<table>
<thead>
<tr>
<th><strong>DOCKETED</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Docket Number:</strong></td>
<td>19-IEPR-04</td>
</tr>
<tr>
<td><strong>Project Title:</strong></td>
<td>Transportation</td>
</tr>
<tr>
<td><strong>TN #:</strong></td>
<td>227308</td>
</tr>
<tr>
<td><strong>Document Title:</strong></td>
<td>Presentation - Assessing Electric Vehicle Charging Infrastructure Needs in California</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>Presentation at IEPR Staff Workshop on March 11 - Implementing AB 2127</td>
</tr>
<tr>
<td><strong>Filer:</strong></td>
<td>Denise Costa</td>
</tr>
<tr>
<td><strong>Organization:</strong></td>
<td>California Energy Commission</td>
</tr>
<tr>
<td><strong>Submitter Role:</strong></td>
<td>Commission Staff</td>
</tr>
<tr>
<td><strong>Submission Date:</strong></td>
<td>3/11/2019 2:20:21 PM</td>
</tr>
<tr>
<td><strong>Docketed Date:</strong></td>
<td>3/11/2019</td>
</tr>
</tbody>
</table>
Assessing Electric Vehicle Charging Infrastructure Needs in California

Implementing Assembly Bill (AB) 2127
In Case of Emergency
<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00</td>
<td>Welcome &amp; Introductions to Energy Commission Charging Assessments</td>
</tr>
<tr>
<td>10:15</td>
<td>AB 2127 Requirements and Process</td>
</tr>
<tr>
<td>10:30</td>
<td>Coordination with Air Resources Board and Public Utilities Commission</td>
</tr>
<tr>
<td>11:15</td>
<td>Data Collection: Overview</td>
</tr>
<tr>
<td>11:30</td>
<td>Infrastructure Analysis: Needs and Ongoing Research</td>
</tr>
<tr>
<td>12:00</td>
<td>Public Comments</td>
</tr>
<tr>
<td>12:15</td>
<td>Lunch Break</td>
</tr>
<tr>
<td>1:15</td>
<td>Common Definitions for Charging Infrastructure Elements</td>
</tr>
<tr>
<td>1:35</td>
<td>Public Comments</td>
</tr>
<tr>
<td>2:00</td>
<td>Data Collection: Deeper Dive Activities for On-Road Sector Vehicles</td>
</tr>
<tr>
<td>3:45</td>
<td>Public Comments</td>
</tr>
<tr>
<td>4:00</td>
<td>Next steps to engage with the Infrastructure Assessment Adjourn</td>
</tr>
</tbody>
</table>
Housekeeping

- Please speak into microphones, introducing yourself and organization.
- Remote participants are muted; please chat your question to the host or use the “raise hand” button to ask a question and be unmuted.
- Moderators will allow for questions after the panel of presenters are completed.
- To facilitate open discussion, staff will not be strictly timing comments. Please defer to the moderator’s discretion during your comment, as they will consider the number of others waiting in the queue.
- Workshop is being recorded and transcribed. These will be added to the IEPR Docket 19-IEPR-04 and posted online.
AB 2127 Requirements and Process

- Legislative background and requirements
- Possible outcomes

Noel Crisostomo
Fuels and Transportation Division
AB 2127 In Context

• Address increases in transportation vehicle miles traveled demand and emissions
• Accelerate deployment of 5 million ZEVs and 40% reduction of GHG by 2030
• Transition to a 60% renewable portfolio by 2030 and 100% clean electricity by 2045
• Assess infrastructure needs and enable installation of grid-integrated charging

SB 100

AB 2127 et al.
• Biennial statewide charging infrastructure assessment to meet:
  • 5 million ZEV by 2030
  • Reducing GHG 40% below 1990 by 2030
• Expand upon the CEC’s EV infrastructure projections to consider all necessary charging infrastructure:
  • Charging infrastructure
  • Make-ready electrical equipment
  • Hardware and software
  • Other programs to accelerate adoption
• Examine existing and future needs:
  • Throughout California
  • Low-income communities
• Seek data and input from stakeholders:
  • CPUC, CARB, utilities, transportation & transit agencies, electrical infrastructure, environmental groups, automobile manufacturers, and others

All Vehicle Categories
• Road
• Highway
• Off-road
• Port
• Airport
Considerations for Expanded EV Infrastructure Projections

Decarbonization
Vehicle Regulation
Land Use Changes

Energy Storage
Charging Technologies
Automation, Connectivity, & Sharing

Renewables Integration
Electric Grid Modernization
Expanded EV Infrastructure Projections

