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Filer:	Denise Costa
Organization:	California Energy Commission
Submitter Role:	Commission Staff
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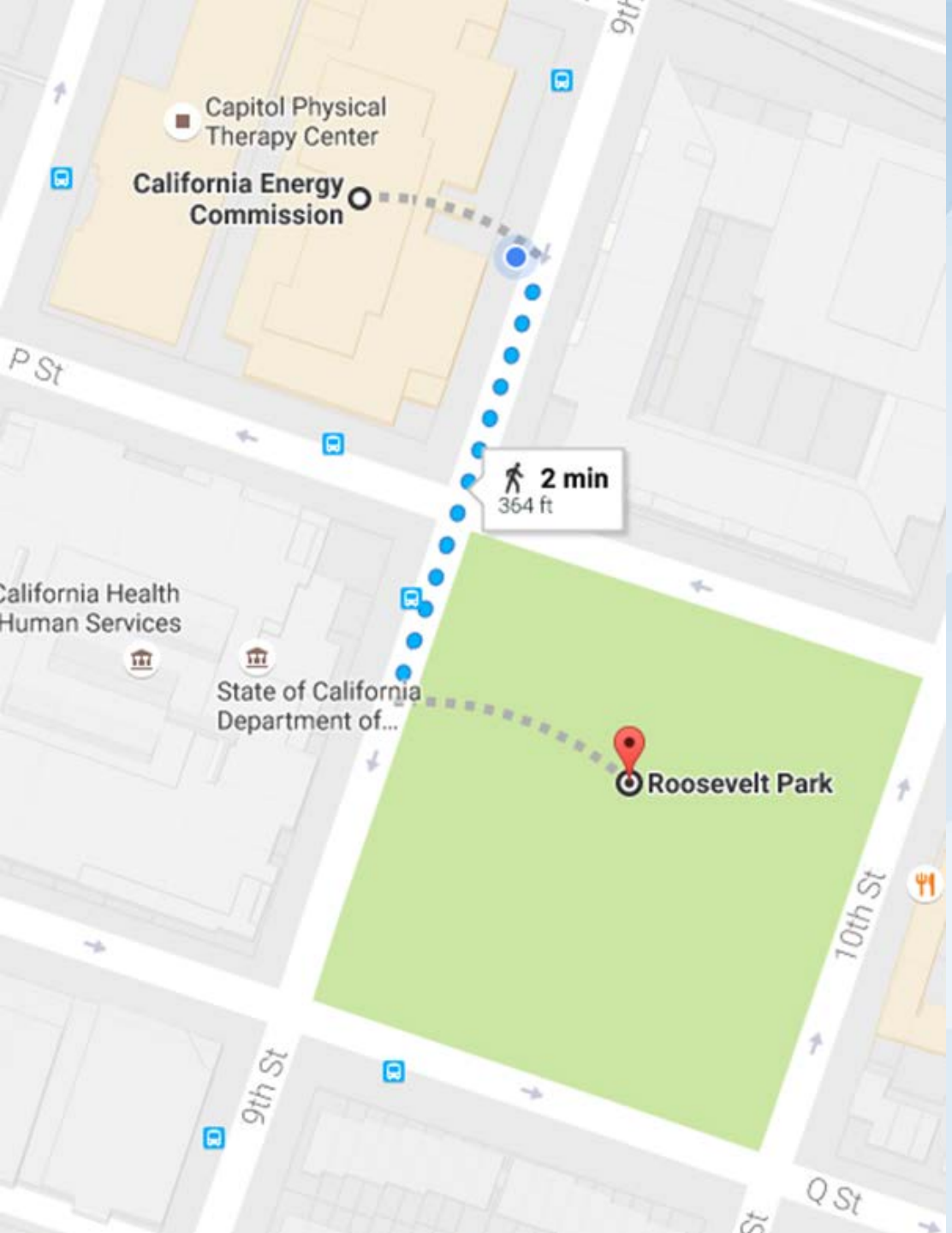
Assessing Electric Vehicle Charging Infrastructure Needs in California

Implementing Assembly Bill (AB) 2127

2019 Integrated Energy Policy Report (IEPR) Staff Workshop
March 11, 2019
California Energy Commission



In Case of Emergency

Agenda

Time	Topic
10:00	Welcome & Introductions to Energy Commission Charging Assessments
10:15	AB 2127 Requirements and Process
10:30 11:15 11:30	Coordination with Air Resources Board and Public Utilities Commission Data Collection: Overview Infrastructure Analysis: Needs and Ongoing Research
12:00	Public Comments
12:15	Lunch Break
1:15	Common Definitions for Charging Infrastructure Elements
1:35	Public Comments
2:00	Data Collection: Deeper Dive Activities for On-Road Sector Vehicles
3:45	Public Comments
4:00	Next steps to engage with the Infrastructure Assessment Adjourn

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.

