

**DOCKETED**

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



# AB 2127 Second Assessment Kickoff Workshop

California Energy Commission Fuels and Transportation Division

September 19, 2022 | 1:00 p.m.



# Agenda

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- 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

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- 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:

<https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=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



Scan the code on a phone or tablet with a QR reader to access the 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

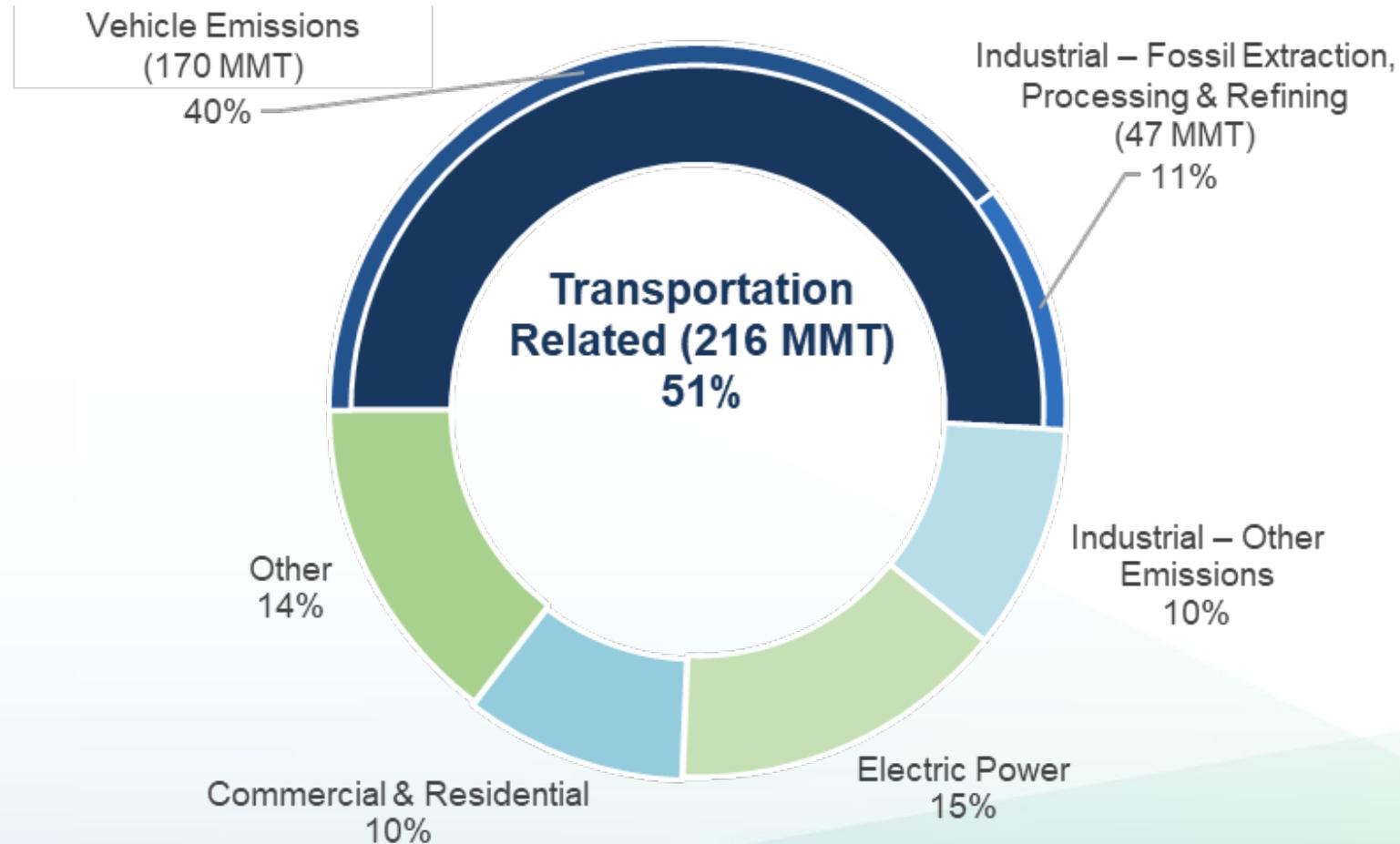
## Survey Link:

[https://forms.office.com/Pages/ResponsePage.aspx?id=RBI6rPQT9k6NG7qicUgZTqEU3EeANX9DvlX\\_on7oPclUNIRYOFVYTVJlQzIIUTFQSjgyVkhaOVRXQS4u](https://forms.office.com/Pages/ResponsePage.aspx?id=RBI6rPQT9k6NG7qicUgZTqEU3EeANX9DvlX_on7oPclUNIRYOFVYTVJlQzIIUTFQSjgyVkhaOVRXQS4u)



# **Introduction to the AB 2127 Assessment**

# Transportation Emissions





# Assessment Goals

## 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

- **July 2021:** [First AB 2127 assessment](https://efiling.energy.ca.gov/getdocument.aspx?tn=238853),  
<https://efiling.energy.ca.gov/getdocument.aspx?tn=238853>
- **April 2022:** [Draft Zero-Emission Vehicle Infrastructure Plan \(ZIP\)](https://www.energy.ca.gov/sites/default/files/2022-04/CEC-600-2022-054.pdf),  
<https://www.energy.ca.gov/sites/default/files/2022-04/CEC-600-2022-054.pdf>
- **July 2022:** [California Electric Vehicle Infrastructure Deployment Assessment: Drive Times to Direct-Current Fast Chargers \(SB 1000\)](https://www.energy.ca.gov/publications/2022/2022-senate-bill-1000-california-electric-vehicle-infrastructure-deployment)  
<https://www.energy.ca.gov/publications/2022/2022-senate-bill-1000-california-electric-vehicle-infrastructure-deployment>
- **August 2022:** [California National Electric Vehicle Infrastructure \(NEVI\) Deployment Plan](https://efiling.energy.ca.gov/GetDocument.aspx?tn=244314&DocumentContentId=78373)  
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=244314&DocumentContentId=78373>



# 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



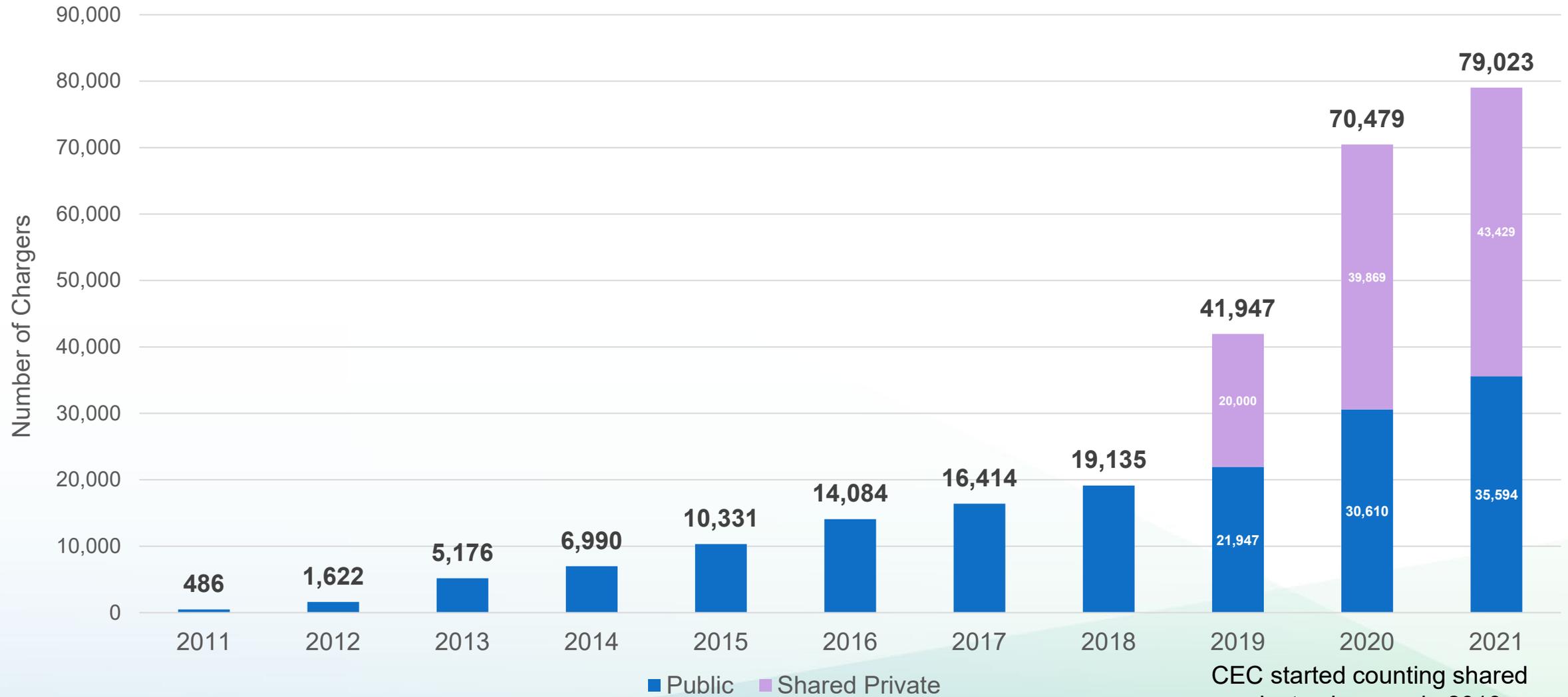
# Assessment Outline

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- 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)