Regulatory Requirements to Achieve GHG and Air Pollutant Reductions

Facilitated Development of New Technology and Deployment Models

Technology Analysis and Modeling of Needed Charging Infrastructure Throughout All of California

Uncertain Systems Interactions & Other Direct/Indirect Factors

Market Demand for Electric Transportation and Driver Behaviors
Ongoing: Development of CEC & researcher technical models

March – May: Scenario development and data collection

May – June: Technical analysis and drafting

January 2020: 1st Report as part of IEPR
December 2020: 2nd Report

Q2: - Off-Road, Port, and Airport Electrification
- Recent Developments in EV Markets
- Grid Impacts of Charging

Ongoing preparations during 2019: Collection of inputs and assumptions
Model development → quantitative analyses
Focus on Collaborative and Applied Analyses

- Goal: Independent, objective technology assessment
  - EVI-Pro-type transportation demand models, technology surveys, site-specific assessments, and others

- CEC will leverage directive and seek information and feedback from stakeholders to learn from experiences and identify priority analyses.

- CEC recognizes the role of AB 2127’s PEV charging infrastructure assessments in answering questions of other State and local efforts:
  1. Availability and sufficiency of infrastructure
  2. Needs for additional infrastructure
  3. Sensitivities of 1 & 2 to changing demand and technology
Coordination with CARB and CPUC

Kathy Jaw
CARB

Joshua Cunningham
CARB

Tony Brasil
CARB

Carolyn Sisto
CPUC
Data Collection (Overview)

- Methods of gathering information
- Organizing data in Scoping Matrix
- Preparing for future data

Wendell Krell
Fuels and Transportation Division
# Data Collection Methodology

## Data Collection

<table>
<thead>
<tr>
<th>Type of Data</th>
<th>Comparability?</th>
<th>Confidential?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forms &amp; Surveys</td>
<td>Quantitative</td>
<td>High</td>
</tr>
<tr>
<td>Interviews</td>
<td>Quantitative and Qualitative</td>
<td>Limited. Needs narration.</td>
</tr>
<tr>
<td>Workshops &amp; Workgroups</td>
<td>Quantitative and Qualitative</td>
<td>Limited or High. Benefit to public.</td>
</tr>
</tbody>
</table>

## Analysis
- Interagency Scenario Formulation
- Technical Assistance (model development, consultant reports)
- Findings of Fact
- Conclusions and Recommendations

## Reporting
- **AB 2127 Charging Infrastructure Assessment**
- Transportation Energy Demand Forecast
- Vehicle-Grid Integration Roadmap
- Assessment of Disproportionate Deployment of Charging Infrastructure (SB 1000, 2018)
New Market Information Will Add to Agencies’ Collected Information

CEC’s Scoping Matrix

- Surveys & Forms
- 1-on-1 Interviews
- Workshops & Workgroup Meetings
- Advanced Technology Demonstrations

CEC EV Divisions
- Fuels and Transportation
- Energy Assessments
- Research and Development

CPUC
- Energy
- Regulations
- Programs
- Technology Assessments

ARB
### CEC’s Scoping Matrix

#### Vehicle Categories
- Road and Highway
  Three sectors for today’s workshop:
  - Light-, Medium-, and Heavy-Duty Vehicles
- Off-Road
- Port
- Airport

#### Infrastructure Elements
- Chargers
- Make-Ready Electrical Equipment
- Hardware and Software
- Other Programs
Data Use

• Which vehicle sectors or infrastructure elements can feasibly be analyzed during the 2019 IEPR?
  – Stakeholders’ data must be incorporated for analysis by mid-May.

• Which areas require additional research and are appropriate for 2020?
Infrastructure Analysis: Needs and Ongoing Research

Kadir Bedir
Fuels and Transportation Division

From data and models… to actionable insights.

California Plug-In Electric Vehicle Infrastructure Projections: 2017-2025
Future Infrastructure Needs for Reaching the State’s Zero-Emission-Vehicle Deployment Goals

California Energy Commission
Edmund G. Brown Jr., Governor
March 2018 | CEC-600-2018-001

Kadir Bedir
Fuels and Transportation Division
Infrastructure Analysis: Needs and Ongoing Research

Eric Wood
National Renewable Energy Laboratory

Colin Sheppard
Lawrence Berkeley National Laboratory

Gil Tal
University of California at Davis
PUBLIC COMMENTS

• What questions do stakeholders have on the process?

• Which topics are of greatest interest to stakeholders, and how could the Energy Commission’s analysis be prioritized?
To account for space, which sector are you most interested in discussing during the afternoon breakout session?