Introduction to Energy Commission Electric Transportation Analysis

Kevin Barker

Deputy Director

Fuels & Transportation Division

Siva Gunda

Deputy Director

Energy Assessments Division

AB 2127 Requirements and Process

- Legislative background and requirements
- Integrated Energy Policy Report phased process
- 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

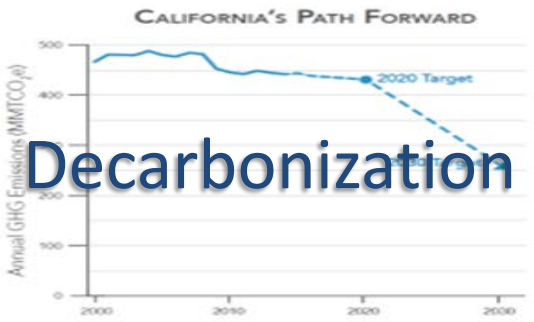
Public Resources Code §25229

- 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

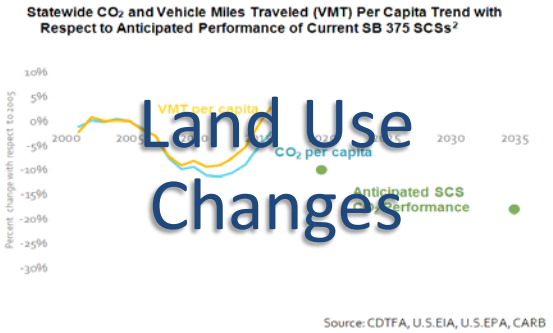
- Road
- Highway
- Off-road
- Port
- Airport

Considerations for Expanded EV Infrastructure Projections

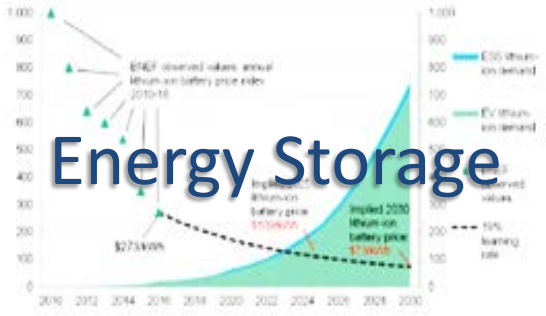


Decarbonization

Vehicle Regulation

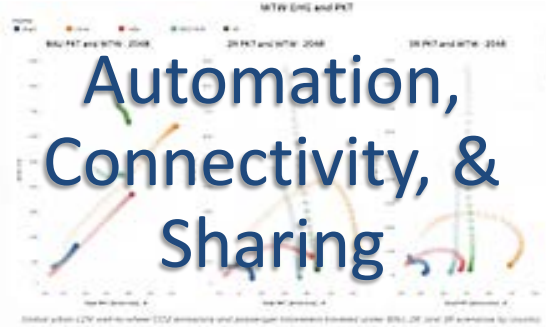


Land Use Changes



Energy Storage

Charging Technologies



Automation, Connectivity, & Sharing

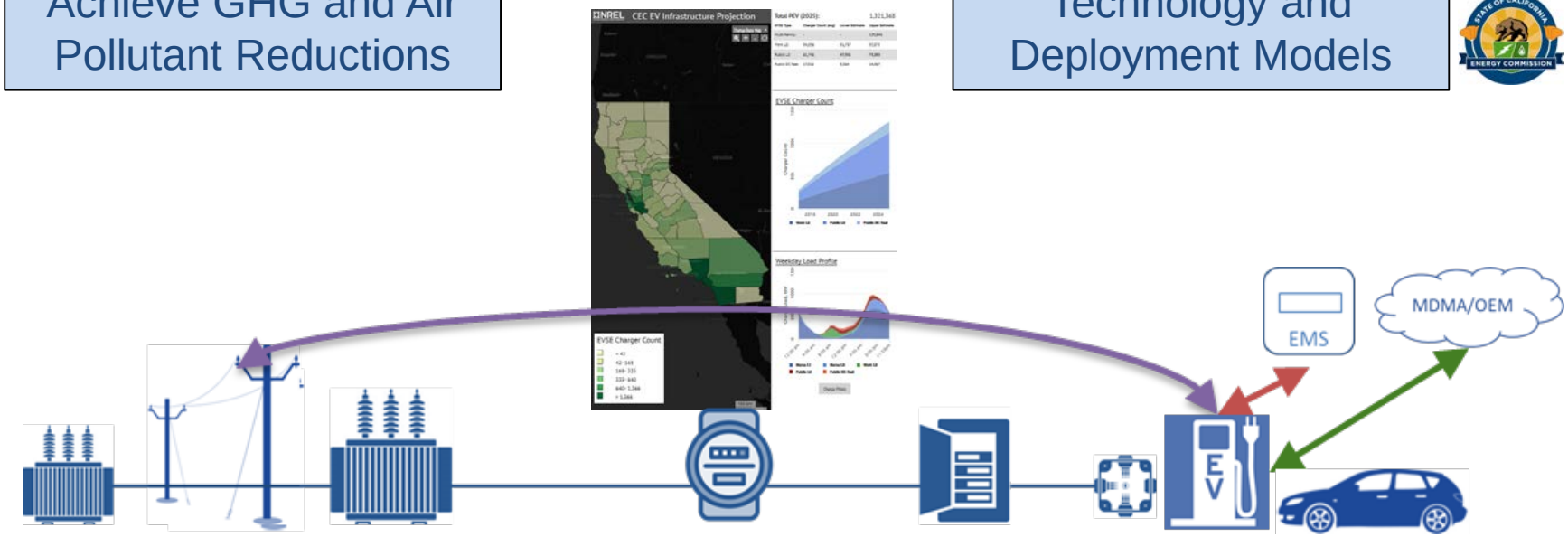
Renewables Integration

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

IEPR / AB 2127 Phased Process

2019				2020				2021
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1

AB 2127

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

IEPR 2019 Workshops

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

2020 Update

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

	Type of Data	Comparability?	Confidential?
Forms & Surveys	Quantitative	High	If yes, apply protections
Interviews	Quantitative and Qualitative	Limited. Needs narration.	If yes, apply protections
Workshops & Workgroups	Quantitative and Qualitative	Limited or High. Benefit to public.	No

