
 - *Coulomb, Leviton, Eaton*
 - Monitor stations/usage
 - Collect fees, Locate stations
 - Email & text notifications
 - Advertise

-chargepoint+



chargepoint

CHARGER COSTS

- Typical *Single* charger
 - \$600 - \$3,500 (X 2 for Double charger)
 - Infrastructure & install costs: + \$3,000 - \$6,000+
- Data connection capability
 - + \$700 - \$2,000+
 - Data service \$7 - \$60 Monthly per charger
- Single vehicle charge \$1.50 – \$6.50
 - $6.6 \text{ kw} \times 6 \text{ hour} \times \$0.09 \text{ Kw/hr.} = \$3.56$ Chevy Volt



Clipper Creek: Tides Inn

ELECTRICAL INFRASTRUCTURE: ESTIMATE SERVICE LOAD

- Level 2 Breaker = $240\text{v} \times 40 \text{ amps} = 9.6\text{kW}$
 - Nisan Leaf = 3.3kW load
 - Chevy Volt = 6.6kW load
- Typically add 10-15% for overload

RETROFIT OR NEW INSTALLATIONS

- Conduit runs – Block-out in structural members, all embed/surface/combo
- Single or multiple conduit runs
- 40 Amp wire fits in a 1/2" + conduit
- (1) 80 Amp wire fits in a 3/4" + conduit
- Station Anchoring – Slab/Wall/Column
- Embed or Post installed anchor wt. 50 & 120 lbs.



MSP Airport



Metro Transit: Target field station

ELECTRICAL ROOM

- Larger Transformer (200 amp = X s.f.)
- Separate panel or circuit breakers (X)
- Charger networking and Controllers (>5sf)

10 EV Stations = 400 amps

= 3' x 2.5' transformer

+ EV panel board = 5' x 2' wall mount

+ Network controller = wall mount in telecom room

20 EV Stations = 800 amps

= 4' x 3' transformer

+ EV panel board = (2) 5' x 2' wall mount

+ Network controller = wall mount in telecom room



MSP airport

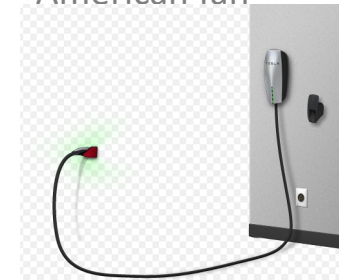
ELECTRICAL SAFETY COMPONENTS

- Connector SAE J1772 (post-2000 electric vehicles) includes:
 - Connection Interlock – No power in cable or connector when not connected to vehicle
 - Ground Fault Protection – when current to ground exceeds predetermined value
 - Automatic De-energization – Strain to cable or connector, resulting in live parts
 - Ventilation Interlock – Charger communicates w/ vehicle and building systems for ventilation battery off-gassing

Reminder: Tesla is not to SAE standard



American fan



tesla



ChargePoint

TERMINOLOGY

HOW MANY EV CS?

EQUIPMENT CHOICES
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FUNCTIONAL DESIGN

SIGNAGE

FUNCTIONAL DESIGN

- What must you consider for installation????
- ADA
- Station protection – Bollard, wall, column, wheel stop, curb
- Vehicle charging port locations
- Stall encroachment

WATCH POINT: ACCESSIBLE EVCS

- You must provide accessible EVCS if you provide **any** EVCS.
- ADA is a civil rights law. You can't deny charging to disabled person by not providing accessible charging units.
- There is no design guideline in DOJ 2010 Standards for making EVCS accessible today.
- In 2016 Access Board issued guidance for ADA parking
- Not adopted by DOJ, but best available reference.



pevcollaborative.org


NEW! GUIDE RECOMMENDATIONS FOR EVCS.

- White paper on EV charging stations (EVCS) accessibility 2012, posted at NPA website 2014.
- Apply table **separately** to EV CS stalls.
 - Example: 1000 parking spaces
 - 3% EVCS per LEED = 30 stalls.
 - 2 Accessible EVCS required, 1 van 1 car.
 - 1000-30 parking spaces = 970
 - 2% accessible stalls = 19.4 spaces, round up to 20 accessible spaces = 4 van, 16 car.
- Comment about symbol of accessibility.
 - If less than 4 total EVCS stalls, don't need to sign the one that is accessible (see figure!)

