| **DOCKETED** |
|------------------|------------------|
| **Docket Number:** | 19-AB-2127 |
| **Project Title:** | Implementation of AB 2127 Electric Vehicle Charging Infrastructure Assessments |
| **TN #:** | 246149 |
| **Document Title:** | EVI-Pro AB2127 Workshop |
| **Description:** | N/A |
| **Filer:** | Christina Cordero |
| **Organization:** | California Energy Commission |
| **Submitter Role:** | Commission Staff |
| **Submission Date:** | 9/19/2022 3:39:23 PM |
| **Docketed Date:** | 9/19/2022 |
Agenda

1) Introduction to the second AB 2127 assessment
2) Scenarios and analysis for next AB 2127 assessment
3) EVI-Pro 3 model methodology, inputs and assumptions, and outputs
4) Q&A and Public Comment
Housekeeping

• Workshop is being recorded

• Workshop Event Webpage:
  https://www.energy.ca.gov/event/workshop/2022-09/assembly-bill-ab-2127-assessment-workshop

• Written Comments to Docket # 19-AB-2127:

Deadline for Written Comments: 5:00pm on Friday, October 14, 2022
Commitment to Diversity

The CEC adopted a resolution strengthening its commitment to diversity in our funding programs. The CEC continues to encourage disadvantaged and underrepresented businesses and communities to engage in and benefit from our many programs.

To meet this comment, CEC staff conducts outreach efforts and activities to:

• Engage with disadvantaged and underrepresented groups throughout the state;

• Notify potential new applicants about the CEC’s funding opportunities;

• Assist applicants in understanding how to apply for funding from the CEC’s programs;

• Survey participants to measure progress in diversity outreach efforts.
Diversity Survey

One Minute Survey
The information supplied will be used for public reporting purposes to display anonymous overall attendance demographics

Zoom Participants, please use the link in the chat to access the survey or scan the QR code on the left of the screen with a phone or tablet to access the survey.

Survey will be closed at the end of the day

Survey Link:
https://forms.office.com/Pages/ResponsePage.aspx?id=RBI6rPQT9k6NG7qicUgZTqEU3EeANX9DvIX_on7oPclUNlYOFVYTVJ1QzIUTFQSjgyVkhaOVRXQS4u
Introduction to the AB 2127 Assessment
Transportation Emissions

Transportation Related (216 MMT) 51%

- Vehicle Emissions (170 MMT) 40%
- Industrial – Fossil Extraction, Processing & Refining (47 MMT) 11%
- Other 14%
- Commercial & Residential 10%
- Electric Power 15%
- Industrial – Other Emissions 10%

Source: CARB GHG Inventory
Electric vehicle charging infrastructure needed to support:

• Assembly Bill 2127
  • By 2030, at least 5 million zero-emission vehicles (ZEVs)
  • By 2030, reduce greenhouse gas emissions to 40% below 1990 levels

• Executive Order N-79-20
  • By 2035, 100 percent ZEV sales for new passenger vehicles and 100% ZEV operations for drayage trucks and off-road vehicles and equipment
  • By 2045, 100 percent ZEV operations for medium- and heavy-duty vehicles, where feasible
Related Efforts


AB 2127 Charging Infrastructure Assessment Process

• Upcoming Workshops:
  • HEVI-LOAD
  • Labor and Workforce

• Fall/Winter 2022: Modeling, scenario runs, preliminary results

• Early 2023: Staff Report published (draft for comment)

• Early 2023: Workshop and public comment on Staff Report

• Summer 2023: Revisions and publication of Commission Report (final draft) that will be presented at a Business Meeting

• Every two years: Updated AB 2127 Charging Infrastructure Assessments
Assessment Outline

• Existing Charging Infrastructure
• Current ZEV Trends
• Modeling California’s Charging Needs
  • EVI-Pro 3: Infrastructure for Light Duty Vehicles
  • HEVI-LOAD: Infrastructure for Medium- and Heavy-Duty Vehicles
  • WIRED: Infrastructure for TNCs
  • EDGE: EVSE Deployment and Grid Evaluation
• Vehicle-Grid Integration
• Labor and Workforce
Existing Chargers in California (2011 – 2021)

- **2011**: 486 chargers
- **2012**: 1,622 chargers
- **2013**: 5,176 chargers
- **2014**: 6,990 chargers
- **2015**: 10,331 chargers
- **2016**: 14,084 chargers
- **2017**: 16,414 chargers
- **2018**: 19,135 chargers
- **2019**: 41,947 chargers
- **2020**: 70,479 chargers
- **2021**: 79,023 chargers

Existing Charger Distribution Analysis (SB 1000)

• First Report (December 2020)
  • Low-income communities, on average, have fewer public chargers per capita than middle- or high-income communities.