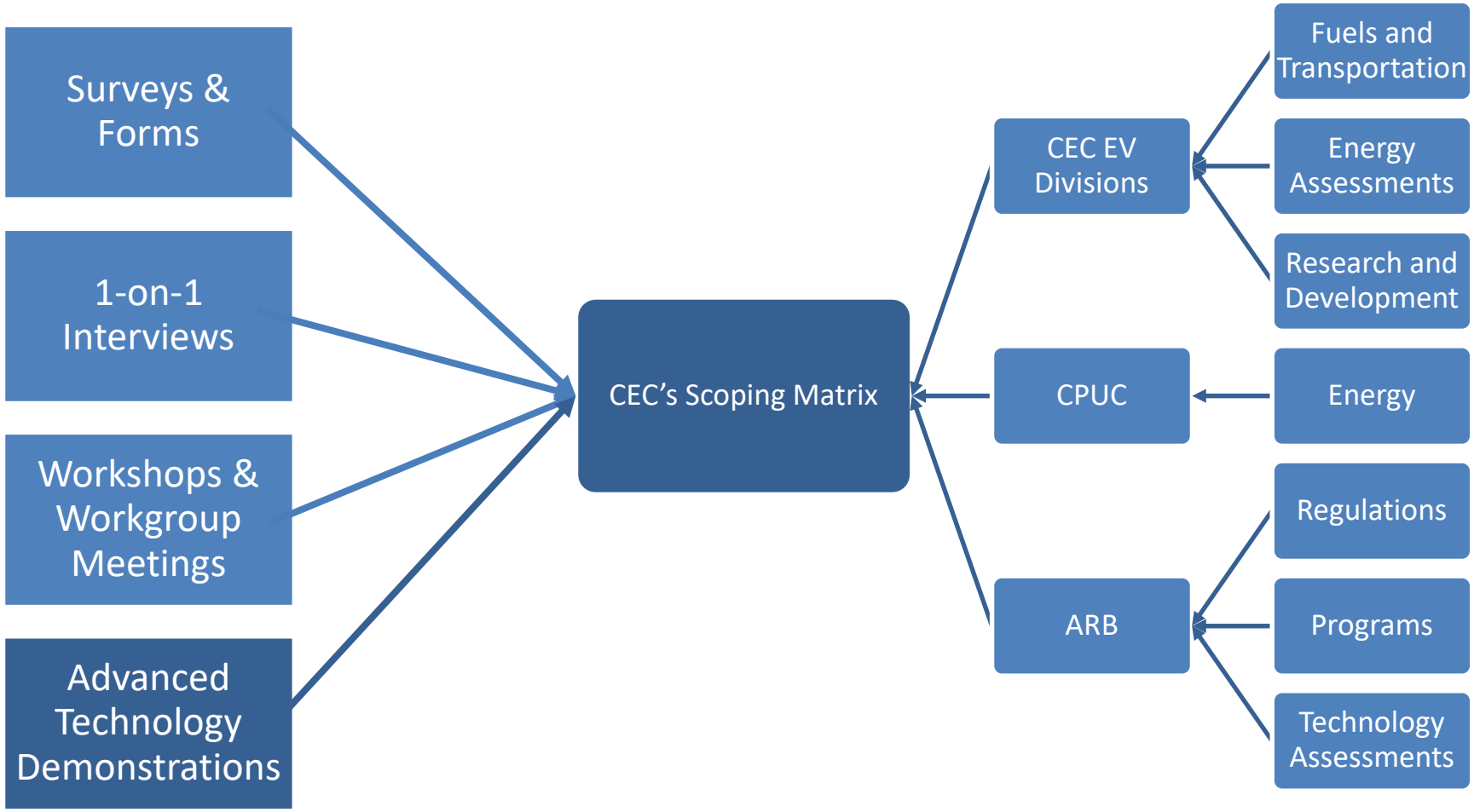
Analysis

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

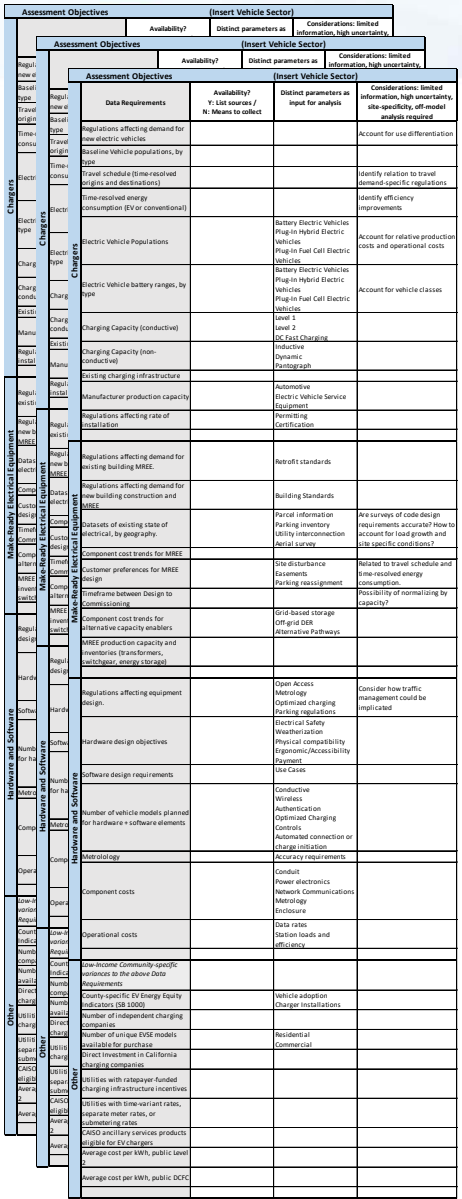
Reporting

- ***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



Assessment Objectives	(Insert Vehicle Sector)		
	Availability?	Distinct parameters as	Considerations: limited information, high uncertainty,

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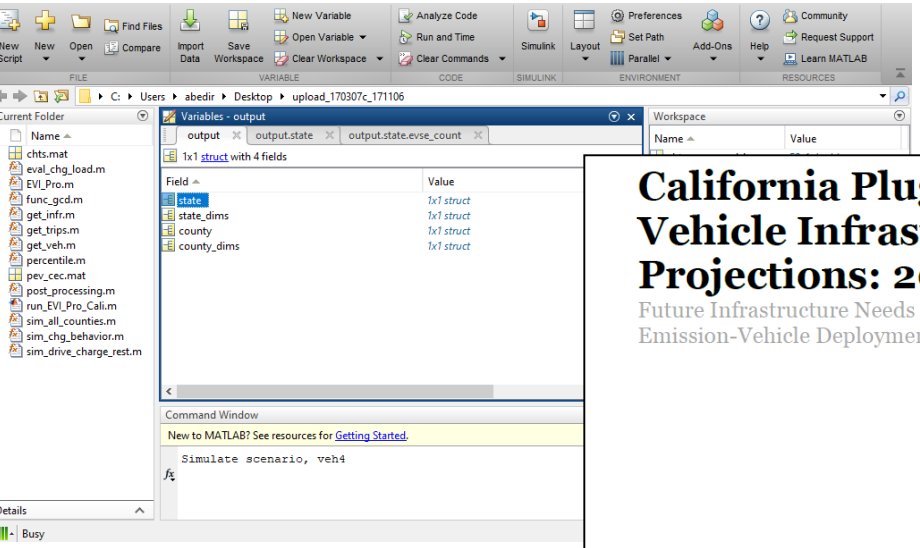
Assessment Objectives	(Insert Vehicle Sector)		
Data Requirements	Availability? Y: List sources / N: Means to collect	Distinct parameters as input for analysis	Considerations: limited information, high uncertainty, site-specificity, off-model analysis required
Regulations affecting demand for new electric vehicles			Account for use differentiation
Baseline Vehicle populations, by type			
Travel schedule (time-resolved origins and destinations)			Identify relation to travel demand-specific regulations
Time-resolved energy consumption (EV or conventional)			Identify efficiency improvements
Electric Vehicle Populations		Battery Electric Vehicles Plug-in Hybrid Electric Vehicles Plug-in Fuel Cell Electric Vehicles	Account for relative production costs and operational costs
Electric Vehicle battery ranges, by type		Battery Electric Vehicles Plug-in Hybrid Electric Vehicles Plug-in Fuel Cell Electric Vehicles	Account for vehicle classes
Charging Capacity (conductive)		Level 1 Level 2 DC Fast Charging	
Charging Capacity (non-conductive)		Inductive Dynamic Pantograph	
Existing charging infrastructure			
Manufacturer production capacity		Automotive Electric Vehicle Service Equipment	
Regulations affecting rate of installation		Permitting Certification	
Regulations affecting demand for existing building MREE.		Retrofit standards	
Regulations affecting demand for new building construction and MREE		Building Standards	