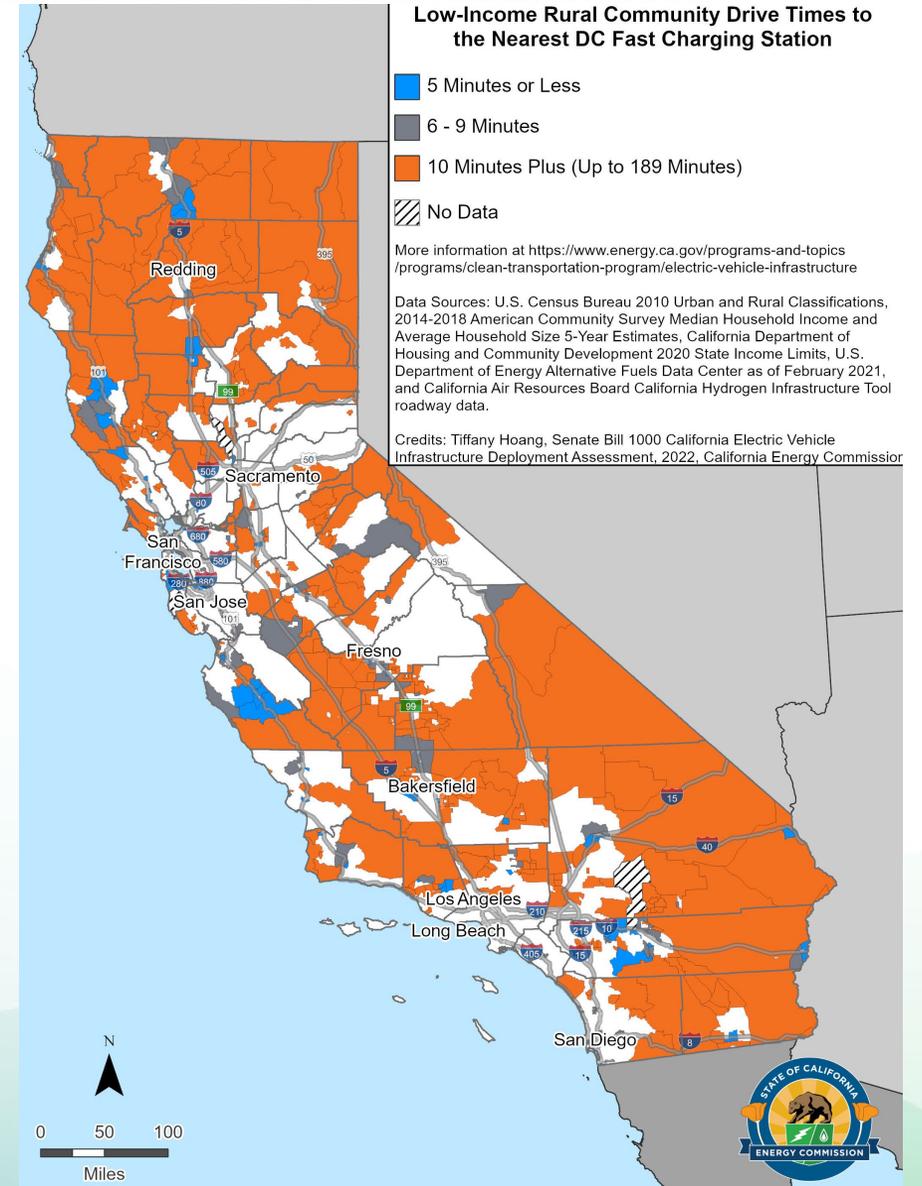


CEC started counting shared private chargers in 2019



# 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



EVI-Pro



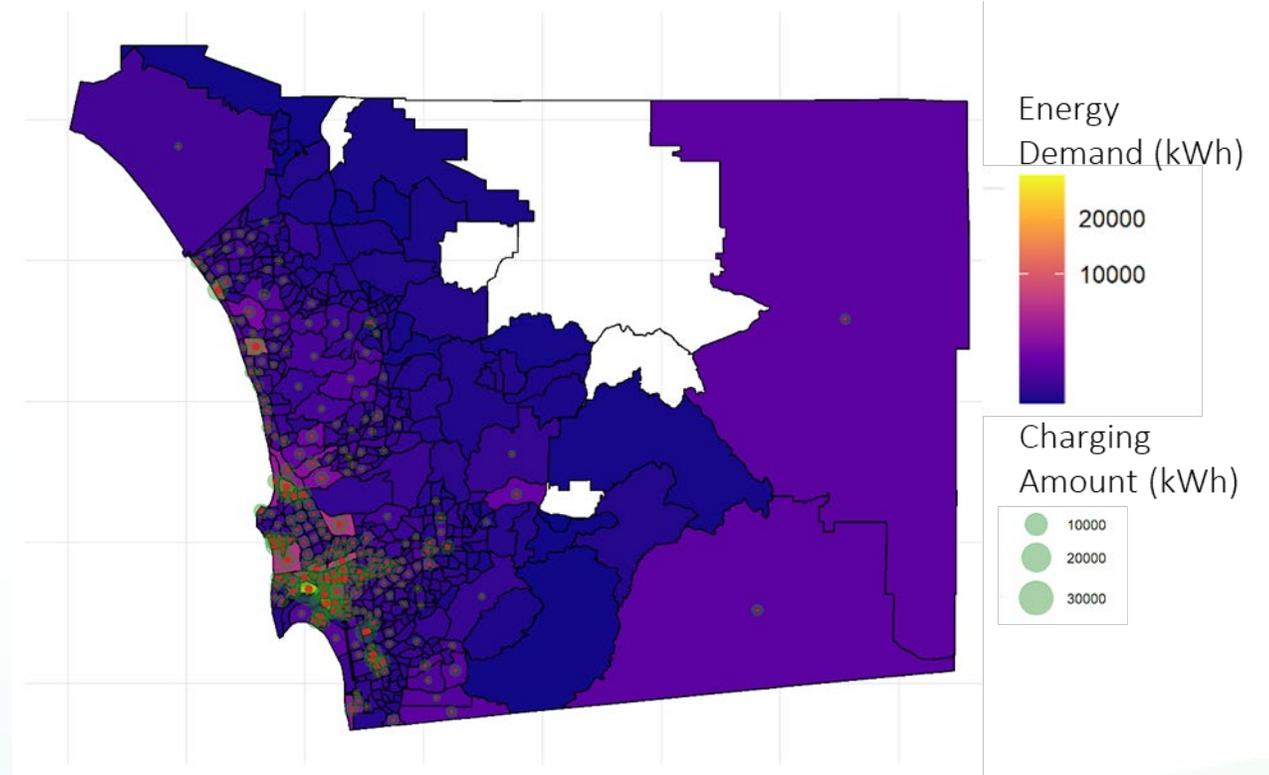
EVI-RoadTrip





# 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





# HEVI-LOAD: Infrastructure for Medium- and Heavy-Duty Vehicles

Simulation model to:

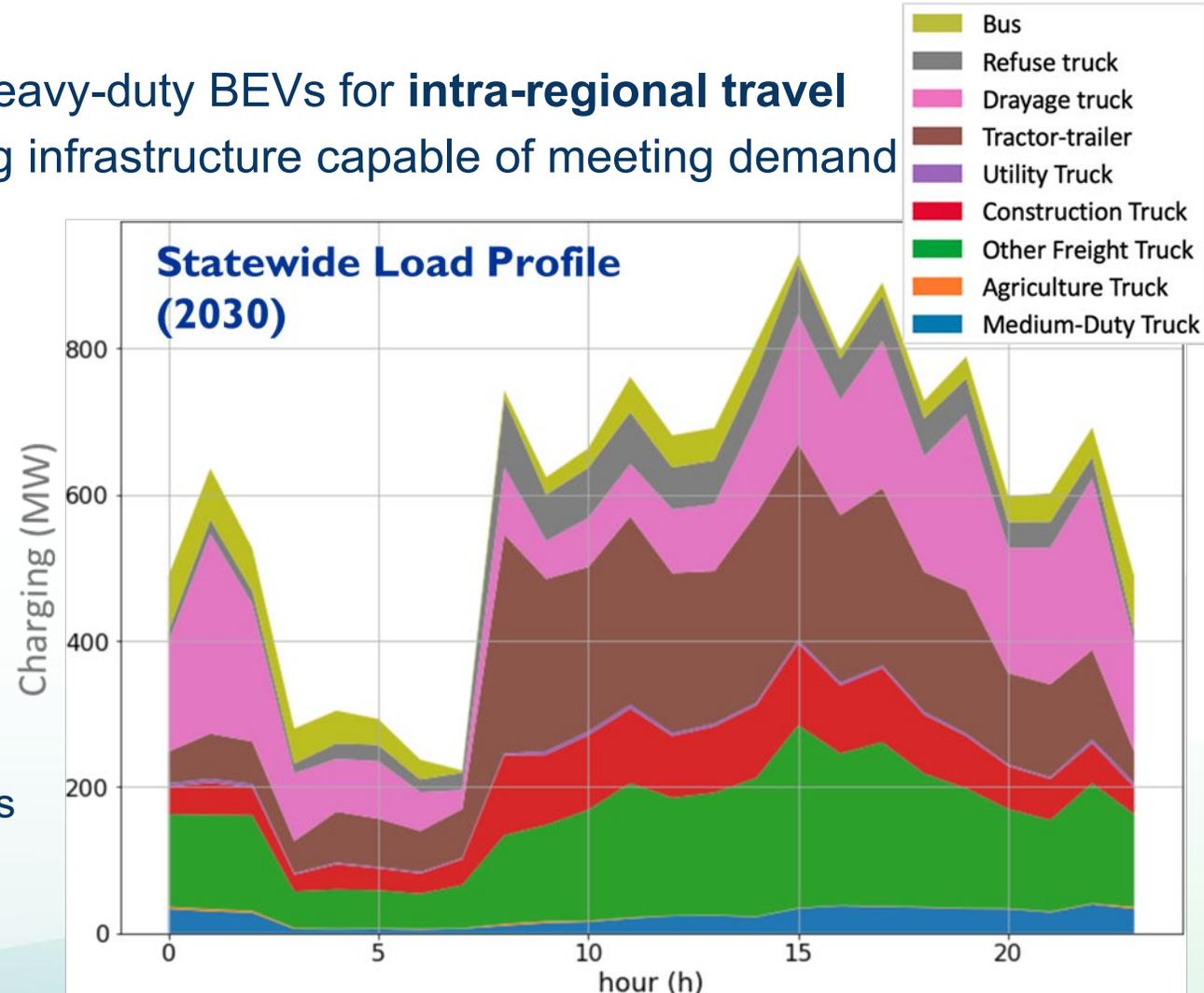
- 1) Estimate charging demand from medium- and heavy-duty BEVs for **intra-regional travel**
- 2) Design supply of overnight and daytime charging infrastructure capable of meeting demand without behavior changes

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)