Electric Vehicle Charging Stations

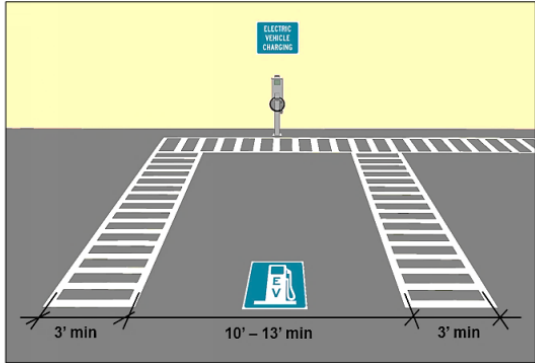


The Standards do not include specific provisions for electric vehicle (EV) charging stations. However, it is advisable to address access to EV charging stations so that they are usable by people with disabilities. If provided, accessible spaces at EV charging stations cannot count toward the minimum number of accessible car and van parking spaces required in a parking facility.

 **Recommendations:** Provide access to a reasonable number of spaces serving EV charging stations or use the scoping table in §F208.2 to determine an appropriate number. (The number of accessible spaces serving EV charging stations must be determined separately from the required number of car and van parking spaces.)

Accessible EV Charging Stations

Accessible Route
Provide an accessible route on both sides of the vehicle space that connects to the charging station for easier access.



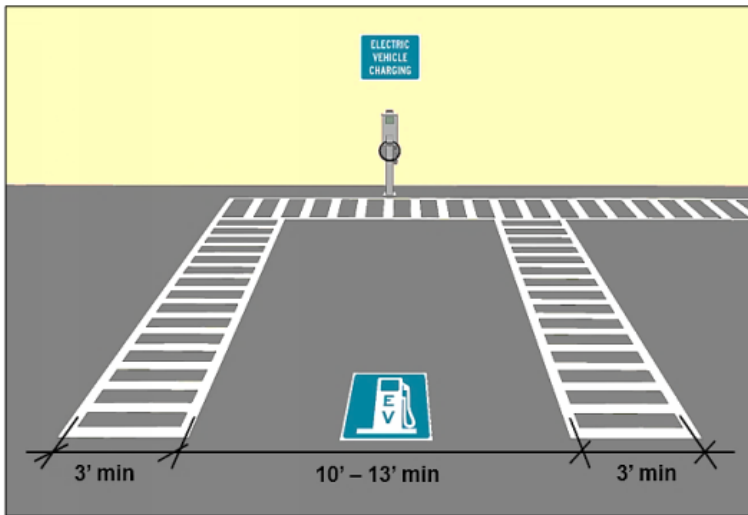
Vehicle Space
A vehicle space at least 10' - 13' wide is advisable. A 10' width offers an extra 2' that effectively provides a 5' aisle on one side when paired with the accessible route; a 13' wide space will allow an 8' aisle. This flexibility is helpful since the parking direction is determined by the location of the charging station and the vehicle connection. Use the International Symbol of Accessibility only where spaces are reserved exclusively for people with disabilities.

(Page 14)

ONLY DIFFERENCE IS SIZE OF ACCESSIBLE STALLS.

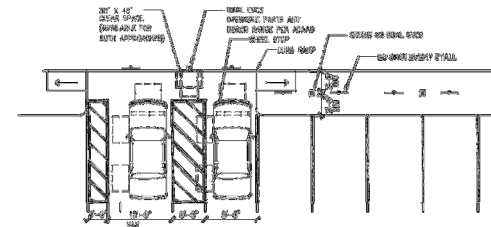
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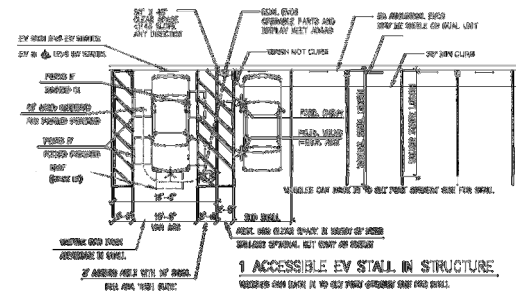