Light-duty vehicles
Medium-duty vehicles
Heavy-duty vehicles

PLEASE RAISE YOUR HANDS
The workshop will resume at 1:15 p.m.
Common Definitions of Charging Infrastructure Elements

• Including, but not limited to
  – Chargers
  – Make-Ready Electrical Equipment
  – Supporting Hardware and Software
  – Other

Noel Crisostomo
Fuels and Transportation Division
What is Specifically Meant by the Term “Chargers”?

- Connector(s)
- **AC**: Electric Vehicle Supply Equipment or **DC**: Off-Board Charger
- Infrastructure
- Station
EV Supply Equipment (EVSE) or DC Fast Charger

Level 1 EVSE

Level 2 EVSE

DC Fast Charger

AC/DC Charger

DC Battery
Need to Use Consistent Terminology

<table>
<thead>
<tr>
<th>Type</th>
<th>Outlets</th>
<th>Connectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Fast</td>
<td>10</td>
<td>CHAdeMO, SAE CCS</td>
</tr>
</tbody>
</table>

**Station Address:** 2774 Livermore Outlets Dr., Livermore, CA

- Several groups of DCFCs

**Electrify America’s 10 DCFCs:**
- Three images above from the AFDC, PlugShare, and EA websites
- 10 vehicle parking spots
- Each DCFC has 2 connectors
  - 1 CHAdeMO and 19 CCS connectors total
- 150 kW DCFCs (8)
  - CCS-only
- 350 kW DCFCs (2)
  - 1 CCS, 1 CCS + CHAdeMO
CEC’s EVI-Projections quantify the **Level 1 & 2 EVSEs and DCFCs needed to serve the power capacity demanded by an EV** given an individual’s driving, coincident charging demand from other drivers, and increasing onboard charger and DCFC power ratings.

Quantification of need should specify maximum connector capacity and account for: 1) reductions in throughput that delay service, given e.g. parking configurations or power management objectives, and 2) user behaviors.
Make-Ready Electrical Equipment

Utility Right-of-Way
- Primary Circuit
- Secondary Circuit
- Secondary Transformer
- Substation

Customer Premises
- Service Drop
- Meter
- EV Meter
- EV Panel
- Customer Cost (dedicated)
- Customer Cost (behind-the-meter)

EVSE
- Junction Box
- EVSE
- Separate Service (+Submetering)

Pre SB 350 Distribution Cost (non-dedicated)

Post SB 350

Distribution Cost (non-dedicated)
Hardware and Software

Physical & Transactional Compatibility
Charging Controls*
Electrical Safety
Meter Accuracy*
Network Connectivity*
Load Efficiency
Secure Authentication*
Secure Payment

3rd Party Submetering (Either through an EVSP or an EMS with validated association with the AMI)

Utility Submetering (Accounted directly to EVSE load, or as part of other AMI load)

Electricity (Physical and Accounted)

* = Vehicle-grid integration related hardware and software requirements

+ Others…

+ Wireless, High-Power, Pantograph, Automated Connections

* = Vehicle-grid integration related hardware and software requirements
Working with Common Definitions

- Prior analyses of charging infrastructure elements based on Energy Commission experience, research, independent technical reports, and utility programs.

- Interagency Vehicle-Grid Integration Communications Protocols Working Group
  - Draft Final VGI Glossary of Terms
  - Not finalized or adopted by CPUC, but serves as a useful starting point to propose definitions.

- Energy Commission staff will plan to refer to portions of the VGI Glossary and to refine and further develop them as part of AB 2127 analysis.
Accounting for Interactions Between Infrastructure Factors

- A pathways and systems approach to assessing needs
  - Charging in context of the transportation system
  - LDV driver preferences for public DCFC or Level 2 charging in EVI-Pro 2018 Alternative Pricing Scenario

<table>
<thead>
<tr>
<th>Travel Demanded</th>
<th>• Types and locations of economic activity</th>
</tr>
</thead>
</table>
| Vehicles Used   |  • Vehicle type scenarios  
                  |  • Mode shifts and tradeoffs               |
| Infrastructure Needed |  • Home/Facility & Public EVSEs  
                          |  • Power and use tradeoffs                |
Accounting for Interactions Between Infrastructure Factors

• Capability to offer the needed *charging services*
  • Consider the speed of deploying different asset types that could attain EV deployments and GHG reductions

• Service Resilience
  • P.U. Code §237.5:
    “Transportation Electrification” means the use of electricity from *external sources of electrical power*, including the electrical grid, for all or part of…”
  • Emerging charging paths: distributed energy resources, storage, fuel cell, etc.