Datasets of existing state of electrical, by geography.		Parcel information Parking inventory Utility interconnection Aerial survey	Are surveys of code design requirements accurate? How to account for load growth and site specific conditions?
Component cost trends for MREE			
Customer preferences for MREE design		Site disturbance Easements Parking reassignment	Related to travel schedule and time-resolved energy consumption.
Timeframe between Design to Commissioning			Possibility of normalizing by capacity?
Component cost trends for alternative capacity enablers		Grid-based storage Off-grid DER Alternative Pathways	
MREE production capacity and inventories (transformers, switchgear, energy storage)			
Regulations affecting equipment design.		Open Access Metrology Optimized charging Parking regulations	Consider how traffic management could be implicated
Hardware design objectives		Electrical Safety Weatherization Physical compatibility Ergonomic/Accessibility Payment	
Software design requirements		Use Cases	
Number of vehicle models planned for hardware + software elements		Conductive Wireless Authentication Optimized Charging Controls Automated connection or charge initiation	
Metrology		Accuracy requirements	
Component costs		Conduit Power electronics Network Communications Metrology Enclosure	
Operational costs		Data rates Station loads and efficiency	
Low-income Community-specific variances to the above Data Requirements			
County-specific EV Energy Equity indicators (SB 1000)		Vehicle adoption Charger installations	
Number of independent charging companies			
Number of unique EVSE models available for purchase		Residential Commercial	
Direct investment in California charging companies			
Utilities with ratepayer-funded charging infrastructure incentives			
Utilities with time-variant rates, separate meter rates, or submetering rates			
CAISO ancillary services products eligible for EV chargers			
Average cost per kWh, public Level 2			
Average cost per kWh, public DCFC			

