EV Infrastructure Recommendations

Revised from Public Comment for FHWA Request For Information

Regarding:	Prepared by:
Docket # FHWA-2021-0022 Federal Register Document # 2021-25868	Ted Corgan, CSSGB

Objective

This comment document is intended to aid development of the EV Charging Program guidance per the Bipartisan Infrastructure Law, as requested by the Federal Highway Administration. The original version was submitted to the DOT Federal Highway Administration RFI.

Summary

It is critical that the proposed electric vehicle (EV) infrastructure will support widespread usage of EVs by the general public. The Bipartisan Infrastructure Law aims to "establish an interconnected network [of EV charging infrastructure] to facilitate data collection, access, and reliability."[1] Those are three critical targets.

Our goal should be to enable consumers to adopt electric vehicles like they adopted smartphones. To that end, I recommend strategic terminology and proven practices to guide implementation of those three targets.

[1] https://www.transportation.gov/regulations-fr/notices/2021-25868

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Discussion

There are three stated goals for the proposed EV charging network: data communication, consumer access, and trusted reliability. Furthermore, it must generate public enthusiasm to gain widespread acceptance and use.

Consumer Access

Availability

The charging stations must be simple to find. They should be as ubiquitous and obviously advertised as gas stations. We have a century of automotive culture built on gasoline fueling landmarks. See figure below.

Figure 1. Fueling landmark from Pixar's Cars movie.

Consumers need to feel that car charging stations are similarly universal, available, and (if possible) exciting.

Level 1 chargers should be as widely available for retail purchase as jumper cables are. Ideally, consumers should be able to find them at auto parts stores and home improvement stores.

Faster charging stations should be audaciously convenient and provide a great user experience. Abundant quantities of Level 2 charging stations should be advertised – with fun, upbeat branding - at most destinations, like parking lots, parking garages, restaurants, and grocery stores. Plenty of Level 2 charging stations should also be available at commercial and industrial workplaces.

Fast charging stations (Level 3 charging) should be clearly marked and commonly found along county roads, state routes, and interstate highways.

The Department of Transportation should accompany these construction projects with a major publicity campaign to spread the news story. When drivers are aware that they're always near opportunities to recharge their vehicles, they will be far more likely to use them.

Ease of Use

Electric vehicle infrastructure (including vehicles, charging supply equipment, and their usage) must be easy to use. They need to have low economic cost, low required effort, and low time cost.

In order to disrupt generational habits surrounding gasoline usage, it must be easy for consumers to change their behavior to adopt this new technology. The learning curve needs to be smaller than we think.

Communication

We need to set the language foundation well. EV usage should be modeled like car usage, electric power tool usage, and smartphone usage, which are commonly used today with familiar lexicons.

To make recharging stations easy for consumers, they should have low prices that are simple to comprehend quickly. We're accustomed to reading gasoline refueling prices as $/gallon. **Prices for electric recharging should NOT include kW or kWh**; those measurement units will be confusing for most consumers.

Figure 2. Screenshot of EV charging prices.

Instead, prices should be expressed as dollars per minute ($ / minute). That measurement would correspond to common estimates for vehicle usage; for example, you might park your car for $0.10 per hour at a meter or $15 per day at a garage. You might refuel a car with $10 of gasoline, as shown below, to be budget-conscious.

Figure 3. Common gasoline refueling practices.

This recommendation might sound too simplistic to capture the electrical nuances. Current EV supply equipment uses complex terms.

However, current refueling pumps are more complex than we typically consider. Colloquially, we refer to typical gas refueling in simple terms, and electrical recharging should be similarly accessible, much like electric power tools. Refer to the table below.