• Track the pace and breadth of *other programs*, including existing infrastructure incentives
• What stakeholder terminology or resources may be incorporated?

• What alignments may be made across agencies?
Data Collection (Deep Dives)

- Purpose: offer insights on questions in the Scoping Matrix
- Provide answers to data requirements.
- Suggest resources to improve analysis. Volunteer yourself or colleagues to assist with further discussions.

I WANT TO PARTICIPATE

Sign up below and Energy Commission staff will contact you to conduct an Electric Vehicle Charging Infrastructure Assessment (AB 2127) interview

<table>
<thead>
<tr>
<th>NAME</th>
<th>COMPANY/AGENCY</th>
<th>PHONE</th>
<th>EMAIL</th>
<th>TOPICS OF INTEREST</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Identify important considerations, concerns, or challenges with the analysis.
Data Collection (Deep Dives)

- How: Breakout groups facilitated by staff for each major on-road vehicle sector
  - Light-Duty Vehicles – Noel Crisostomo, Kim Ho
  - Medium-Duty Vehicles – Tim Olson, Wendell Krell
  - Heavy-Duty Vehicles – Ben De Alba, Adeel Ahmad

- Summary Reports
  - Information gaps and analytical needs
  - Questions and ideas to follow up
### Breakout (70 minutes)

<table>
<thead>
<tr>
<th>Assessment Objectives</th>
<th>(Insert Vehicle Sector)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Requirements</strong></td>
<td><strong>Availability?</strong> Y: List sources / N: Means to collect</td>
</tr>
<tr>
<td>Regulations affecting demand for new electric vehicles</td>
<td>Account for use differentiation</td>
</tr>
<tr>
<td>Baseline Vehicle populations, by type</td>
<td>Identify relation to travel demand-specific regulations</td>
</tr>
<tr>
<td>Travel schedule (time-resolved origins and destinations)</td>
<td>Identify efficiency improvements</td>
</tr>
<tr>
<td>Time-resolved energy consumption (EV or conventional)</td>
<td>Account for relative production costs and operational costs</td>
</tr>
<tr>
<td><strong>Electric Vehicle Populations</strong></td>
<td>Battery Electric Vehicles Plug-In Hybrid Electric Vehicles Plug-In Fuel Cell Electric Vehicles</td>
</tr>
<tr>
<td></td>
<td>Account for vehicle classes</td>
</tr>
<tr>
<td>Electric Vehicle battery ranges, by type</td>
<td>Battery Electric Vehicles Plug-In Hybrid Electric Vehicles Plug-In Fuel Cell Electric Vehicles</td>
</tr>
<tr>
<td>Charging Capacity (conductive)</td>
<td>Level 1 Level 2 DC Fast Charging</td>
</tr>
<tr>
<td>Charging Capacity (non-conductive)</td>
<td>Inductive Dynamic Pantograph</td>
</tr>
<tr>
<td>Existing charging infrastructure</td>
<td>Automotive Electric Vehicle Service Equipment</td>
</tr>
<tr>
<td>Manufacturer production capacity</td>
<td>Permitting Certification</td>
</tr>
<tr>
<td>Regulations affecting rate of installation</td>
<td>④</td>
</tr>
</tbody>
</table>

1. Offer market information, reports, databases, etc.

2. Detail inputs that may affect the “Need” for:
   - Chargers
   - Make-ready electrical equipment
   - Hardware and software
   - Other programs

3. Identify considerations to refine, improve relevance of analysis, and how to analyze.

4. Provide additional suggestions for information to collect
Summary (30 minutes)

For each breakout group:

• Sector Reports (5 minutes)
  – Learnings
  – Analytical needs to follow up in further data collection
  – Closing remarks

• Comments from the other two groups (5 minutes)
PUBLIC COMMENTS
Next opportunities to engage

- Written Comments: Written comments should be submitted to the Dockets Unit by 5:00 p.m. on March 29, 2019.

- For the 2019 IEPR, the Energy Commission encourages use of its electronic commenting system: https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=19-IEPR-04,

- Additional AB 2127 workshops related to off-road, port, and airport electrification and other topics will be scheduled for the 2nd quarter

- AB 2127-related material will be served to: energypolicy, transportation, altfuels, diversity, and DCAG. Sign up for automatic notifications at: https://www.energy.ca.gov/listservers/.
Thank you!

For questions, please contact:
Noel Crisostomo
Noel.crisostomo@energy.ca.gov
916-653-8625