• Second Report (July 2022)
  • Rural communities have sparse public fast charging coverage compared to urban communities.
  • Low-income rural communities have the least coverage.
Charger Reliability

• Workshop in March 2022

• Workshop in October 2022

Incorporating reliability requirements for all CEC-funded chargers

Photo Credit: Dekra
EVI-Pro 3: Infrastructure for Light Duty Vehicles

Simulation model to:

1) Estimate charging demand from light-duty PEVs for *intra- and inter-regional travel*
2) Design supply of residential, workplace, and public charging infrastructure capable of meeting demand

Key outputs:

1) Number, type, and location of chargers required to meet charging demand
2) Load profiles associated with charging demand
WIRED: Infrastructure for TNCs

• Optimizing Charging Infrastructure Buildout For TNC Electrification

• Interesting challenges for future infrastructure deployment:
  • Significantly higher utilization of public DC fast charging
  • Need for high-speed charging to minimize driving/service downtime
  • Spatial coverage to reduce travel/deadheading for TNC service vehicle
Simulation model to:
1) Estimate charging demand from medium- and heavy-duty BEVs for intra-regional travel
2) Design supply of overnight and daytime charging infrastructure capable of meeting demand without behavior changes

Key outputs:
1) Number, type, and location of chargers required to meet charging demand
2) Load profiles associated with charging demand

What’s new in second assessment?
• Updated methodology to address dynamic pricing, parking flexibility, smart charging, and site-specific grid impact assessment
• Key improvements compared to inaugural report analysis (e.g., more diverse set of charging power levels)
• Sensitivity analysis, including a stronger focus on drayage analysis and challenges (quantitative and qualitative)
EVSE Deployment and Grid Evaluation (EDGE) Tool

- Close the gap for capacity planning and understand regional load characteristics
- Maximize data and technical accessibility of make-ready equipment analyses, deployment, and investments
- Map distribution circuits to charging connectors
- Provide technical/analytical capabilities to support utilities

Source: CEC staff
(Data from November 2021)
Vehicle-Grid Integration

• Need and strategies to scale VGI
• CEC initiatives supporting VGI
  • Interoperability and testing
  • V2G Equipment List
  • Funding solicitations
  • Technical requirements
  • Load Management Standards
• Outstanding challenges and future work
Labor and Workforce

- EVSE Workforce Ecosystem
- Electric Vehicle Infrastructure Training Program (EVITP)
- SB 589
- Program Workforce Partnerships and Investments

Photos: KIGT Inc.
Scenarios
Fleet Scenarios in 1st AB 2127 Report

![Graph showing fleet scenarios from 2020 to 2030. The graph includes three scenarios: EAD Low Scenario, EAD Aggressive Scenario, and CARB Mobile Source Strategy. The y-axis represents Total ZEVs ranging from 0 to 8,000,000. The x-axis represents years from 2020 to 2030. The graph shows a steady increase in ZEVs across all scenarios over the years.]
Fleet Scenarios in 2\textsuperscript{nd} AB 2127 Report

![Graph showing the number of PEVs (Plug-In Electric Vehicles) from 2020 to 2035 under two scenarios: Advanced Clean Cars (2022) and Mobile Source Strategy (2020).]
EVI-Pro (NREL slides)
EVI-Pro Updates for California’s Statewide Charging Infrastructure Assessment (AB2127)

Eric Wood, Fan Yang, Yanbo Ge, Tim Jonas, D-Y Lee, and Nick Reinicke
CEC AB2127 Workshop
Sept 19, 2022
Charging Networks: Design Concepts

Coverage vs. Capacity
Establish coverage, then build capacity.

Corridors vs. Communities
- Corridor needs are relatively small, but expensive and critical for adoption.