Vehicle Space

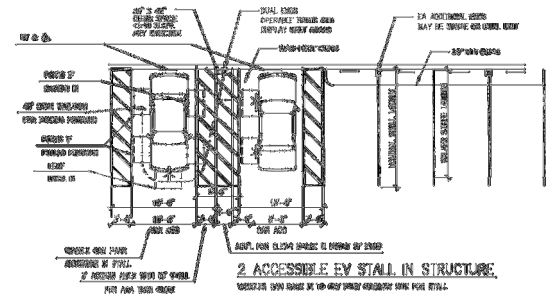
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OVERHANG SIDEWALK



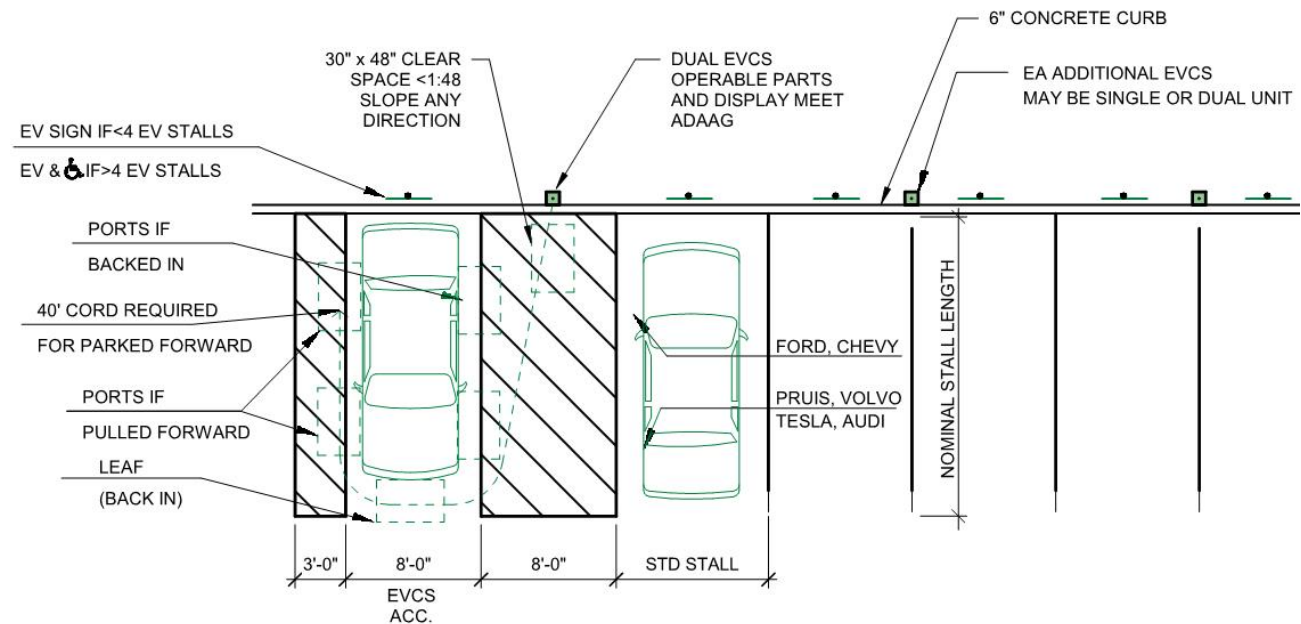
1 ACCESSIBLE EV STALL IN STRUCTURE



2 ACCESSIBLE EV STALL IN STRUCTURE

90 DEGREE PARKING

- Provide accessible aisle on each side of vehicle
- Problem is Leaf recharging port is on front of vehicle. Can't back in; car will stick out 3' or more into aisle.