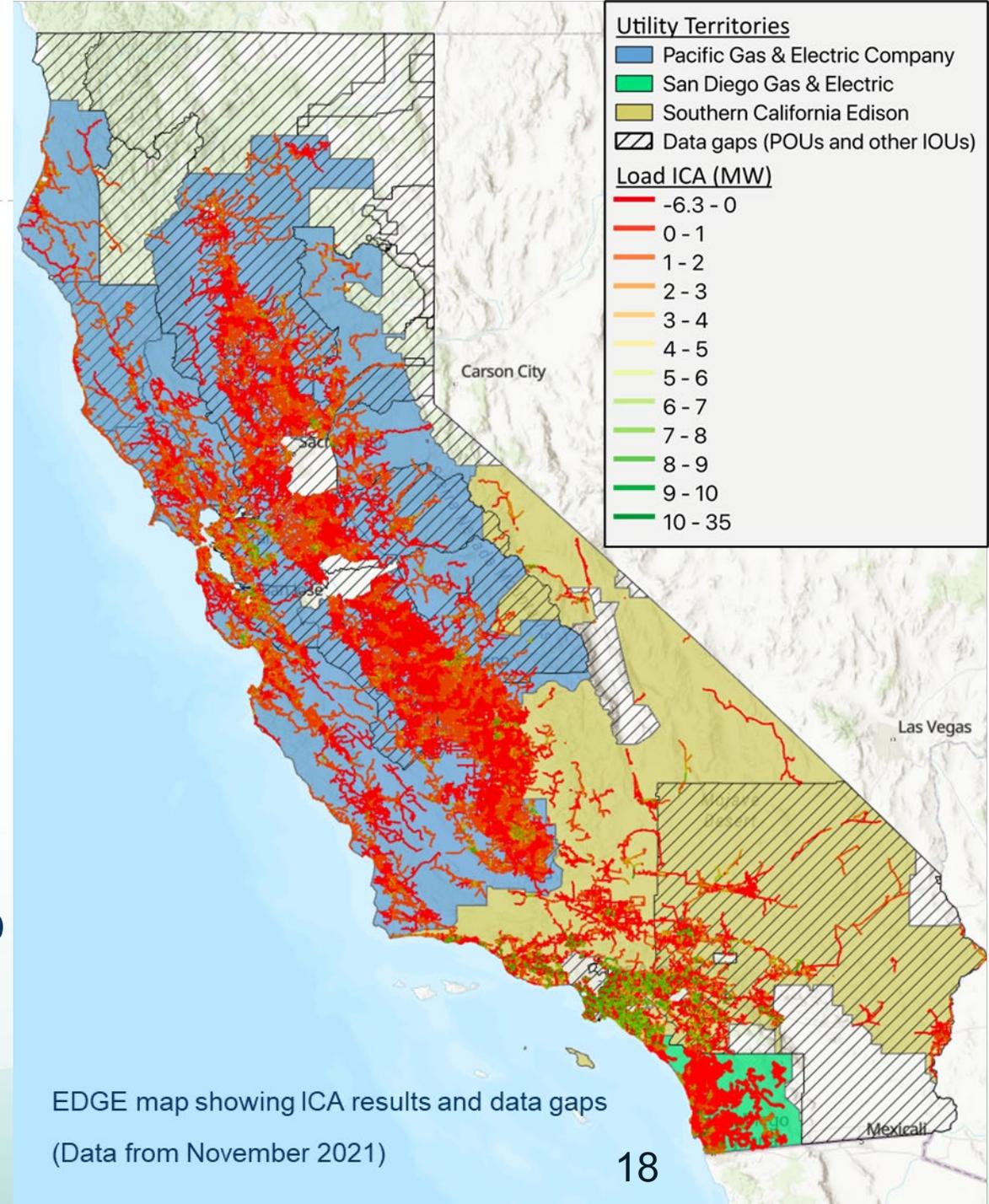




# EVSE Deployment and Grid Evaluation (EDGE) Tool

- 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





# 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



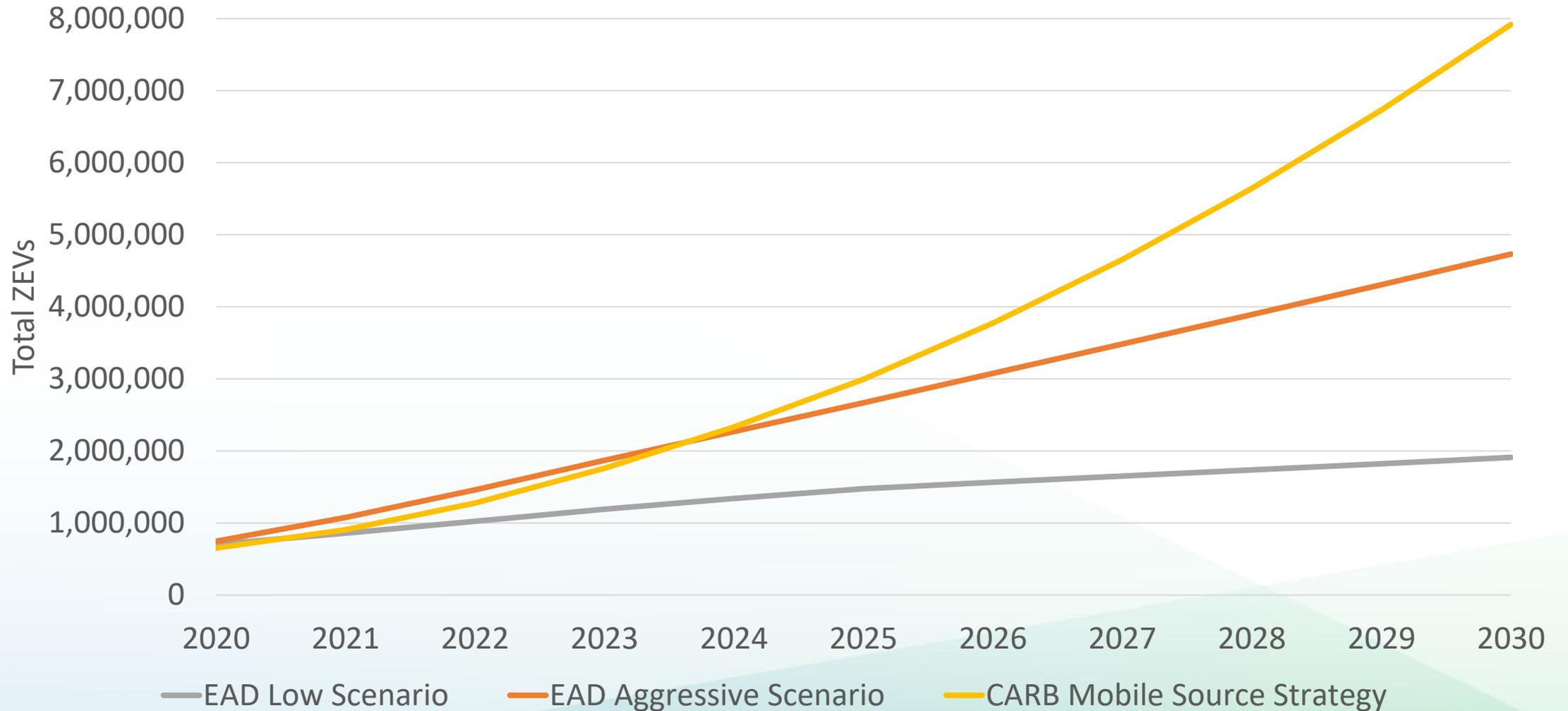
Photos: KIGT Inc.



# Scenarios

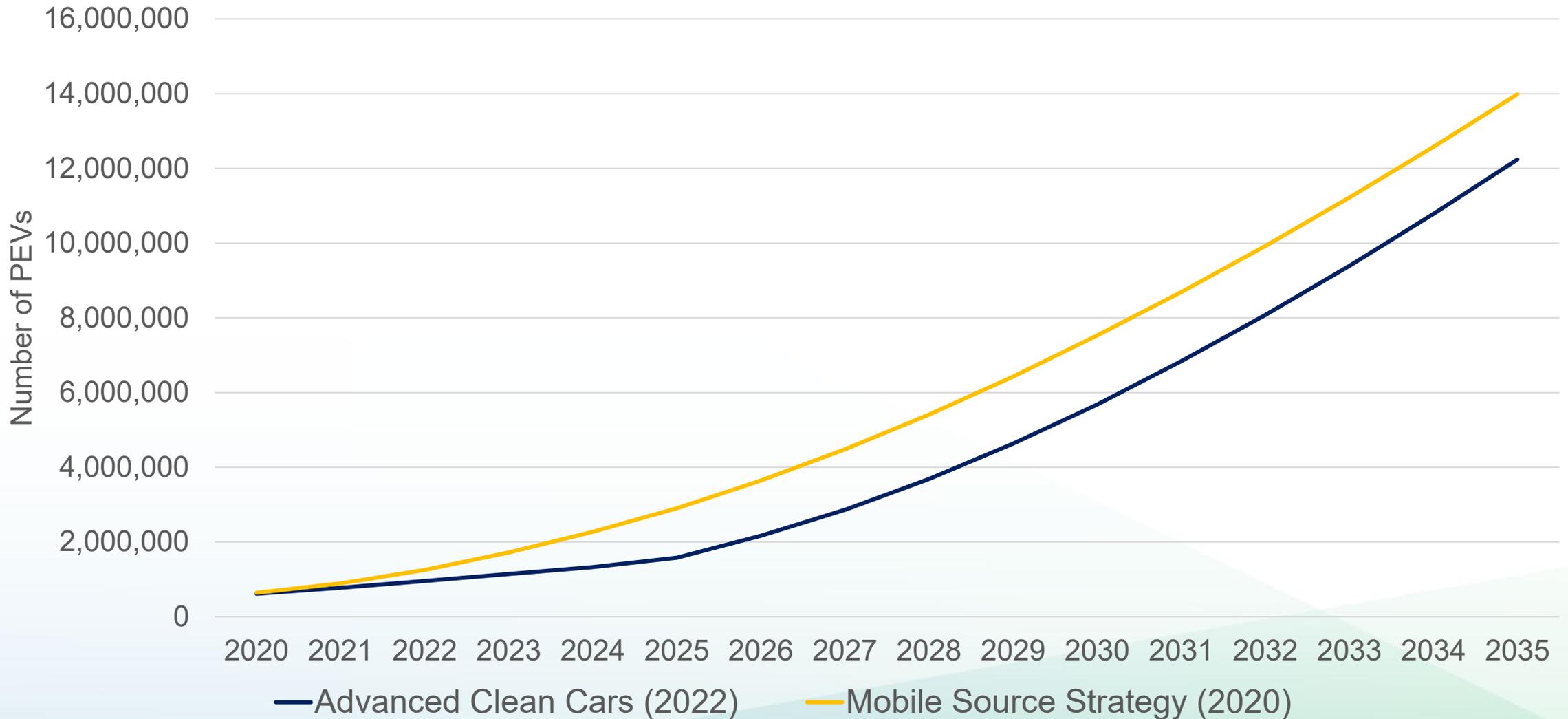


# Fleet Scenarios in 1<sup>st</sup> AB 2127 Report





# Fleet Scenarios in 2<sup>nd</sup> AB 2127 Report





# **EVI-Pro (NREL slides)**



# EVI-Pro Updates for California's Statewide Charging Infrastructure Assessment (AB2127)

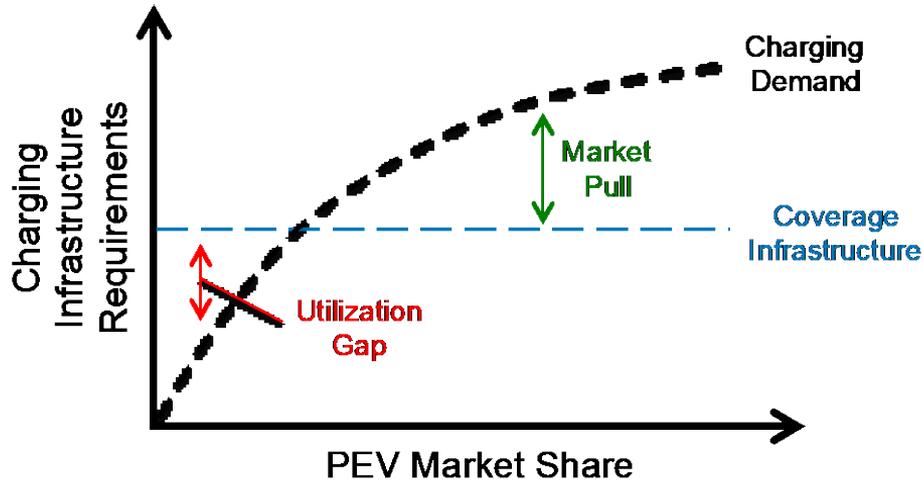
Eric Wood, Fan Yang, Yanbo Ge, Tim Jonas,  
D-Y Lee, and Nick Reinicke  
CEC AB2127 Workshop  
Sept 19, 2022