Home Charging is Foundational
- Today, most EVs do most of their charging at home.
- In the long-term, we expect the share of EVs without home charging to increase.
What is EVI-Pro?

- Simulation model to:
  - Estimate intra-city charging demand from light-duty PEVs
  - Design supply of workplace and public charging infrastructure capable of meeting demand

- Originally developed through CEC/NREL collaboration and applied to estimate statewide infrastructure needs aligned with California ZEV goals

PEV = plug-in electric vehicle
ZEV = zero emission vehicle
### Driving / Charging Simulations

#### Travel Data

<table>
<thead>
<tr>
<th>Departure</th>
<th>Arrival</th>
<th>Destination</th>
<th>Driver A</th>
<th>Driver B</th>
<th>Driver C</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 AM</td>
<td>7:45 AM</td>
<td>Public</td>
<td>None</td>
<td>None</td>
<td>None - Public DCFC</td>
</tr>
<tr>
<td>9:30 AM</td>
<td>10:30 AM</td>
<td>Public</td>
<td>None</td>
<td>Public L2</td>
<td>None</td>
</tr>
<tr>
<td>12:45 PM</td>
<td>3:00 PM</td>
<td>Public</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>4:00 PM</td>
<td>5:00 PM</td>
<td>Home</td>
<td>Home L2</td>
<td>Home L2</td>
<td>None</td>
</tr>
</tbody>
</table>

#### Simulated Charge Events

- **Charging demand to satisfy travel**

#### Sample Vehicle / Infra Assumptions:
- 250-mile BEV
- DCFC = 150kW
- L2 = 7.2kW

#### Sample Choice / Access Assumptions:
- Charge every night, home dominant
- Plug-in only if needed, even at home
- No home-charging, reliant on public infrastructure
EVI-RoadTrip for Long-Distance Travel

- Sister tool to EVI-Pro designed to estimate light-duty vehicle charging demand along highway corridors for supporting long-distance travel
  - Relies on the Caltrans Statewide Travel Demand Model (CSTDM)
  - Original developed through CEC/NREL collaboration in support of inaugural AB2127 analysis

Currently, existing stations are not considered in the process of station siting or network design in EVI-Pro RoadTrip.

TAZ-by-TAZ net deficit of DCFC plugs required
Year 2030
Aggressive BEV adoption
Recent Modeling Enhancements

- Implemented charging behavior heterogeneity
- Refined approach to simulating multi-day charging behavior
- Variable cost of charging (within day and seasonal) and responsive charging behavior
- Updated travel data
  - More granular activity types
  - Configurable commuter shares
- New high-power AC and DC charging types represented

Increase/decrease of demand for a non-residential charging type
Backcasting 2021 Approach

- Compare modeling results to today’s statewide network based on recent ZEV adoption
EVI-Pro was configured to simulate 828,000 PEVs statewide using inputs from recent CEC and UC Davis research on:
- Residential access
- Charging behavior
- Commuter shares
Statewide Backcasting Results (2021)

CA Statewide L2 Network (2021)

CA Statewide DCFC Network (2021)
• EVI-Pro relies on travel survey data as the primary input for driving behavior.
• Consequently, it is difficult to draw a direct comparison between the L2 access types provided by CEC and activity types simulated by EVI-Pro.
• In order to overcome this challenge, a crosswalk has been developed that brings all EVSE (real and simulated) into a common classification system, as shown below.

### L2 Access Types

<table>
<thead>
<tr>
<th>Location</th>
<th>Shared Private</th>
<th>Public</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUD</td>
<td>Shared Private</td>
<td>MUD</td>
</tr>
<tr>
<td>Office</td>
<td>Shared Private</td>
<td>Office</td>
</tr>
<tr>
<td>Retail</td>
<td></td>
<td>Retail</td>
</tr>
<tr>
<td>Other Locations</td>
<td></td>
<td>Other Locations</td>
</tr>
</tbody>
</table>

### CA Statewide L2 Network (2021)

- **Public**
- **Shared Private**
- **While at work**
- **While not at home/work**
- **While at MUD**
This refined classification system prompts questions about the future evolution of the statewide charging network:

- As adoption increases and PEV use expands beyond commuters, will the relative role of charging at (public and private access) offices decrease?
- As the market for used PEVs increases, will demand for charging at retail locations increase – particularly from employees without access to charging at home?
Front of Lot vs. Back of Lot Charging

Questions for 2030 (and beyond):
• Which occupations are least likely to have charging at home, and thus benefit the most from workplace charging?
• Could charging at public retail locations offer:
  • Paid fast charging for short dwell patrons at the front of the lot and
  • Free/discounted slow charging for long dwell employees at the back of the lot?