Typical Metric (approximate)	**Typical Measurement Unit for Gasoline-Fueled Vehicle**	**Typical Measurement Units for Electric Devices**	**Typical Measurement Units for Electric Vehicle**
Price for Refueling	$ / gallon $ / week for average budgets	Minutes (negligible dollars)	$ / kWh
Supply Speed	Gallons / minute	Minutes	Level 1 Level 2 Level 3 Amps Volts
Type of Refueling	Unleaded (Regular) Midgrade (Plus) Premium Diesel Ethanol (E85) *Note that ***miles*** and ***range*** are NOT listed; they promote range anxiety.	USB Wall socket (110 V)	Level 1 Level 2 Level 3
Socket or Receptacle Sizes	Gasoline Diesel	USB Wall socket	J SAE/CCS Tesla CHAdeMo
Common Measurement	$ / gallon	Minutes	TBD
Common Term	Car Truck	Smartphone Phone Cordless Drill Drill	TBD

Figure 4. Terminology for Vehicles and Devices.

I recommend some terms for common use in discussing electric vehicles and related infrastructure. Note that ***miles*** and ***range*** are NOT included, because they promote range anxiety. Instead, the terms emphasize simple, positive characteristics.

Metric	Recommended Terms for Electric Vehicles
Common Measurement for Use	Minutes (time to recharge) $ / minute (price to recharge)

Figure 5. Recommended Terms for Electric Vehicles.

An example of a good charging display interface is shown below. It's similar to gasoline fuel gauges and smartphone battery gauges.

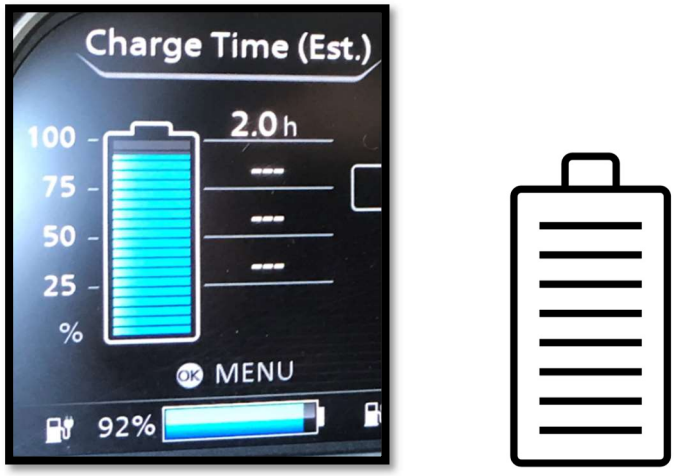

Figure 6. Charging display from a 2018 Nissan Leaf. Typical battery charging gauge.

Recharging levels 1, 2, and 3 should be color-coded ***intuitively*** for quick reference. A proposed color coding plan, modeled after a framework we all know (common traffic light colors), is shown here:

Charging Tier	Recommended Visual Marker
Level 1 (residential)	L1
Level 2 (commercial destination)	L2
Level 3 (fast charging)	L3

As detailed above, I recommend that EV terminology be kept as simple as possible, to encourage common use.

Incentives

A customer who plugs into a charging station should have a great experience. That will encourage them to be repeat customers and spread the positive news.

Customers who use Level 2 chargers at restaurants should earn, for example, a complimentary cookie or drink. Federal funds could pay for these perks up to a certain amount, or businesses could earn tax credits if they document this practice.

This comes down to behavioral science and the way humans work. In order for us to adopt a new behavior successfully, the new behavior must be ***ridiculously*** easy and pleasant for at least a short time upon startup.

Level 3 stations should have good restrooms and fast Wi-Fi available for free, so that the customer can refresh himself and recharge his car at the same time. They should elevate the convenience store and rest stop concepts to the next level.

Reliability

Consumers expect that electric devices will simply operate on-demand. They expect that electric sockets will always function. They expect that conventional gasoline-fueled cars will almost always work. Electric vehicles and supply equipment must maintain approximately 99.999% reliability to earn similar trust.