# 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.

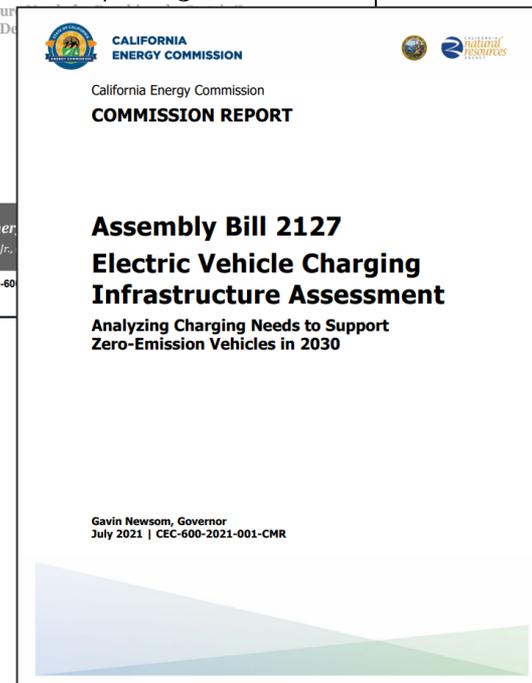
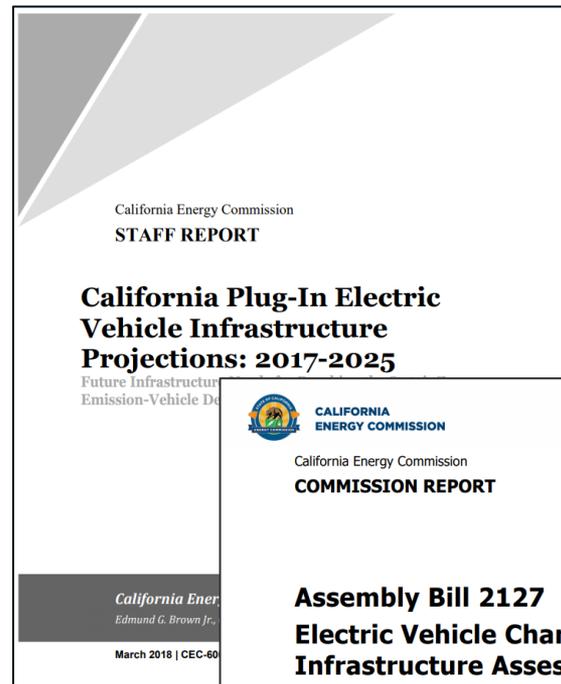
## Home Charging is Foundational



- 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



# Driving / Charging Simulations



## Travel Data

## Simulated Charge Events

Departure	Arrival	Destination	Driver A	Driver B	Driver C
7:00 AM	7:45 AM	Public	None	None	Public DCFC
9:30 AM	10:30 AM	Public	None	Public L2	None
12:45 PM	3:00 PM	Public	None	None	None
4:00 PM	5:00 PM	Home	Home L2	Home L2	None

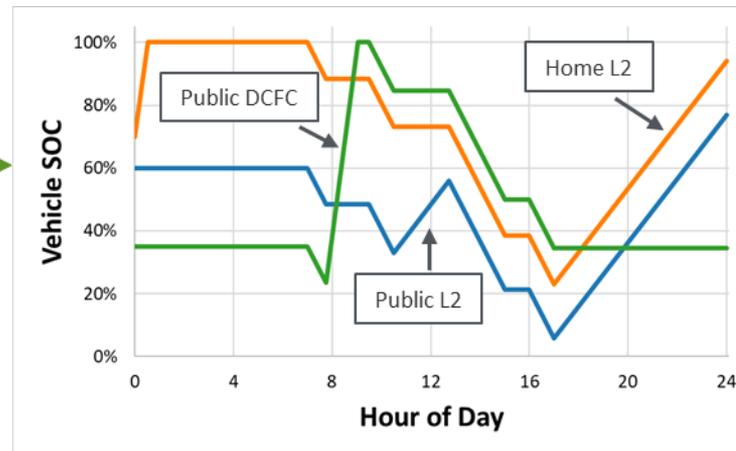
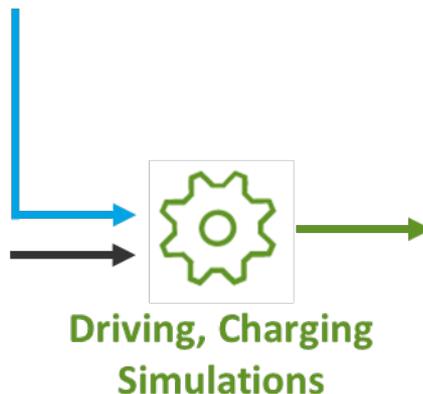
Charging demand to satisfy travel

### 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

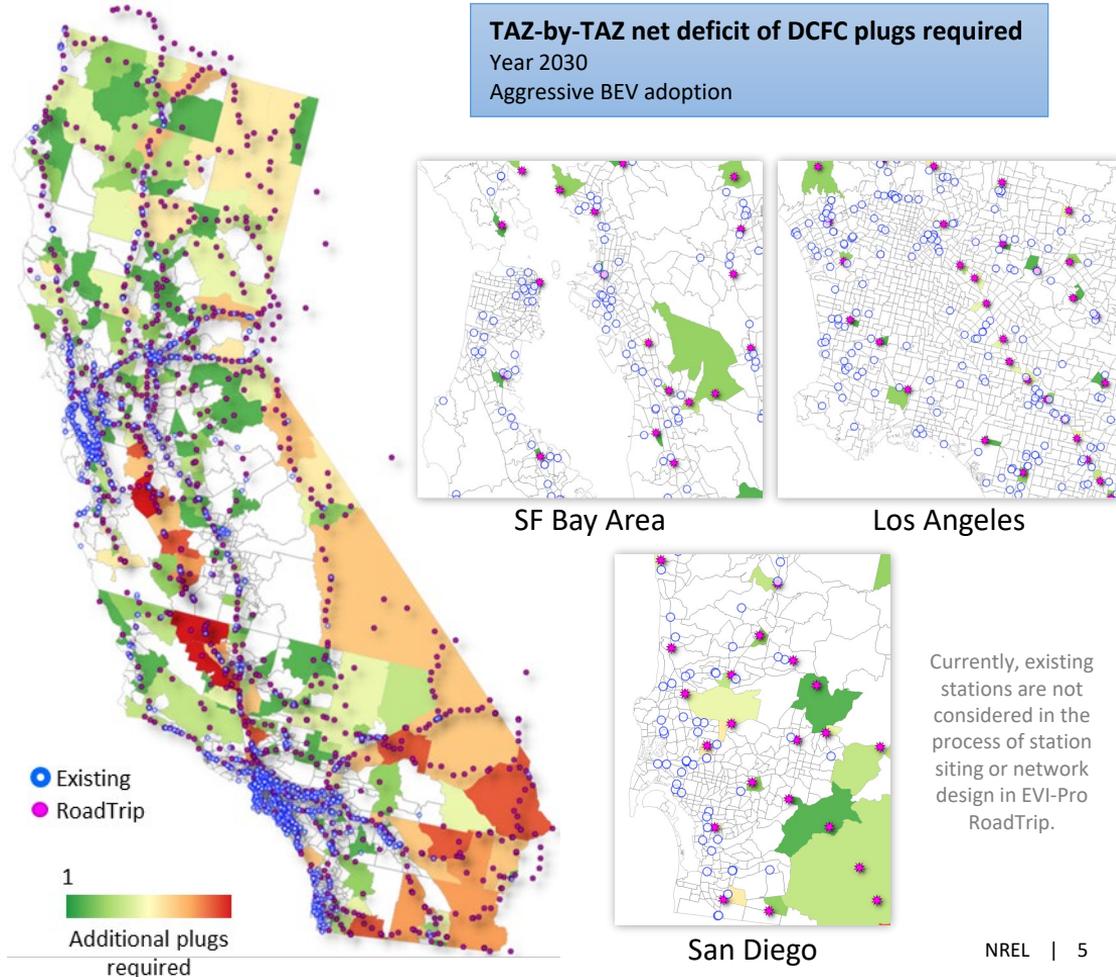


# EVI-RoadTrip for Long-Distance Travel

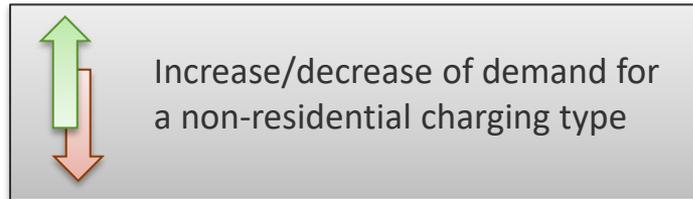
- Sister tool to EVI-Pro designed to estimate light-duty vehicle charging demand along highway corridors for supporting long-distance travel
  - Relies on the Caltrans Statewide Travel Demand Model (CSTDM)
  - Original developed through CEC/NREL collaboration in support of inaugural AB2127 analysis



EVI-RoadTrip



# Recent Modeling Enhancements



- Implemented charging behavior heterogeneity  L2  DCFC
- Refined approach to simulating multi-day charging behavior  DCFC
- Variable cost of charging (within day and seasonal) and responsive charging behavior  L2  DCFC
- Updated travel data
  - More granular activity types  Work  Public
  - Configurable commuter shares
- New high-power AC and DC charging types represented  L2  DCFC

