Getting Ready for Electric Vehicle Charging Stations

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Where were we in 2011?

Global unit sales

- Electric Vehicles
- Charging Stations

California Estimates

- 250,000 to 275,000 PEVs by 2015

Battery cost/kwh curve

- High cost
- Medium cost
- Low cost
- Learning curve not predictable in long term

Big disruptive market

- Total EV cost of ownership improves as battery costs decrease
- Most manufacturers launching in 2011 … 3-5% of global production by 2015
- Typical early market issues – complexity, confusion, dynamic environment
Where are we in 2015?

Source: Plug-In Electric Vehicle Collaboration
Positive Geographic Factors Favoring EVs*

Top cities for EV Consumers (based on hybrid sales)

Least severe weather extremes

Average commute < 55 miles

*Source: PEV Readiness Study
“Tailwinds”

$7,500 US Federal Tax Credit

CARB Clean Vehicle Rebate Project
- AB 118, Alternative and Renewable Fuel Vehicle Technology Programs.
- $46MM of $108MM still available for 2014-2015FY
- $192MM issued since inception

Green Clean Air Vehicle decals allow HOV lane use without meeting the occupancy restrictions
Incentives to Install EVSEs

LEED
SS Credit 4.3, Option 2, 3 Points
Alternative-fuel fueling stations for 3% of total vehicle parking capacity

EVSE Rebates (not offered by PG&E)
CO₂ Emission Reduction

California Total Electric Power Industry 2008

CO₂ Emissions: 62,543,565 metric tons

Electrical Generation: 207,984,263 MWh

EV Emissions
0.24 lbs per mile
@ 0.36 kWh per mile*

Conventional car (ICE):
0.916 lbs per mile

* EPA Fuel Economy Comparison – Chevy Volt Electric Operation
Code & Standard Organizations

Society of Automotive Engineers (SAE)

Underwriters Laboratories

National Fire Protection Association (NFPA)

NEMA Electrical Vehicle Supply Equipment Section (no standards at this time)

Support the development of the electric vehicle supply equipment market
Educate the market on the features and value of the electric vehicle supply equipment infrastructure around the world
Develop the technology and application and product standards
Terms

Grid Enabled Vehicle (GEV)

Battery Electric Vehicles (BEV)

Plug-in Hybrid-Electric Vehicle (PHEV)

Hybrid-Electric Vehicle (HEV)

Electric Vehicle Charging Stations

Internal Combustion Engine (ICE)
Anatomy of a Hybrid PEV

Electric Drive

“Series Connected” Gas Engine

Lithium Ion Battery
SAE J1772-2012

Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler Connector

Charging Levels

Safety

Signaling
# PEV Conductive Charging Methods (SAE J1772-2010)

<table>
<thead>
<tr>
<th>Charge Method</th>
<th>Electrical Characteristics</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Voltage</td>
</tr>
<tr>
<td>AC Level 1</td>
<td>120 V 1Ph</td>
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<tr>
<td>AC Level 2</td>
<td>208 - 240V 1 Ph</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Mfgr</th>
<th>Model</th>
<th>Battery Range (miles)</th>
<th>Battery kWh</th>
<th>Recharge Time (hours)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Level 1</td>
</tr>
<tr>
<td>Nissan</td>
<td>Leaf</td>
<td>100</td>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td>Chevrolet</td>
<td>Volt</td>
<td>40+ (375 total)</td>
<td>16</td>
<td>11</td>
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</tbody>
</table>
PEV Conductive Charging Methods (SAE J1772-2012)

Adds DC Fast Charging

“Combo” connector

Consensus with Europe

Japan/ Nissan/ Mitsubishi still apply a separate port, “Chademo” fast-charge protocol
Level 2 Charging Station

An “Outlet”, not a “charger”

Gives vehicle battery charger access to higher volume of energy (and decreased charge time)

Special functionality built in per SAE and UL

Hardwired or plug-in into premises wiring system
SAE J1772 Charger Operation
Levels 1 and 2

Supply equipment detects EV

EV detects presence of plug and cannot be driven away while plugged in.

Supply equipment ready to supply energy

EV ventilation interlock

Supply equipment current capacity provided to EV

EV commands energy flow

Continuous monitoring of safety ground

Charge interrupted by removing plug
UL Standards

- UL 62, Flexible Cords and Cables
- UL 50E, Enclosures for Electrical Equipment, Environmental Considerations
- UL 2202, Electric Vehicle (EV) Charging System Equipment
- UL 2251, Plugs, Receptacles and Couplers for Electric Vehicles
- UL 2594, Electric Vehicle Supply Equipment
- UL 2231, Standard for Safety of Personnel Protection Systems for EV Supply Circuits
UL 2594, Electric Vehicle Supply Equipment

Limited to equipment rated no greater than 250 Vac

Ventilation not required.

Enclosure requirements (minimum thickness, strength, etc.)

EV Cable cannot exceed 25 feet without cable management. No minimum length.

Ampacity confirmed by temperature rise testing

Instructions must state maximum continuous branch circuit rating

Short circuit rating not req’d to be marked on unit.
UL 2231, Personnel Protection Systems for EV Supply Circuits

Reduce the likelihood of muscle tetanization

Protect parts capable of being contacted by a person

- Charging Circuit Interruption Device (CCID), 5mA or 20mA
- Grounding monitor/interrupter
- Isolation monitor/interrupter
- Double insulation

Specific combinations of these may be required depending on the voltage between conductors and voltage to ground
NEC Article 625

625.14: charging loads to be considered as continuous loads. *(No exceptions)*

625.21: Overcurrent protection sized for 125% of the continuous load current.

No exception for 100% rated circuit breakers.