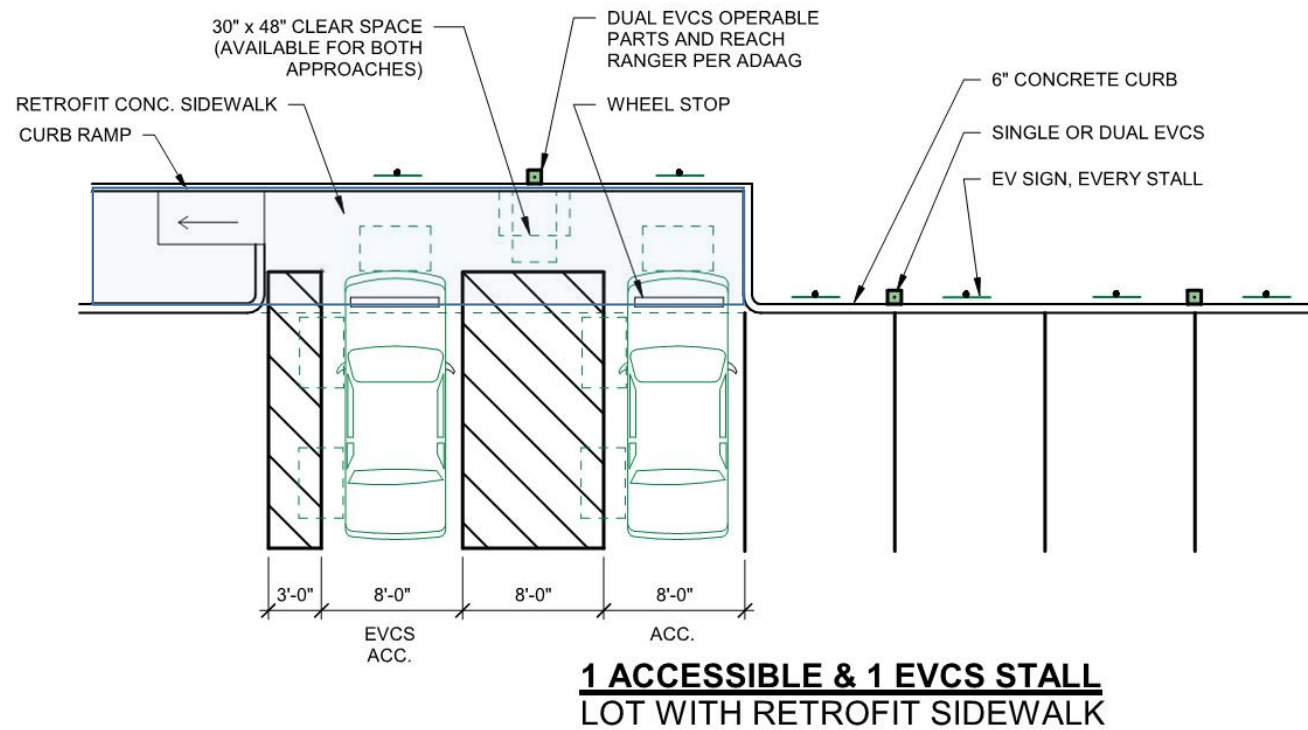


1 ACCESSIBLE EV STALL WITH CONCRETE CURB

VEHICLES CAN BACK IN TO GET PORT CORRECT SIDE FOR STALL

90 DEGREE PARKING – LOT RETROFIT

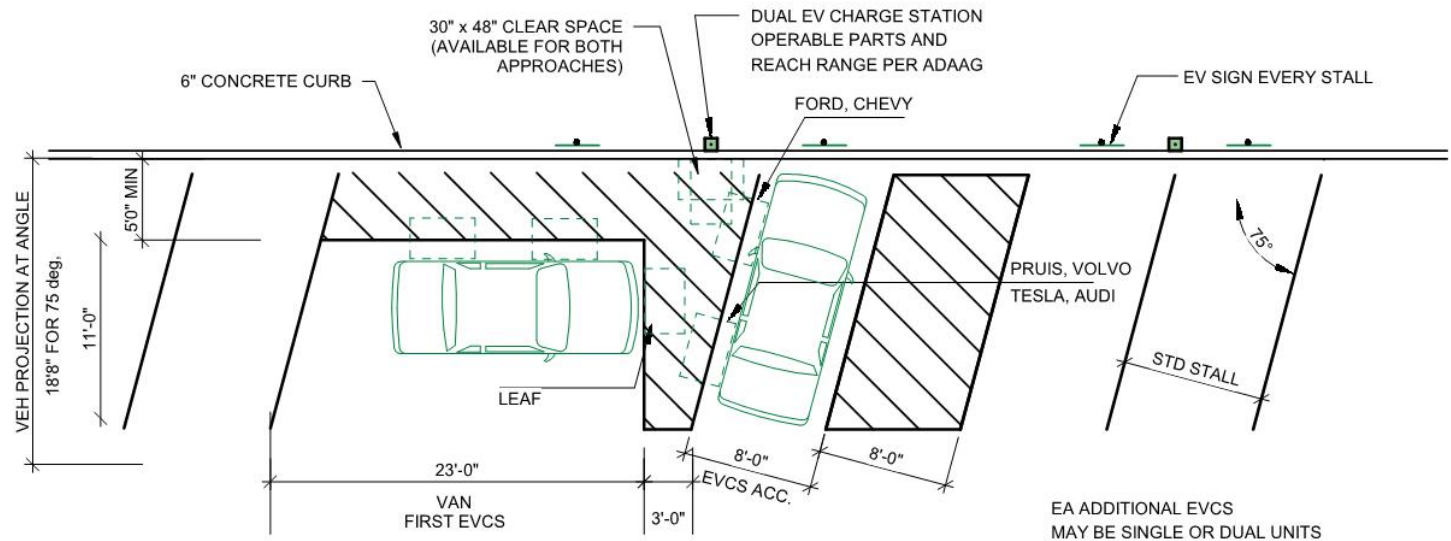
- Provide accessible aisle on each side of vehicle
- Problem is Leaf recharging port is on front of vehicle. Can't back in; car will stick out 3' or more into aisle.



ANGLED PARKING IS TRICKIER

These are not the only options, just showing some principles in layout.

Problem is Leaf recharging port is on front of vehicle. Can't back in; car will stick out 3' or more into aisle.



2 ACCESSIBLE EVCS STALLS ANGLED PARKING

APPLY ADAAG TABLE TO TOTAL EVCS STALLS TO DETERMINE NUMBER ACCESSIBLE REQ'D
IF 4 OR FEWER TOTAL EVCS STALLS, ONE VAN ACC REQUIRED BUT NOT SIGNED ACCESSIBLE
IF >25 EVCS STALLS, SECOND EVCS STALL MUST BE ACCESSIBLE (ONE VAN, ONE CAR)
SECOND VAN ACCESSIBLE STALL NOT REQUIRED UNLESS >150 EVCS (RARE)

APPLYING EVCS ACCESSIBILITY

- Apply table for accessible parking to number of EVCS stalls, i.e., treat EVCS as separate “facility” per ADA.