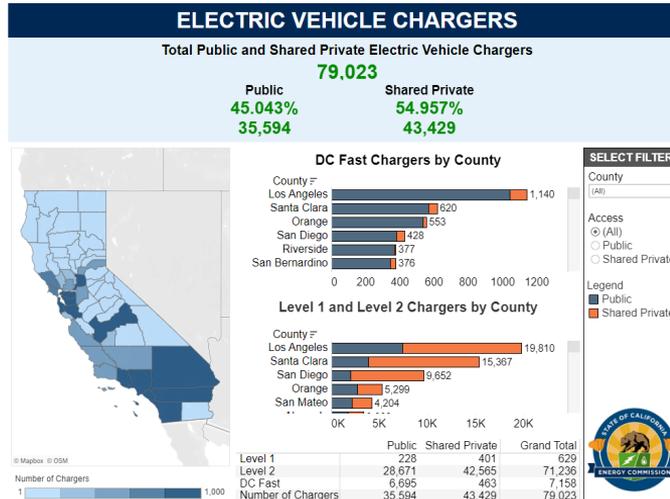
# Backcasting 2021

## Approach

- Compare modeling results to today's statewide network based on recent ZEV adoption

ZEV POPULATION		
Total Light-Duty Vehicles end of 2021		
<b>837,887</b>		
Battery Electric (BEV)	Plug-in Hybrid (PHEV)	Fuel Cell (FCEV)
1.745%	1.020%	0.034%
522,445	305,315	10,127

Res access, res type, driving patterns, charging behavior, network utilization



## Simulated Statewide Network

# Backcasting 2021

## Calibration

- 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



**CALIFORNIA ENERGY COMMISSION**




California Energy Commission  
**STAFF REPORT**

**Home Charging Access in California**

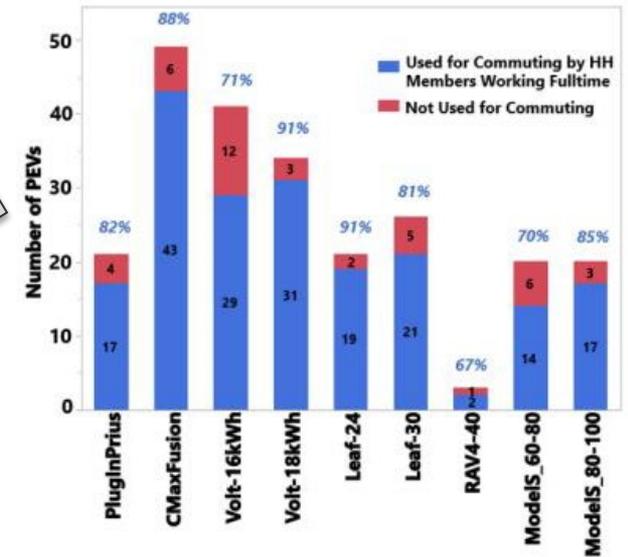
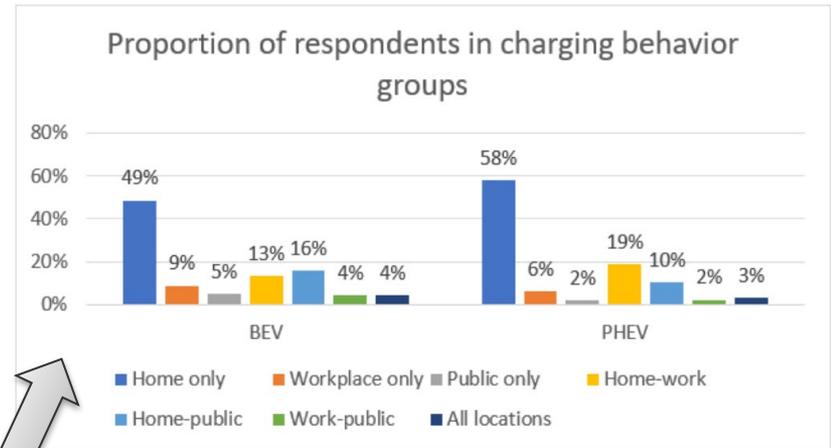
Advanced Plug-in Electric Vehicle Travel and Charging Behavior Final Report  
(CARB Contract 12-319 – Funding from CARB and CEC)

April 10, 2020

Prepared By:  
Gil Tal, Ph.D.  
Seshadri Srinivasa Raghavan  
Vaishnavi Chaitanya Karamam  
Matthew P. Favetti  
Katrina May Sutton  
Jade Motayo Ogunmakin  
Jae Hyun Lee, Ph.D.  
Christopher Nima, Ph.D.  
Kenneth Kurani, Ph.D.  
Debagyeya Chakraborty, Ph.D.  
Michael Nicholas, Ph.D.  
Tom Turrentine, Ph.D.

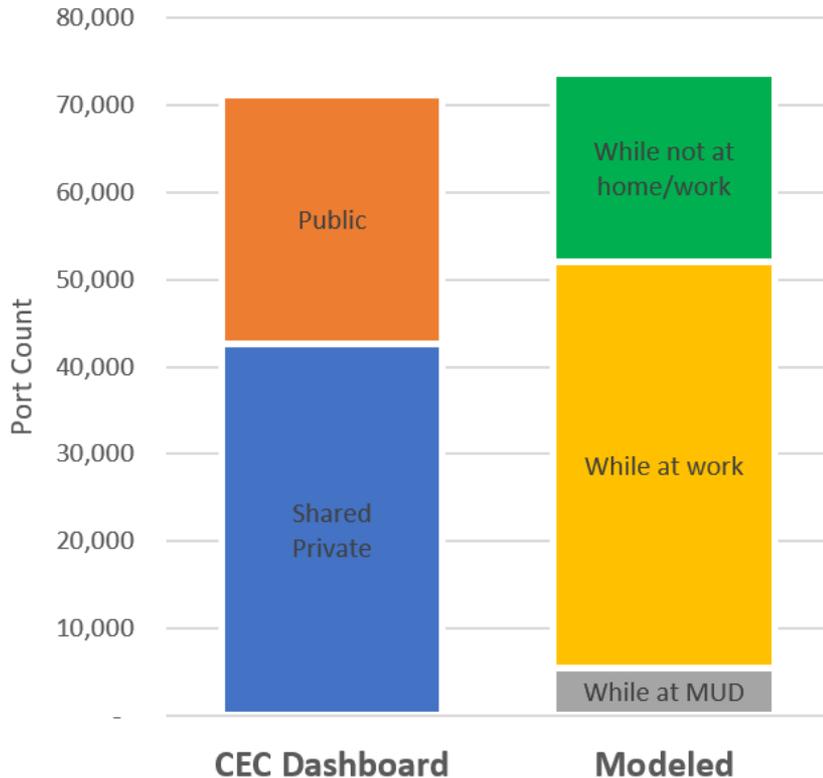
**UC DAVIS**  
PLUG-IN HYBRID & ELECTRIC VEHICLE RESEARCH CENTER  
*of the Institute of Transportation Studies*

Prepared For:  
California Environmental Protection Agency  
**Air Resources Board**