Coupling means must be stored/located at a height:

- Indoors 625.29(B): 18 inches to 4 feet from floor level
- Outdoors 625.30: 24 inches to 4 feet from floor level,
- Unless specifically listed for the purpose.
NEC Article 625.13

Cord and plug connections permitted for 15A and 20A, 125V single phase maximum.

2011: TIA issued to allow cord and plug connection:
250V maximum
Connected to receptacle 50A maximum
Supply cord 6 ft maximum
NEC 625.25 and 625.26

No backfeed of power from EVSE on loss of utility source (625.25)

Unless identified and intended for use as a standby source or electrical power production source (625.26)

Articles 702 or 705 apply
### NEC 2014 Changes to Article 625 (partial)

<table>
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<tr>
<th>2011</th>
<th>2014</th>
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<tr>
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<td>625.44</td>
<td>EVSE Connection: Included 2011 TIA</td>
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<tr>
<td>625.14</td>
<td>625.41</td>
<td>Rating: Allows EVSE rating to be maximum load permitted by automatic load management systems</td>
</tr>
<tr>
<td>625.17</td>
<td>625.17</td>
<td>- Add reqmts for Power Supply cord. [625.17(A)]</td>
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<tr>
<td></td>
<td></td>
<td>- 12 inch maximum Power Supply cord when EVSE contains personnel protection. [625.17(A)(3)(a)]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Overall maximum cord length 25 feet. Reqmts differ when EVSE is fastened in place [625.17(C)]</td>
</tr>
<tr>
<td>625.21</td>
<td>625.40</td>
<td>Overcurrent Protection (125% rule)</td>
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<tr>
<td>625.23</td>
<td>625.42</td>
<td>Disconnecting Means</td>
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<td>625.25</td>
<td>625.46</td>
<td>Loss of Primary Power</td>
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<td>Interactive Systems</td>
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<tr>
<td>625.29</td>
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<td>625.29(C) and (D)</td>
<td>625.52</td>
<td>Ventilation</td>
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EVSE Surge Withstand Capabilities

6 kV crest @ 3,000 A

Typical for:
- Long branch circuits
- Wiring/equipment housed well within building
- “Low Exposure” external locations.

Apply SPDs for more severe applications

SPD integrally mounted on a branch panel assembly
EV Charging Station Selection

Who will use it?

– Open access
– Limited access
– RFID Access
– Credit card swipe access

Subscription required (monthly fee)?
EV Charging Station Selection

Mounting types
- Single pedestal
- Double pedestal
- Wall mount
- Pole mount

Displays and indicators

Upgradability
EV Charging Station Selection

Network communications
– Monitor/ control load levels
– Monitor/ control access
– “SmartGrid” controls
– CPUC Submetering Protocol
  IOU Roadmap report issued 2011
A Closer Look

What’s inside?

**Controller**
- Provides user with charger status and messages via LED Bar, Vacuum Fluorescent Display, or external communications
- Allows user configurable overload protection
- Performs CCID20 ground fault protection per UL 2231
- Provides single phase metering

**Contactor**
- Responsible for energizing and de-energizing of EVSE connector
- Operates in conjunction with controller to meet UL and NEC requirements

**Connector**
- Compliant with SAE J1772 standard
- UL listed for EVSE applications

**Fuses**
- Provides overload and short circuit protection

- LED Bar Charger Status
- VFD Screen
- RFID (optional)
- Plug Holder
- Power Cord Holder
- Access Panel (on side)
- Base to accept power and fasten to concrete
RFID - Hardware

Optional Radio Frequency Identification (RFID) to control user access

Details:

• Single wave of card in front of reader initiates charging
• Monitor/Control of Driver Access/Usage
• Ethernet network to support RFID authorization service

Straightforward In Field Installation

• Side access panel
• Single wired connector

Administration – Programming Cards

• USB connected RFID programmer
• Lightweight and Portable
• Determines class of service, authorization policy, user control and configuration
RFID Option - Software

Local Desktop Application (Windows OS)

Monitor

- Reports EVSE usage and charging status
- Tracks Station charging time
- Connectivity Tracking assists billing
- Charging Status

Control

- Securely enables owner/operator to add, remove, suspend driver authorization
- Manage Drivers/Profiles
- Enable/Disable Users
EV Charging Station Specification

Basic:
1. Supply Needs: 208-240VAC @ 30A with 40A branch (2 pole)
2. GF Protection with Ground Monitor (UL 2231)
3. Charger & Vehicle Communication (NEC 625)
   - Connection Interlock
   - Personnel Protection
   - Automatic De-Energizing Device
   - Ventilation Interlock
4. Connection for SAE J1772 Plug & Cord
5. LED Lights & Display
6. Indoor & Outdoor Enclosure (NEMA 3R)
7. RFID User Authorization Option

Communication Options:
Open Network Communications – Ethernet, RS485, RS232

Consider modular designs that can be upgraded as new technology arrives and customer needs change
Siting Considerations

Cable length
(minimum length not standardized)

Disabled Accessibility/ Compliance with ADA

Cords should not cross heavy foot traffic paths
Ventilation

Hydrogen outgassing

Sealed lead-acid and Nickel-Metal Hydride (NiMH)

EVSE will detect if EV requires ventilation

NEC-2011 625.29(D) Ventilation req’d when required by the listing.

UL 2594 covers electric vehicle supply equipment intended for use where ventilation is not required.

EVSE will alarm and not energize EVs requiring ventilation
Handling High Density EV Loads

Power density: 50W per sq. ft. (30A demand each)

50 EV Chargers = 360kVA

50 Vehicle Area = 80 ft x 120 ft

Voltage drop

More than 300 cars
Thank You!

Q&A