Table 208.2 Parking Spaces

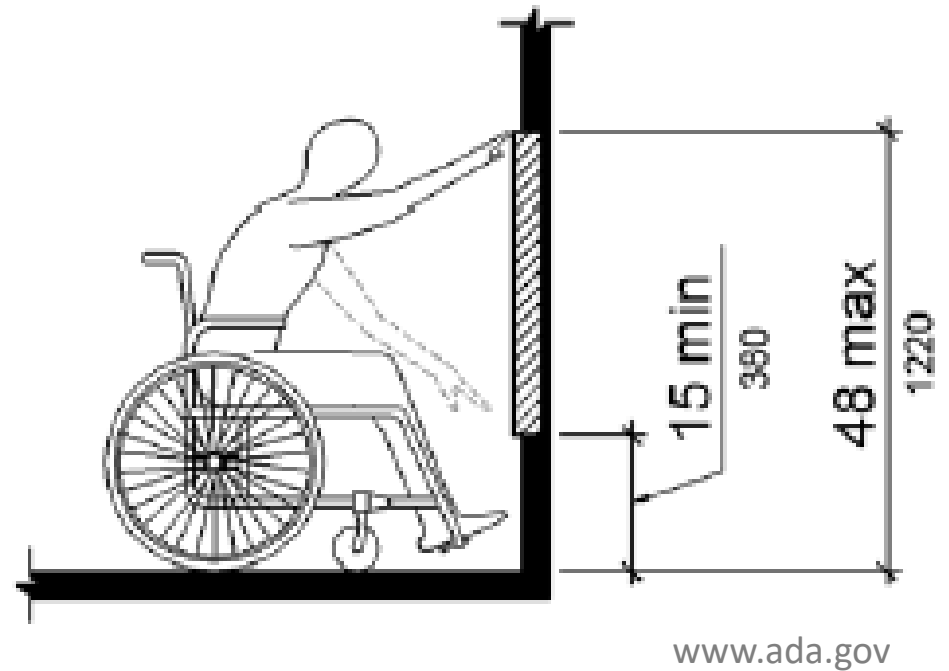
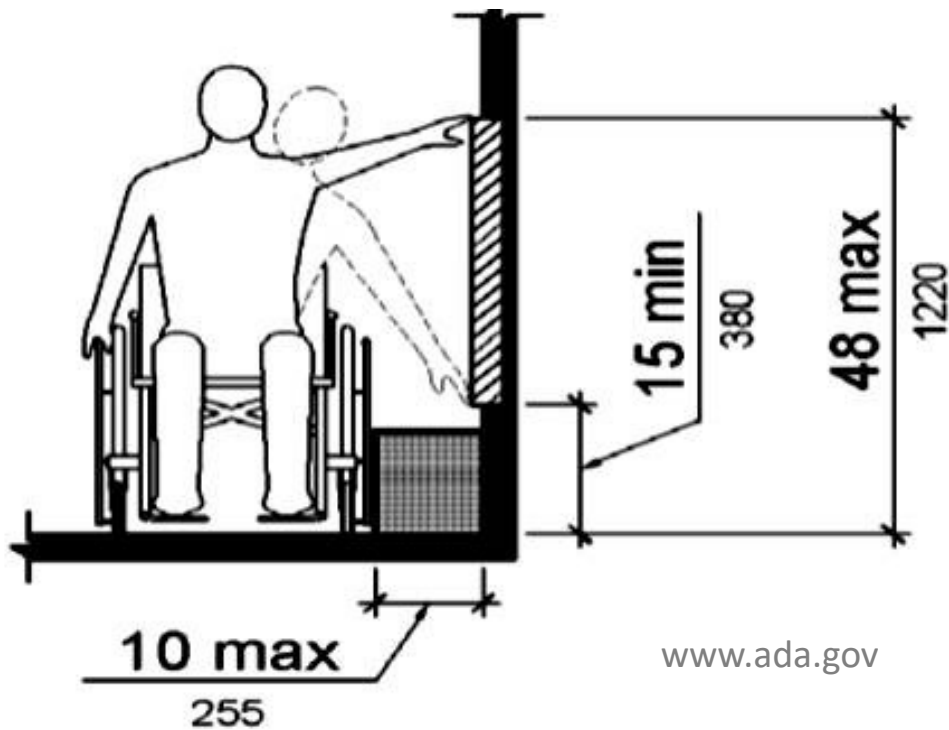
Total Number of Parking Spaces Provided in Parking Facility	Minimum Number of Required Accessible Parking Spaces
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1000	2 percent of total
1001 and over	20, plus 1 for each 100, or fraction thereof, over 1000

EVCS ACCESSIBILITY ISSUES

- EVCS To comply with 2010 ADA Standards:
 - Operable parts
 - Cable management:
 - Cords lying on pavement violate change in level requirements.
 - Weight of connector and cable
 - Level 2 – 5lbs,
 - Level 3 (DCFC)– 19lbs
 - Max permissible under ADA: 5 lbs.
 - Computer Interface – Height, buttons
 - Requests for assistance.
 - Protect chargers but don't restrict access