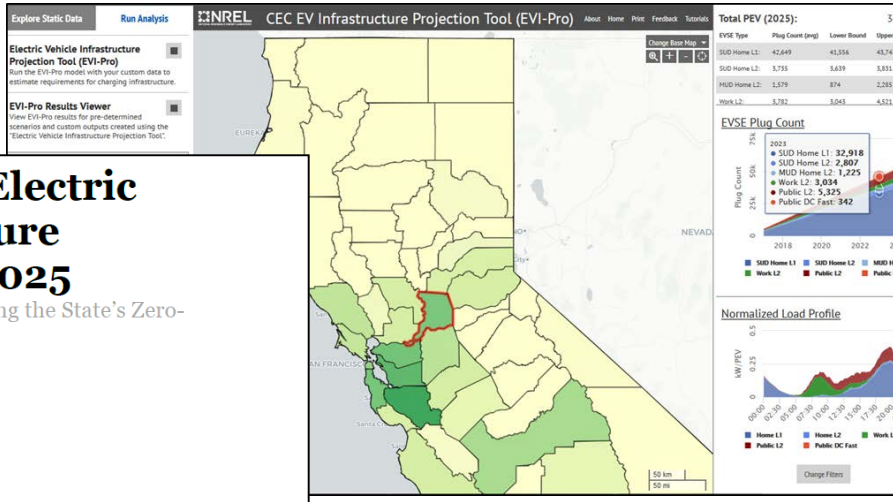
- Vehicle Categories
  - Road and Highway
    - Three sectors for today's workshop:
    - Light-, Medium-, and Heavy-Duty Vehicles
  - Off-Road
  - Port
  - Airport
- Infrastructure Elements
  - Chargers
  - Make-Ready Electrical Equipment
  - Hardware and Software
  - Other Programs

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





From data and models…

to actionable insights.

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

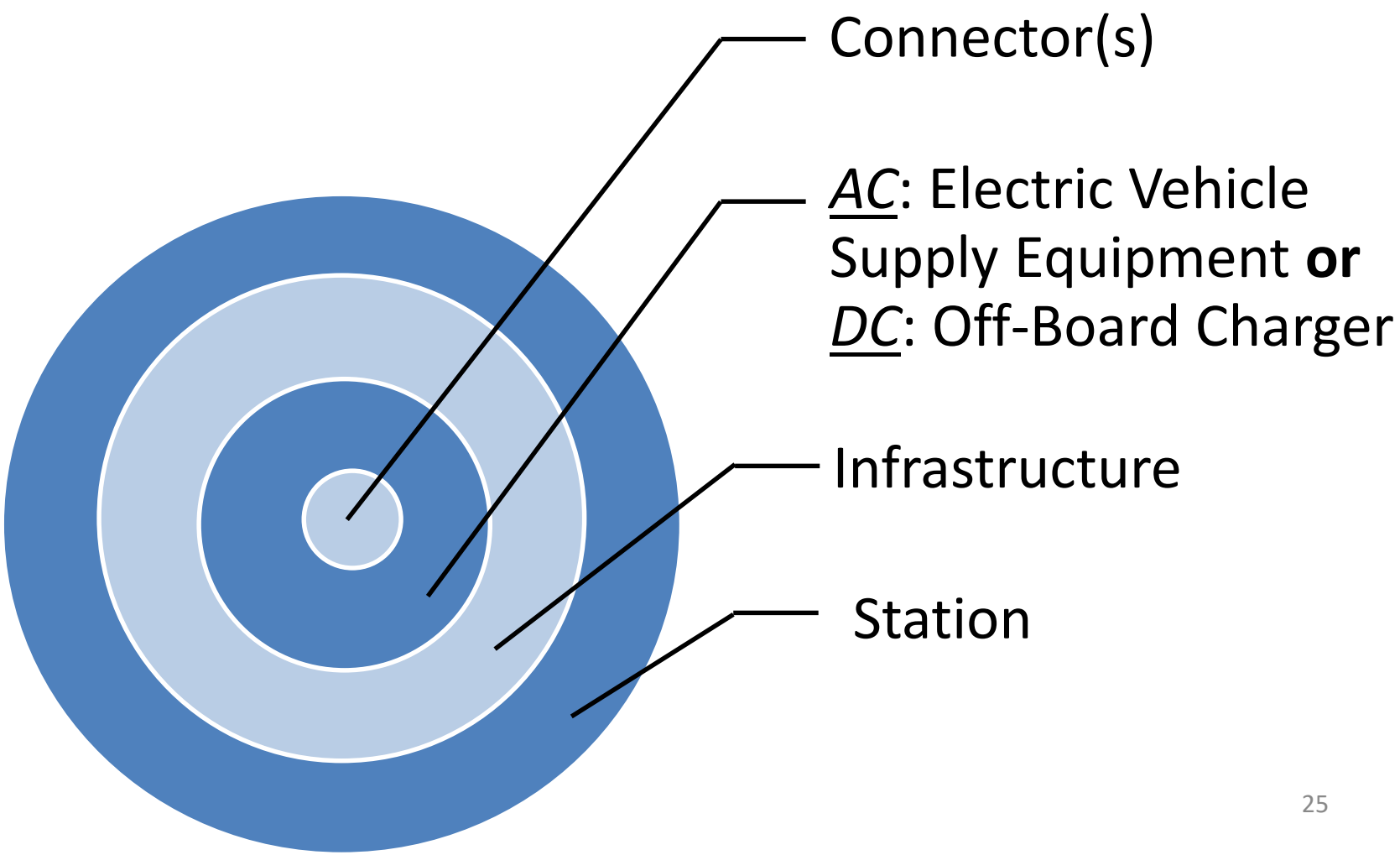
1:15 p.m.