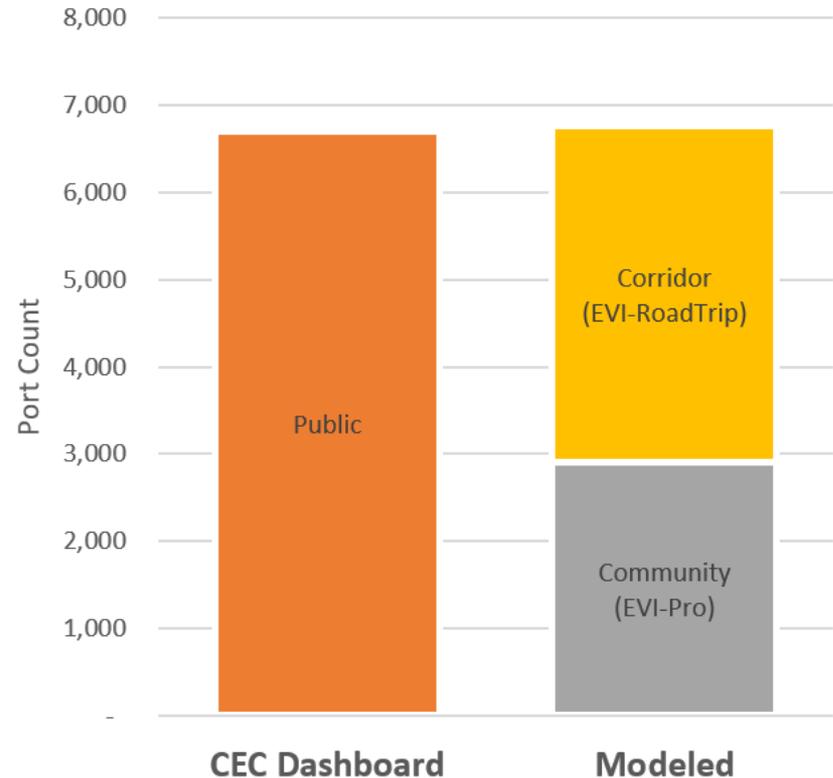



# Statewide Backcasting Results (2021)

## CA Statewide L2 Network (2021)

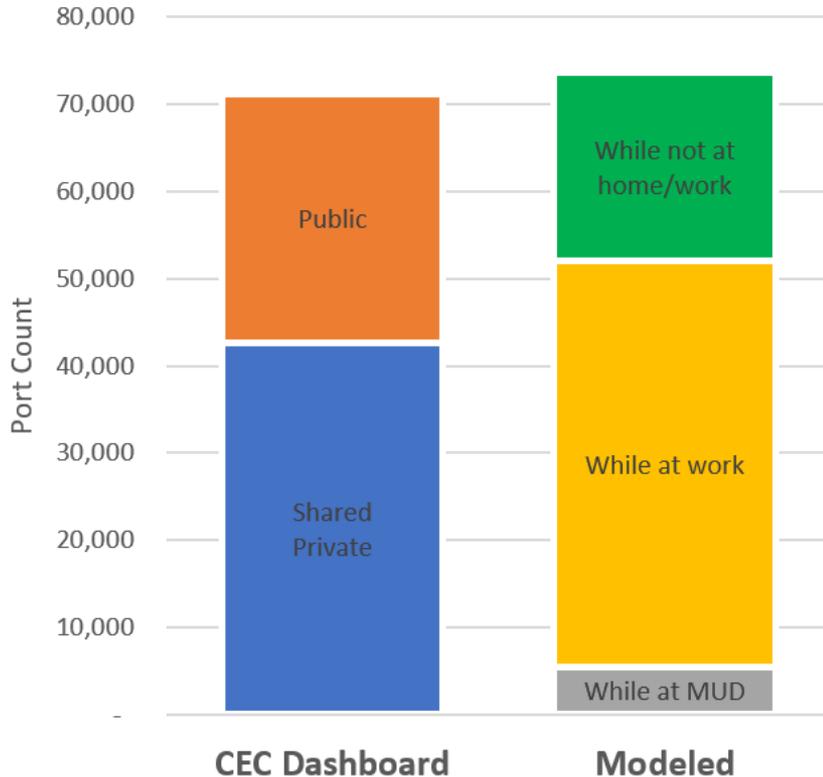


## CA Statewide DCFC Network (2021)



# Statewide Backcasting Results (2021)

## CA Statewide L2 Network (2021)



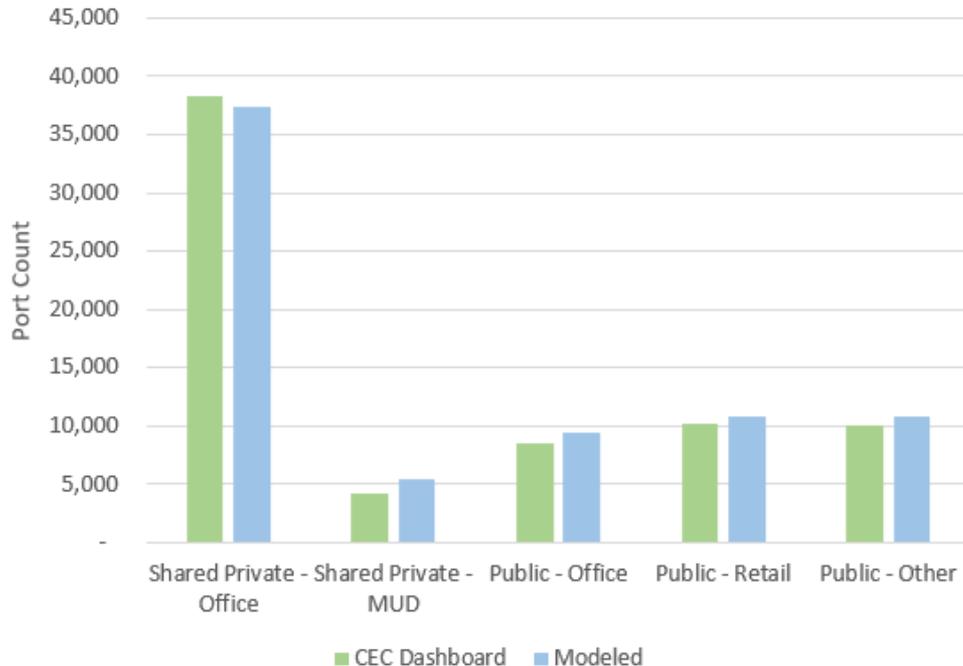
- EVI-Pro relies on travel survey data as the primary input for driving behavior
- Consequently, it is difficult to draw a direct comparison between the L2 access types provided by CEC and activity types simulated by EVI-Pro
- In order to overcome this challenge, a crosswalk has been developed that brings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

## L2 Access Types

	Shared Private	Public
MUD	Shared Private @ MUD	
Office	Shared Private @ Office	Public Access @ Office
Retail		Public Access @ Retail
Other		Public Access @ Other Locations

# Statewide Backcasting Results (2021)

## CA Statewide L2 Network (2021)



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?*

## L2 Access Types

	Shared Private	Public
MUD	Shared Private @ MUD	
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Retail		Public Access @ Retail
Other		Public Access @ Other Locations

# Front of Lot vs. Back of Lot Charging

source: <https://www.labormarketinfo.edd.ca.gov/data/employment-projections.html>

**Long-Term (Ten-years Projections: 2020-2030)**

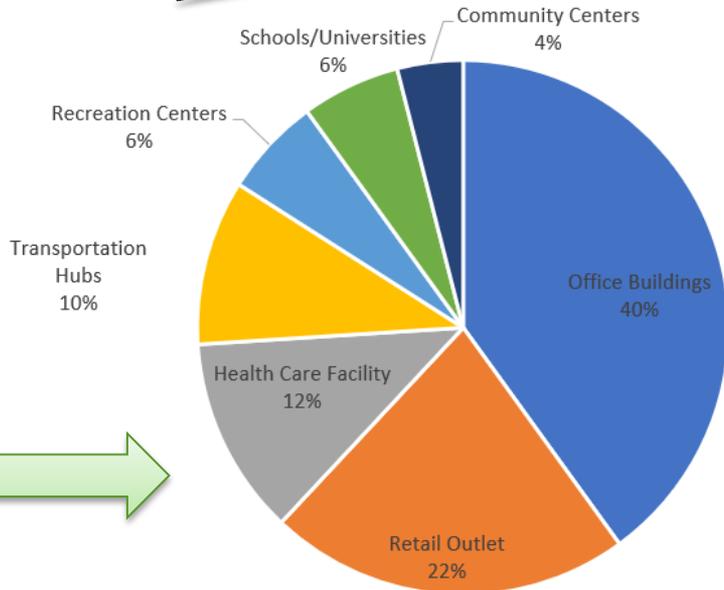
National Employment Matrix title	2020 National Employment Matrix code
Total, All Occupations	00-0000
Management occupations	11-0000
Business and financial operations occupations	13-0000
Computer and mathematical occupations	15-0000
Architecture and engineering occupations	17-0000
Life, physical, and social science occupations	19-0000
Community and social service occupations	21-0000
Legal occupations	23-0000
Educational instruction and library occupations	25-0000
Arts, design, entertainment, sports, and media occupations	27-0000
Healthcare practitioners and technical occupations	29-0000
Healthcare support occupations	31-0000
Protective service occupations	33-0000
Food preparation and serving related occupations	
Building and grounds cleaning and maintenance occupations	
Personal care and service occupations	
Sales and related occupations	
Office and administrative support occupations	
Farming, fishing, and forestry occupations	45-0000
Construction and extraction occupations	47-0000
Installation, maintenance, and repair occupations	49-0000
Production occupations	51-0000
Transportation and material moving occupations	53-0000

**CA 2030 Employment Share by Type**  
(estimated; CA EDD)



**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?



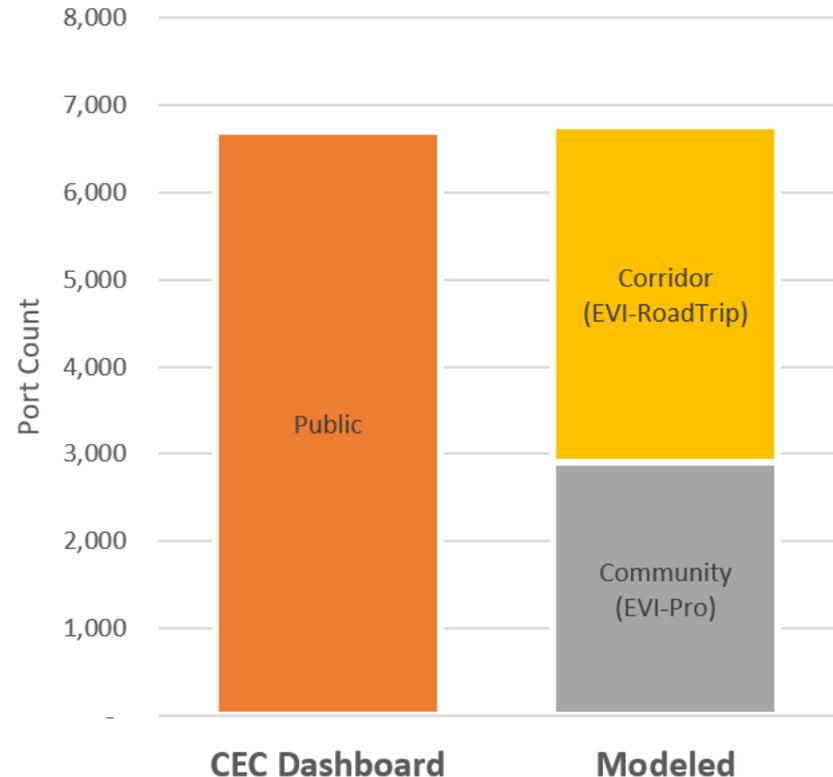
# Statewide Backcasting Results (2021)

- 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:

	<1 mi from nearest highway	>1 mi from nearest highway
Urban	Community DCFC	Community DCFC
Suburban/Rural	Corridor DCFC	Community DCFC

Corridor DCFC = Non-Urban and On-Highway  
 Community DCFC = Urban or Off-Highway

## CA Statewide DCFC Network (2021)



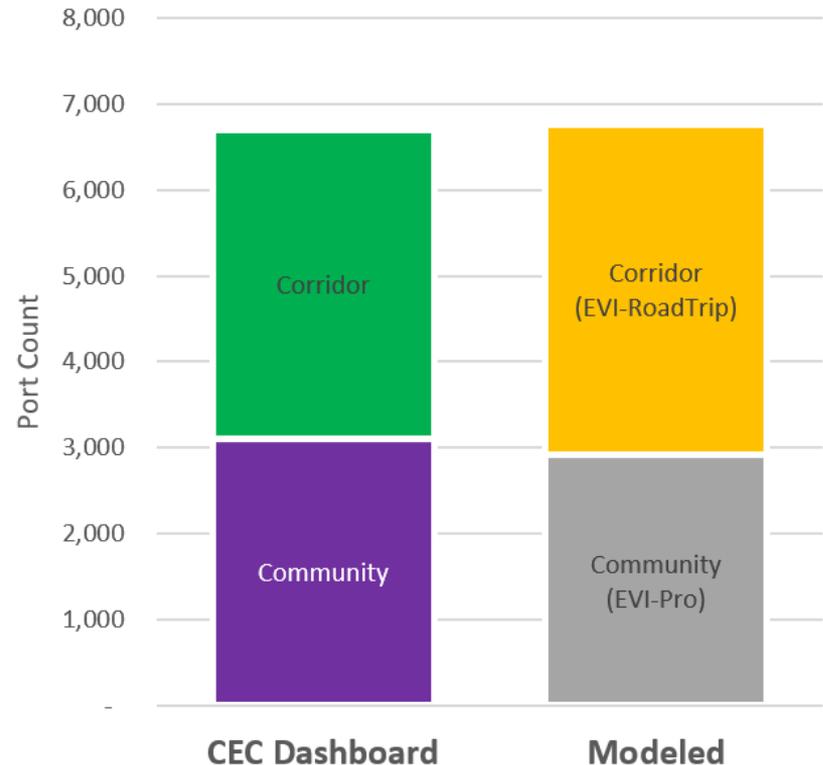
# Statewide Backcasting Results (2021)