I recommend incentivizing charging stations to use locally generated electricity and on-site energy storage, while also being connected to the grid to import and export power. This would drive the construction of distributed electricity sources like solar photovoltaics and wind power, and it would leverage the high-power electrical equipment (like cables and transformers) that distributed energy sources require for grid connection. Locally sourced energy and on-site long-duration energy storage (batteries) would also harden the charging infrastructure to resist outages from imported electrical sources. This Chevrolet dealership shown below had a great example of solar power supplying energy to EV charging stations.

Figure 7. Chevy solar carport with EV charging.

To maintain extremely high reliability, I recommend that charging stations should be built using commonly used components wherever possible. Level 2 chargers should continue to use NEMA 14-50 plugs, which are readily available and typically used for electric ovens.

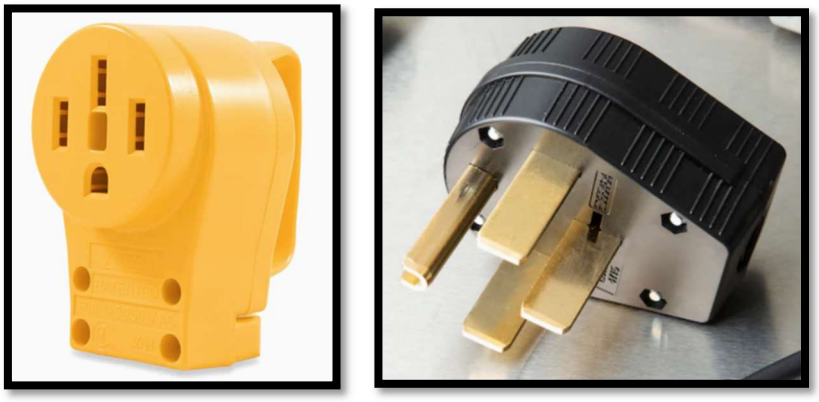

Figure 8. Commercially available NEMA 14-50 socket and plug from Lowes.com.

To promote reliability and safety, the Department of Transportation should require that:

- Charging stations shall adhere to National Electrical Code (NEC) requirements
- Charging stations shall use only equipment certified by UL, CSA, or ETL.
- Each charging branch circuit shall be isolated by a breaker that has ground-fault and arc-fault protection. An example of this kind of readily available circuit breaker is shown below.

Figure 9. Commercially available 50-amp GFCI breaker from Lowes.com.

Designers should continue to keep different plug types non-interchangeable, which helps prevent unsafe electrical connections.

Equity

Ideally, charging stations should be set up with best practices to promote equity and jobs in the community. They should be:

- Built by local labor
- Wired by local qualified electricians
- Maintained by local staff
- Powered by locally generated and stored energy. Urban locations could favor rooftop solar photovoltaic power and virtual power plants (VPPs). Rural areas might prefer utility-scale solar and wind power coupled with long-duration battery storage.
- Public Level 2 and 3 stations should also function as community centers that offer access to restrooms, free highspeed Wi-Fi internet, healthy food options, and small health clinics. Does that sound like a ***local coffee shop*** or ***grocery store***? We want to promote that model of resource accessibility.

Data Collection and Communication

Charging stations should be viewed as hubs within a resilient distributed grid connected by the Industrial Internet of Things (IIoT). As such, I recommend that they should link to power and web networks via high-voltage and internet cables.

Airports operate in a similar way. Air traffic control (ATC) manages data for every aircraft nearby and on-site, in conjunction with the FAA.

Conclusion

This comment document was intended to assist development of the EV Charging Program guidance per the Bipartisan Infrastructure Law. The proposed EV infrastructure must facilitate widespread usage of EVs by the general public. The Bipartisan Infrastructure Law aims to build a network of EV charging infrastructure to promote 3 critical targets: data communication, public access, and reliability.

Our goal should be to enable consumers to adopt electric vehicles like they adopted smartphones. For that reason, I recommended strategic terminology and proven practices to guide implementation of those three targets.