### DOCKETED

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<th><strong>Docket Number:</strong></th>
<th>19-OIR-01</th>
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<tr>
<td><strong>Project Title:</strong></td>
<td>Load Management Rulemaking</td>
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<tr>
<td><strong>TN #:</strong></td>
<td>231541</td>
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<tr>
<td><strong>Document Title:</strong></td>
<td>Presentation - Electric Vehicle Charging Load Management</td>
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<tr>
<td><strong>Description:</strong></td>
<td>Presentation by Noel Crisostomo on technology options for expanding the demand flexibility of the grid through price-responsive EV charging</td>
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<td><strong>Filer:</strong></td>
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<td><strong>Organization:</strong></td>
<td>California Energy Commission</td>
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<tr>
<td><strong>Submitter Role:</strong></td>
<td>Commission Staff</td>
</tr>
<tr>
<td><strong>Submission Date:</strong></td>
<td>1/15/2020 1:39:22 PM</td>
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<tr>
<td><strong>Docketed Date:</strong></td>
<td>1/15/2020</td>
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Electric Vehicle Charging Load

Load Management Rulemaking (19-OIR-01)
Panel 3: Responding to Hourly and Sub-Hourly Grid Signals

Noel Crisostomo
Fuels & Transportation Division | California Energy Commission
January 14, 2020
How can California integrate electric vehicle (EV) charging with a 100% carbon-free electricity supply?

Opportunity and System Impacts
• CEC/NREL & LBNL/UCB analysis of 1.3M and 5M EVs by 2025

Demonstrated, Feasible Technologies
• Flexibility-enabling EV Supply Equipment (EVSE)

Costs and Benefits
• Market benchmarks, components, and possible savings

Appendix
The EV “Dragon Curve” & Avoided Curtailment with Smart Charging in 2025

Statewide Light Duty PEV Charging Load Profile in 2025

- Residential L1
- Residential L2
- Work L2
- Public L2

“Networking technologies that enable the shared use of charging should be leveraged to automate demand responsive charging.”


“...Smart charging lowers the cost of achieving CA's renewable energy targets...Overnight TOU charging is counterproductive...because it results in higher annual curtailment than even unmanaged PEVs.”

Lawrence Berkeley National Laboratory & UC Berkeley (2020). Reduced grid operating costs and renewable energy curtailment with electric vehicle charge management.
Open Standards-Based Network Communications provide both implementation and load flexibility

CA Department of Food and Agriculture EVSE Regulation implementing elements of NIST Handbook 44 Section 3.40 for commercial metrology of EV fueling systems:
- For AC electricity, 1% Acceptance Tolerance for installations on or after 1/1/21. Prior installations shall comply by 1/1/31.
- For DC electricity, 2.5% Acceptance Tolerance for installations before 1/1/33 and 1% afterward.

Multiple viable protocols, dependent on use or situation, for each EVSE with embedded metering:
- Utility Direct or Aggregator-managed demand response or resource controls
- Presence of other EVSEs, non-EV loads, and/or an Energy Management System
- Transfer information across networks (direct between networks or via clearing houses)
- Asset protection for potential use of EVSE across multiple EV Service Providers
Networked residential AC Level 2 EVSEs are first-cost competitive, without accounting for flexible tariff savings.

EVSE analysis is normalized for the features included (i.e. to avoid bundling options that support commercial or public-facing operations e.g. payment interfaces, WAN/LAN networking, robustness/weatherization, plug v. hardwire, cord length & management, etc.)

Compare unit costs by ampacity to ensure that the models’ functional units are substantially similar.

Consider year of introduction and/or by sales weights, if data is available (excluded at right).

Source: CEC March 2019 analysis of EVSE product pages, work papers, and OEM interviews.
Implementing a common, unique EV/EVSE communications protocol based on ISO/IEC 15118 is crucial for seamless charging interoperability to reduce EVSP network software costs and site hosts’ utility operational costs.
With economies of scale production, including a transceiver adds de minimis upfront costs to a L2 EVSE (excluding mfr. design, engineering, supply chain and software integration)

Using conservative assumptions for driver willingness to pay and higher-end component costs demonstrates **net value** for OEMs at volumes <1k units, *excluding* load management benefits.

All parties want lower costs, but asking drivers for inputs overly complicates charging and limits load management

Workplace & Public Charging

- Text message-based user inputs of high-level communication data:
  - Planned departure time
  - Energy (kWh or mi)

- DR participation rate = 48%

Sources:
1) American Honda Motor Co, [CEC-600-2019-033](https://example.com) at 60
2) Lawrence Berkeley National Laboratory, [CEC-500-2019-036](https://example.com) at 40
All parties want lower costs, but asking drivers for inputs overly complicates charging and limits load management.

Workplace & Public Charging

- Histogram of error in user-requested kWh
- 74% request > delivered, 26% request < delivered
- ModeBEV - ModePHEV = 2.5 kWh in excess of delivered charge

Source: National Renewable Energy Laboratory, DOI: 10.1109/ITEC.2018.8450227
All parties want lower costs, but asking drivers for inputs overly complicates charging and limits load management.

Residential Charging

- Maximum % Reduction in EV Load for different reserve SOC values without adversely impacting mobility, for DR events beginning at different hours

- ~65% reduction possible with ½ of battery reserved

Source: ChargePoint, CEC-500-2019-009 at 30
The market is evolving toward a shared vision where “Any PEV can plug into any EVSE, anywhere, anytime and they are able to function without special effort…”

Harmonized standards and regulations [will create:]  
• Interoperable PEVs, EVSE, and communication networks  
• Predictable investment requirements [for industry to achieve scale]  

The Energy Commission can support this vision by:  
• Convening automotive and equipment manufacturers  
• Driving innovation while supporting commercialization  

Sources:  
1) European Commission Joint Research Center / U.S. Department Of Energy - Argonne National Lab, EV-Smart Grid Interoperability Centers  
2) Stakeholder comments to Docket 17-EVI-01
Questions or comments?

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Based on 2 example configurations:

Conservatively, ISO 15118 enabling circuits cost <$10/unit at scale.

Assuming that the Level 2 EVSE is networked, the transceiver marginal cost is about $1.5/unit.

Source: Energy Commission March 2019 analysis of supply equipment charge controllers and wholesale electronics suppliers.