Common Definitions of Charging Infrastructure Elements

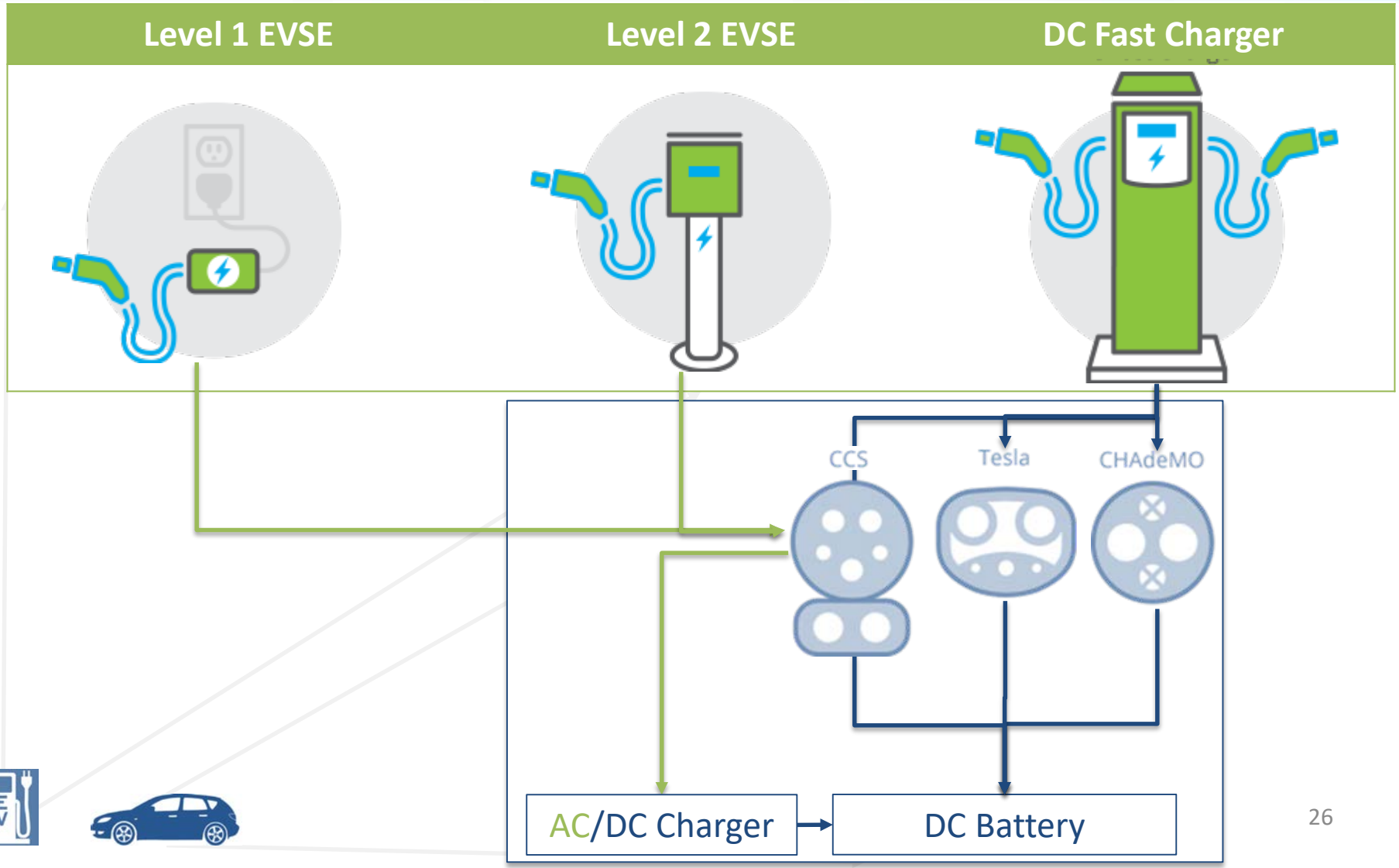
- Including, but not limited to
  - Chargers
  - Make-Ready Electrical Equipment
  - Supporting Hardware and Software
  - Other

Noel Crisostomo
Fuels and Transportation Division

What is Specifically Meant by The Term “Chargers”?