CA 2030 Employment Share by Type
(estimates: CA EDD)
Statewide Backcasting Results (2021)

- Similar to the L2 comparison, the demand for fast charging by use case is difficult to quantify from statewide port counts alone.
- For more rigorous comparison, CA’s public DCFC network was broken out by proximity to highways and population density into the following two classes:

<table>
<thead>
<tr>
<th></th>
<th>&lt;1 mi from nearest highway</th>
<th>&gt;1 mi from nearest highway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>Community DCFC</td>
<td>Community DCFC</td>
</tr>
<tr>
<td>Suburban/Rural</td>
<td>Corridor DCFC</td>
<td>Community DCFC</td>
</tr>
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Corridor DCFC = Non-Urban and On-Highway
Community DCFC = Urban or Off-Highway
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EVI-Pro Enhancements

Load Flexibility

TeMix bundled $/kWh schedule (April 2020)

- Unmanaged charging scenarios tend to produce peaks load when the grid is already most stressed
- Load flexibility features are being developed in EVI-Pro to optimize load subject to grid signals (such as real-time prices) and quantify the implied charging network necessary to achieve said flexibility

EVI-Pro unmanaged scenario from AB2127
EVI-Pro Enhancements

*Increased Spatial Resolution*

- While use of travel survey data inherently limits the geographic resolution of EVI-Pro to the county-level, a process disaggregating infrastructure and charging load to traffic analysis zones (TAZs) has been implemented.

- The approach leverages the Caltrans Statewide Travel Demand Model (CSTDM).

- Increased geographic resolution of EVI-Pro will enable integration with EVI-RoadTrip and CEC’s EDGE framework for distribution system analysis.
Potential Infrastructure Scenarios

- A range of potential scenarios are being considered for infrastructure planning, including:
  - PEV adoption
  - Residential access
  - Charging preferences

- Each of these scenarios poses the question: “How do we transition from the network we have, to the one we want to have?”

- Public feedback is welcome!
Growing a Charging Network from the Ground Up

**The Roots: Home Charging**
(single family, apartments, curbside)

**The Trunk: Fast Charging**
(corridors and retail)

**The Branches: Destination Charging**
(right speeding at offices, recreation, dining, etc.)

Charging Network of the Future

Yesterday

Today

Public Network

Private Network
Thanks! Questions?

www.nrel.gov
Configuration for CEC Analysis

**EVI-Pro**

**Driving Behavior**
- GPS Data
- Travel Surveys

**Charging Behavior**
- Direct Enumeration
- Discrete Choice Models

**Network Design**
- Hierarchical Clustering
- Utilization Data

**Results**
- Stations
- Plugs
- Utilization Load Profiles

**Charging Demand**
- Residential Access, PUMS

**3rd Party Data/Simulations**
- (e.g. POLARIS, BEAM, HIVE)

**Levelized Cost of Charging**

**PEV Fleet Size & PEV Attributes**
- CEC/EAD, CARB/MSS
- ADOPT, MA3T

**PEV Efficiency (RouteE)**

**State of California Energy Commission**
Q&A and Public Comment
Public Discussion

Zoom Participants:
• Use the “raise hand” feature to make verbal comments
• Use the Q&A feature to type in your question

Telephone Participants:
• Dial *9 to raise your hand
• Dial *6 to mute/unmute your phone line.
Discussion Topics

• AB 2127 report structure
• EVI-Pro 3 modeling approach
• EVI-Pro 3 enhancements
• Emerging trends in charging
Written Comments

Electronic Commenting System
Visit the comment page for this docket at:

Comment by E-mail
Email: docket@energy.ca.gov
Subject Line: “Second AB 2127 Assessment”

All comments due by 5:00pm on Friday, October 14, 2022
Thank you