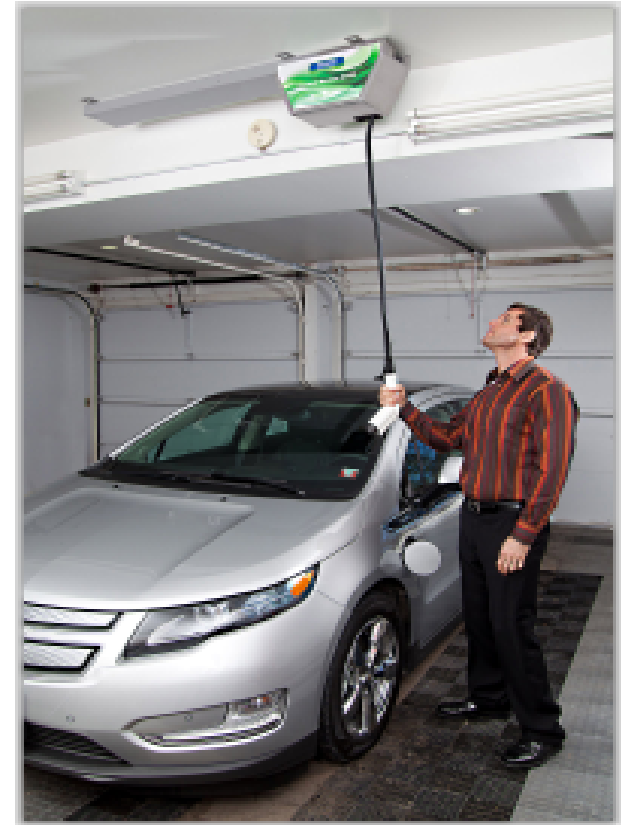


ACCESSIBLE REACH



MAYBE BEST APPROACH FOR ADA. REQUIRES CONTROLS MOUNTED NEARBY WITHIN REACH RANGES.

- Until cable management and weight of coupler issues are resolved, most systems cannot be fully accessible to all users.
- Make accessible per details herein.
- Owner may also have to provide assistance (valet-ish) to some users.



DISPLAY AND OPERABLE PARTS

- Display must be visible to person seated in wheelchair (eyes 3.3' above pavement.)
- All operable parts must be within ADA reach ranges, with “clear space” for approach to device.
 - 15” to 48” above pavement (elevation of wheelchair tires; be careful of added curb height!)
- Device at right has retractable cords, but the touch display is neither readable from wheelchair, nor within reach range.



ACCESSIBILITY CONSIDERATIONS

Recommendation: Owners to have a **WRITTEN** policy that if employee with disability wishes to charge while at work, you will work with the employee to meet his/her needs.



Irishhealing

AS BUILT EXAMPLES



FUNCTIONAL -ACCESSIBLE REACH



WALL MOUNT STALL INTRUSION

- Wall Mount
- Center unit on stripe; use natural
- Access aisle



TERMINOLOGY

HOW MANY EV CS?

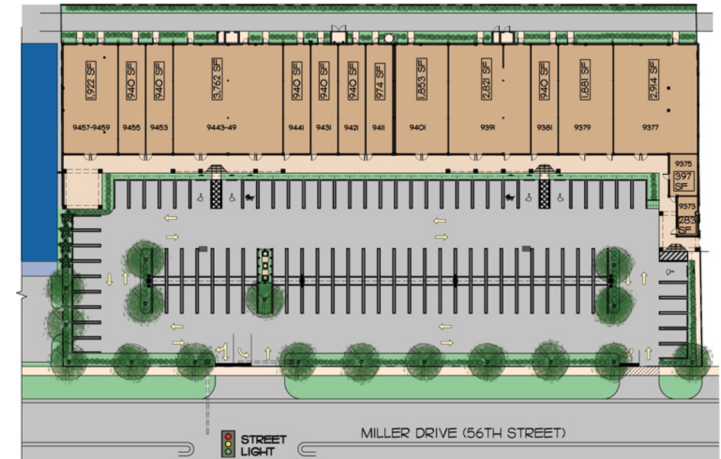
EQUIPMENT CHOICES
& ELECTRICAL

FUNCTIONAL DESIGN

SIGNAGE




WAYFINDING –SIGNAGE REQUIREMENTS

- Outside Lot, Structure
 - Site Direction
- Inside Lot, Structure
 - Location Direction
- Operational
 - Hours/ electrical vehicle only