EV Supply Equipment (EVSE) or DC Fast Charger



Need to Use Consistent Terminology

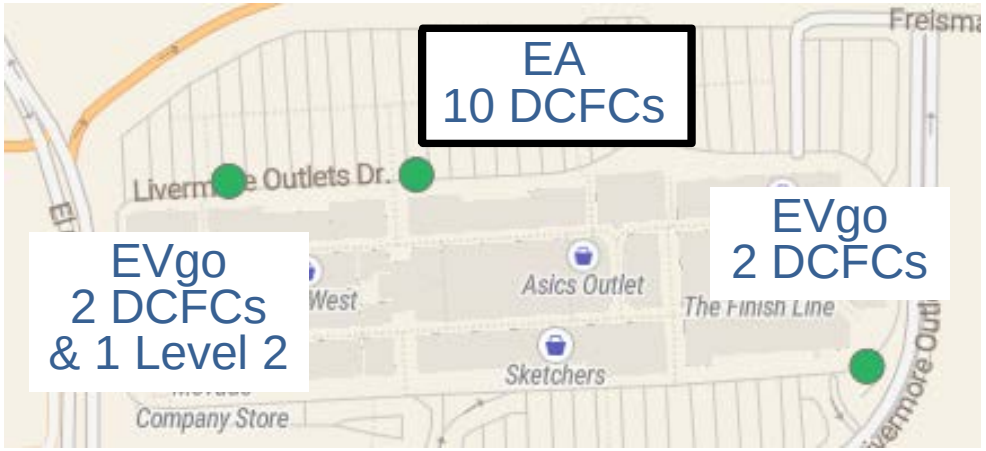
Type	Outlets	Connectors
DC Fast	10	CHAdeMO, SAE CCS

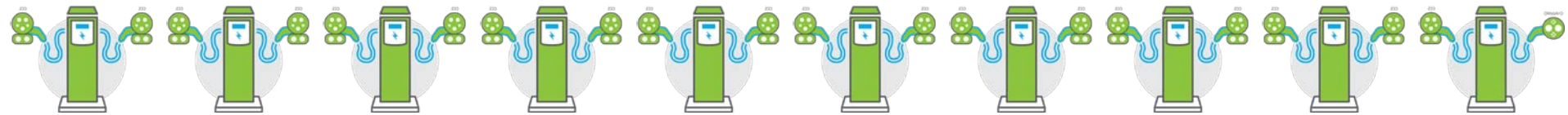
CCS/SAE
10 stations
ElectrifyAmerica

CHAdeMO
1 station
ElectrifyAmerica

San Francisco Premium Outlets
2774 Livermore Outlets Dr. Livermore, CA 94551 — 35 mi
9 CCS, 1 CCS-CHAdeMO

- **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





150	150	150	150	150	150	150	150	350	350

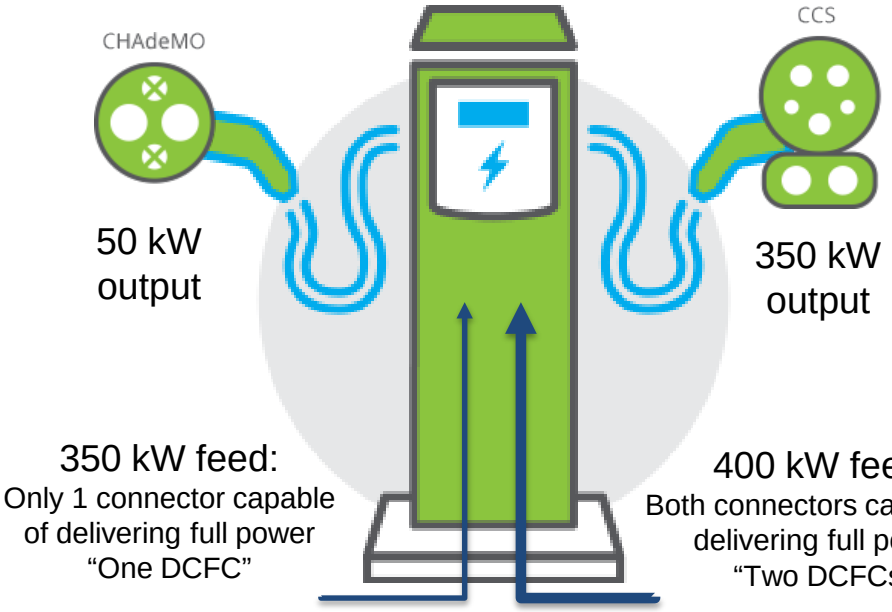
Counting *EVSEs* and *Chargers*

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.