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## CA Statewide DCFC Network (2021)

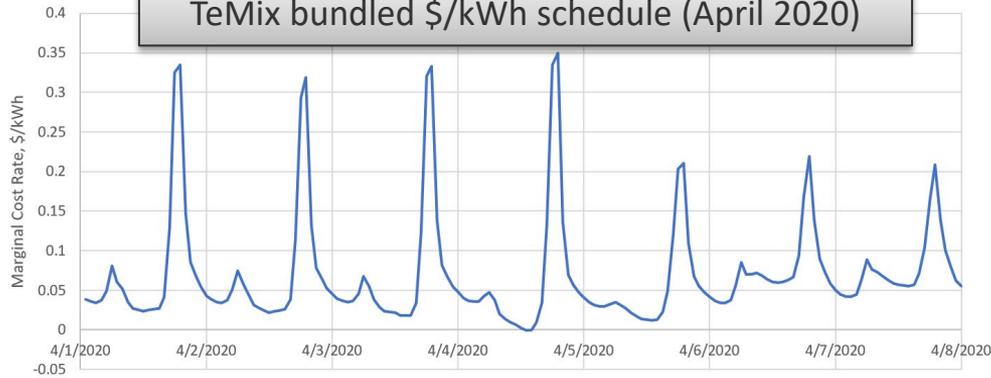


# EVI-Pro Enhancements

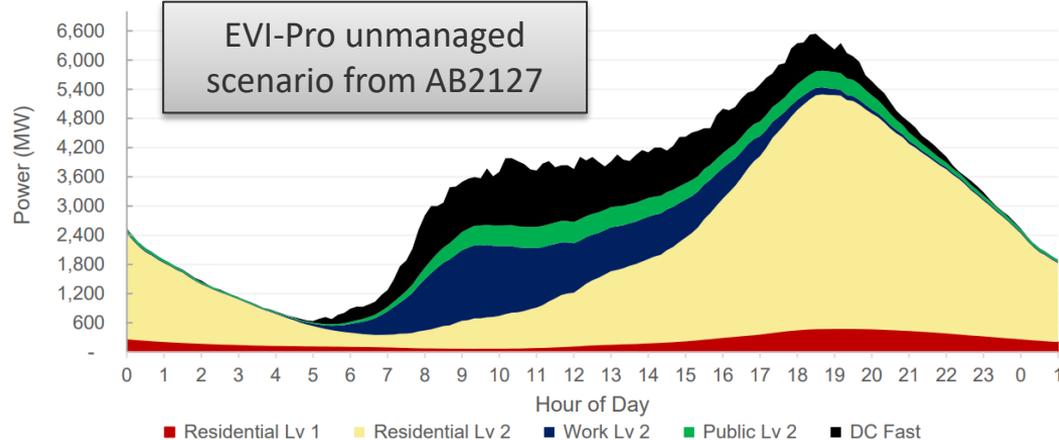
## Load Flexibility

- 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

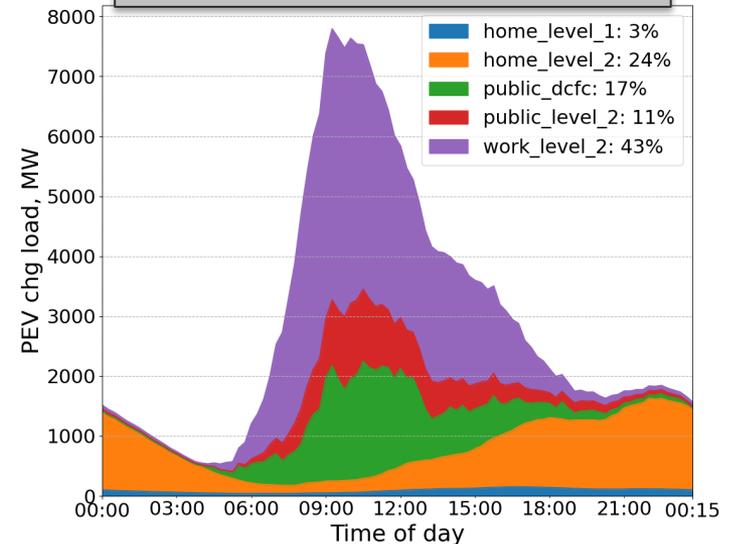
TeMix bundled \$/kWh schedule (April 2020)



EVI-Pro unmanaged scenario from AB2127



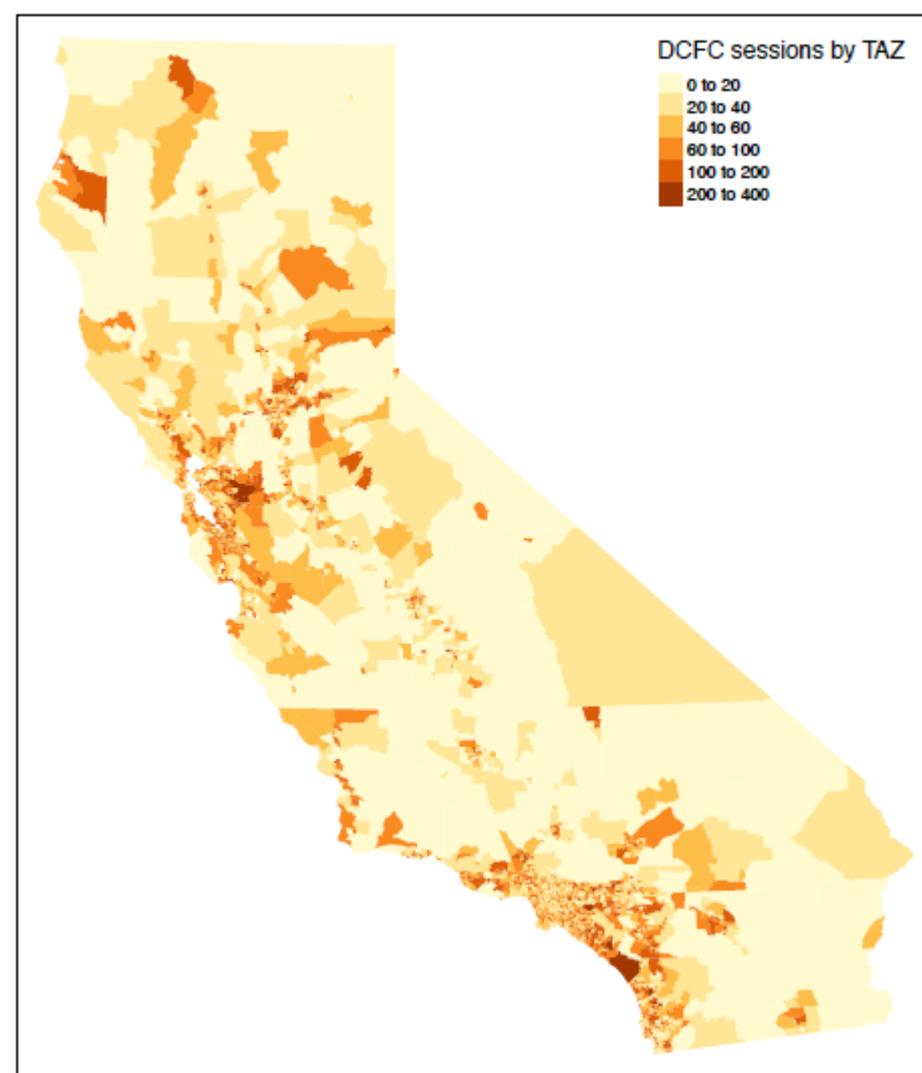
EVI-Pro scenario maximizing non-residential mid-day load



# EVI-Pro Enhancements

## *Increased Spatial Resolution*

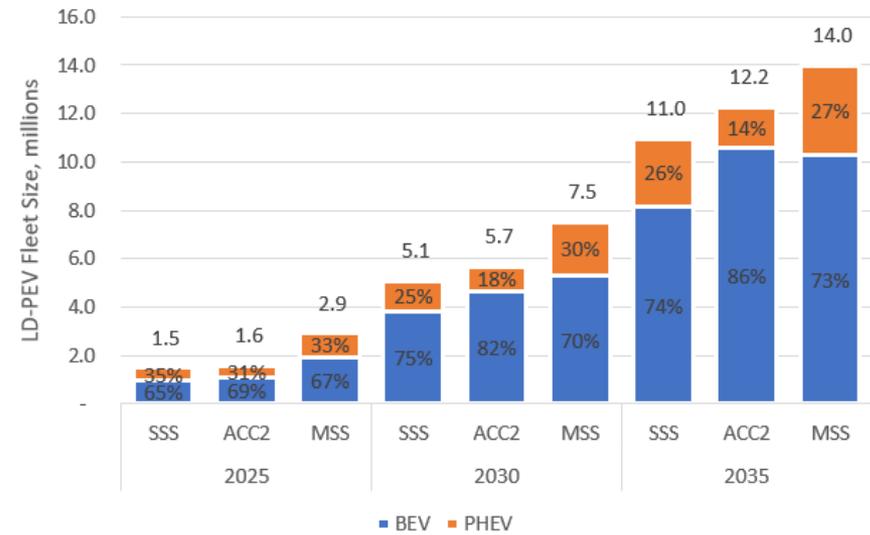
- While use of travel survey data inherently limits the geographic resolution of EVI-Pro to the county-level, a process disaggregating infrastructure and charging load to traffic analysis zones (TAZs) has been implemented
- The approach leverages the Caltrans Statewide Travel Demand Model (CSTDM)
- Increased 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!