REGULATORY SIGNAGE

California & MUTCD

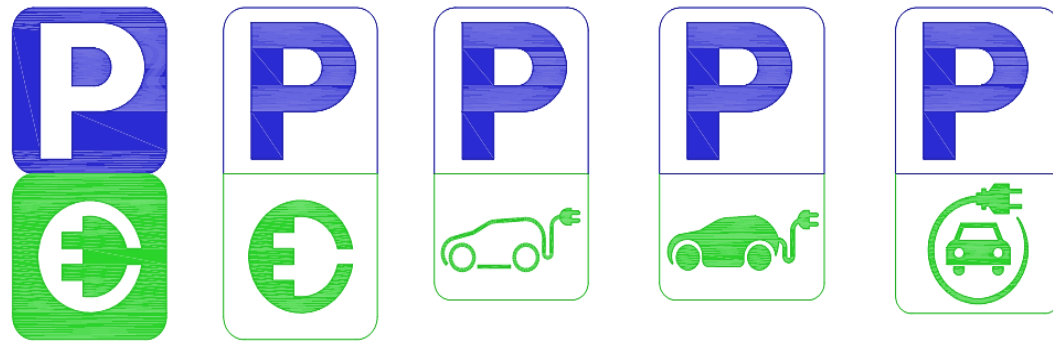
 <p>G66-21 (CA)</p>	 <p>D9-11bP</p>	 <p>D9-11b</p>
<p>Charging Station 12" x 12", 18" x 18" Conventional Road 24" x 24"</p>	<p>Freeway 30" x 24" Expressway 30" x 24" Conventional Road 24" x 18"</p>	<p>Freeway 30" x 30" Expressway 30" x 30" Conventional Road 24" x 24"</p>

Michigan & MUTCD Regulatory

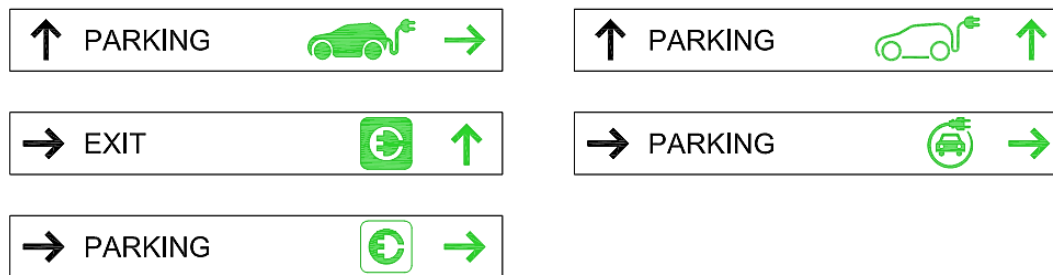
		
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SIGNAGE CONCEPTS

Near Stall



Directional



SUMMARY

- Address **PEV** demand first.
- **PEV's** = 0.28% of vehicles on the road today
 - 2.6% by 2025
- LEVEL 2 Charger 240 Volt and 40 Amps Ea.



InsideEvs mark larson



Motortrend.com

Definitions per <http://electricdrive.org/ht/d/sp/i/2446/TPL/LandingPageTechIss/pid/2446>

SUMMARY CONT'D

- Install 1st Charger (EVCS) as accessible
- Develop charger access rules
- Sign EVCS stalls



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Definitions per <http://electricdrive.org/ht/d/sp/i/2446/TPL/LandingPageTechIss/pid/2446>

THANK YOU!

QUESTIONS?

SCOTT FROEMMING

Sfroemming@waklerconsultants.com

952.595.9116