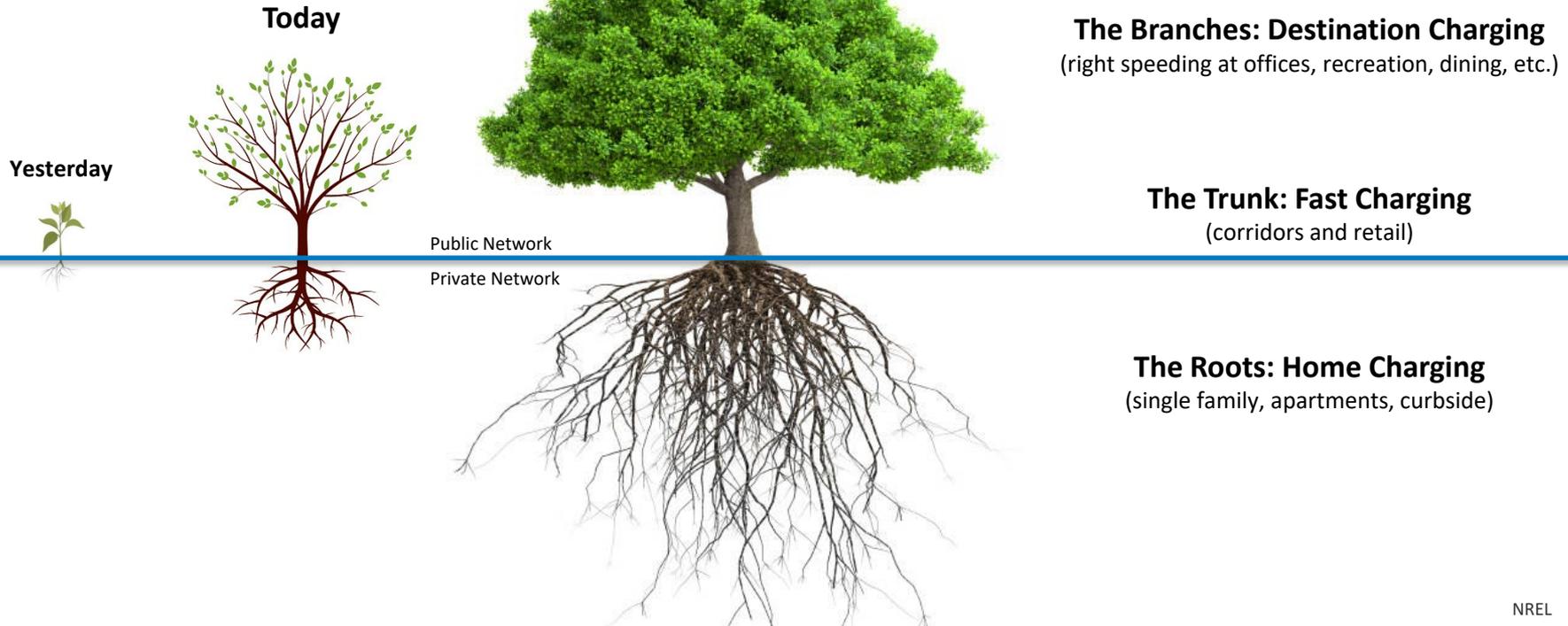
CA Statewide PEV Scenarios



Key Variables	Nominal Value	Alt Scenarios
PHEV Share	20%	10% to 30%
Commuter Share	60%	50% to 70%
Residential Access	70%	50% to 90%
“Lazy” PHEVs	60%	20% to 90%
Free Public-L2	20%	10% to 30%
Fast Charging Dominant	10%	0% to 20%

# Growing a Charging Network from the Ground Up

## Charging Network of the Future

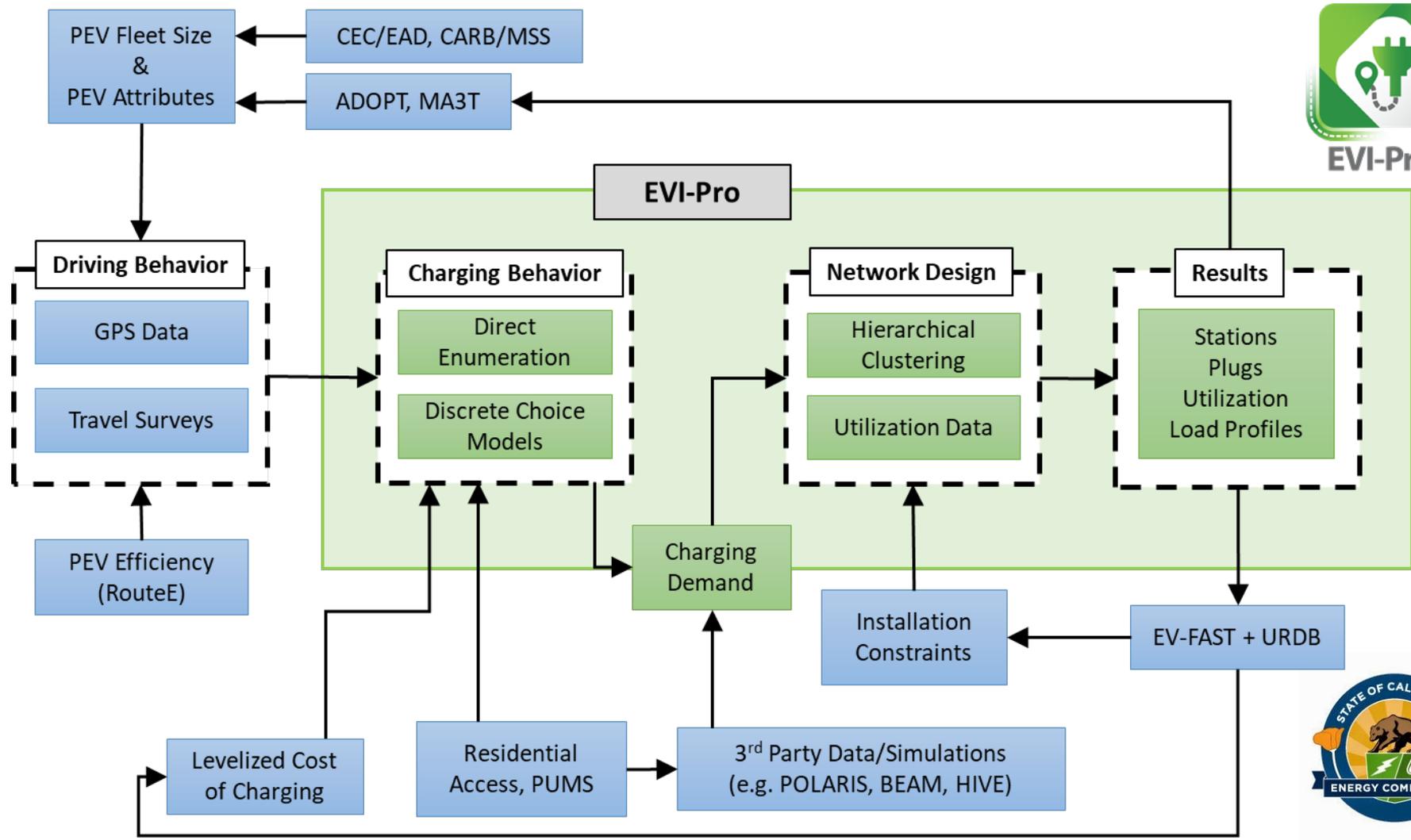


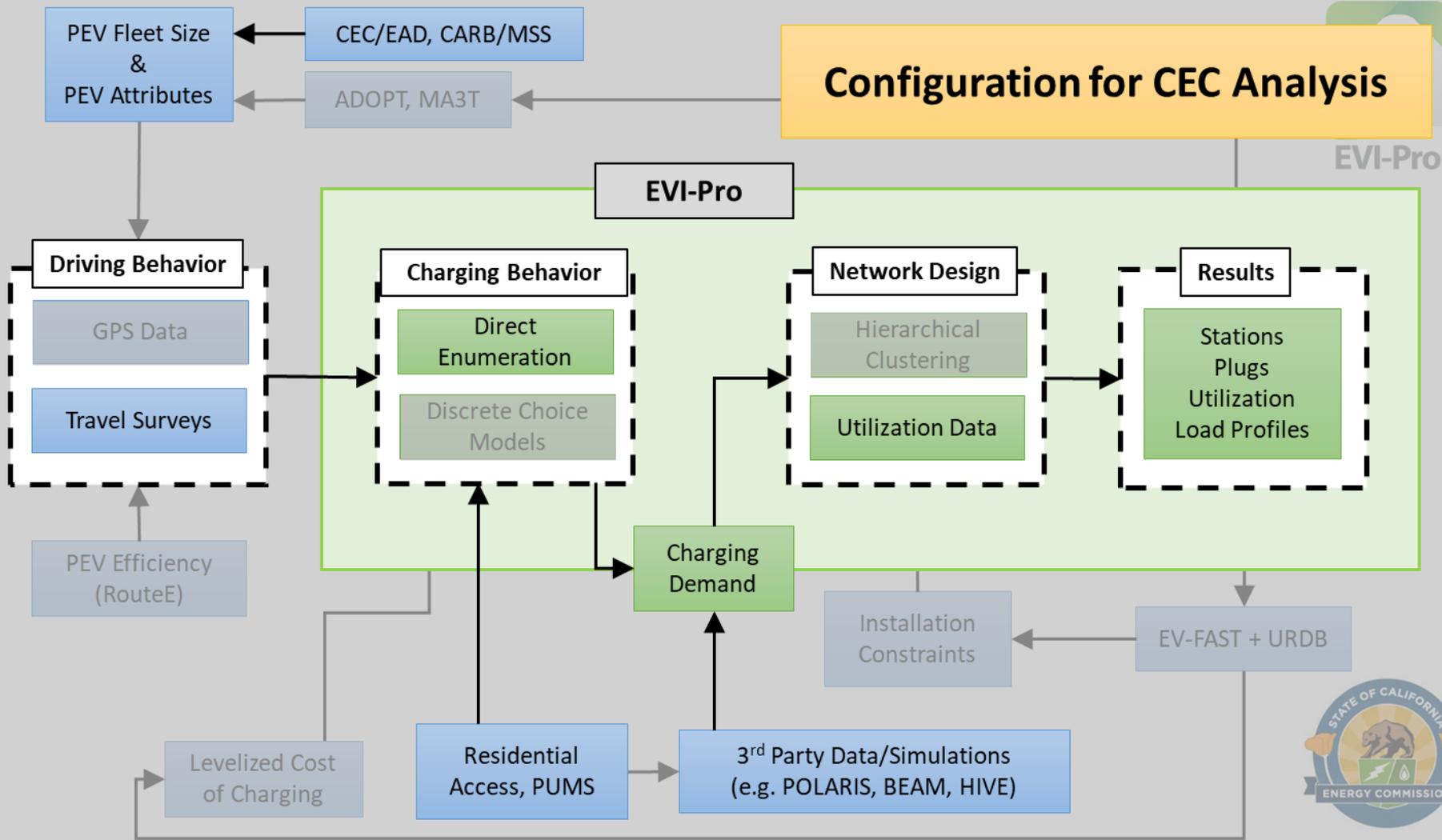


Thanks! Questions?

[www.nrel.gov](http://www.nrel.gov)









# 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.



Q&A



Chat



Raise Hand



# Discussion Topics

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



# Written Comments

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## Electronic Commenting System

Visit the comment page for this docket at:

<https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=19-AB-2127>

## Comment by E-mail

Email: [docket@energy.ca.gov](mailto:docket@energy.ca.gov)

Subject Line: "Second AB 2127 Assessment"

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



**Thank you**