Total PEV (2025): 1,321,368

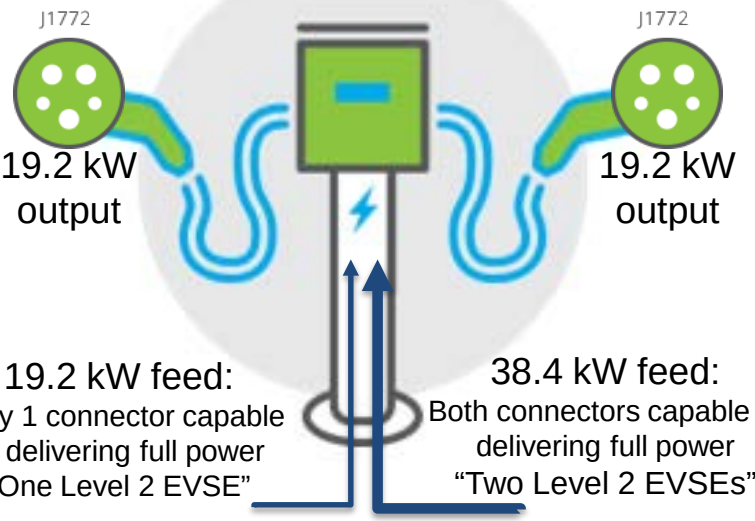
EVSE Type	Charger Count (avg)	Lower Estimate	Upper Estimate
Multi-Family:	-	-	120,843
Work L2:	54,556	51,737	57,375
Public L2:	61,746	47,596	75,895
Public DC Fast:	17,016	9,064	24,967

CEC & NREL, 2018



350 kW feed:
Only 1 connector capable of delivering full power
"One DCFC"

400 kW feed:
Both connectors capable of delivering full power
"Two DCFCs"

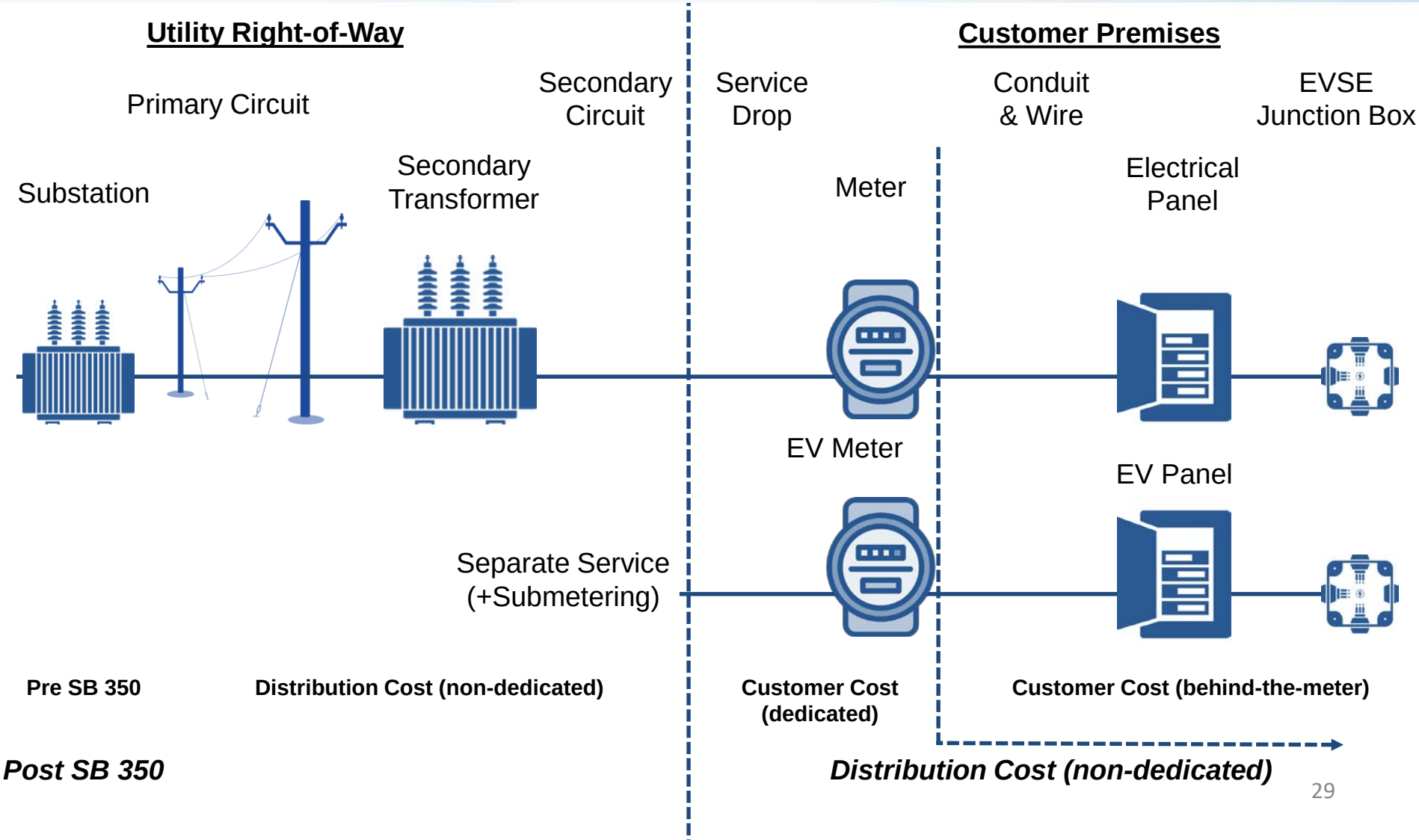


19.2 kW feed:
Only 1 connector capable of delivering full power
"One Level 2 EVSE"

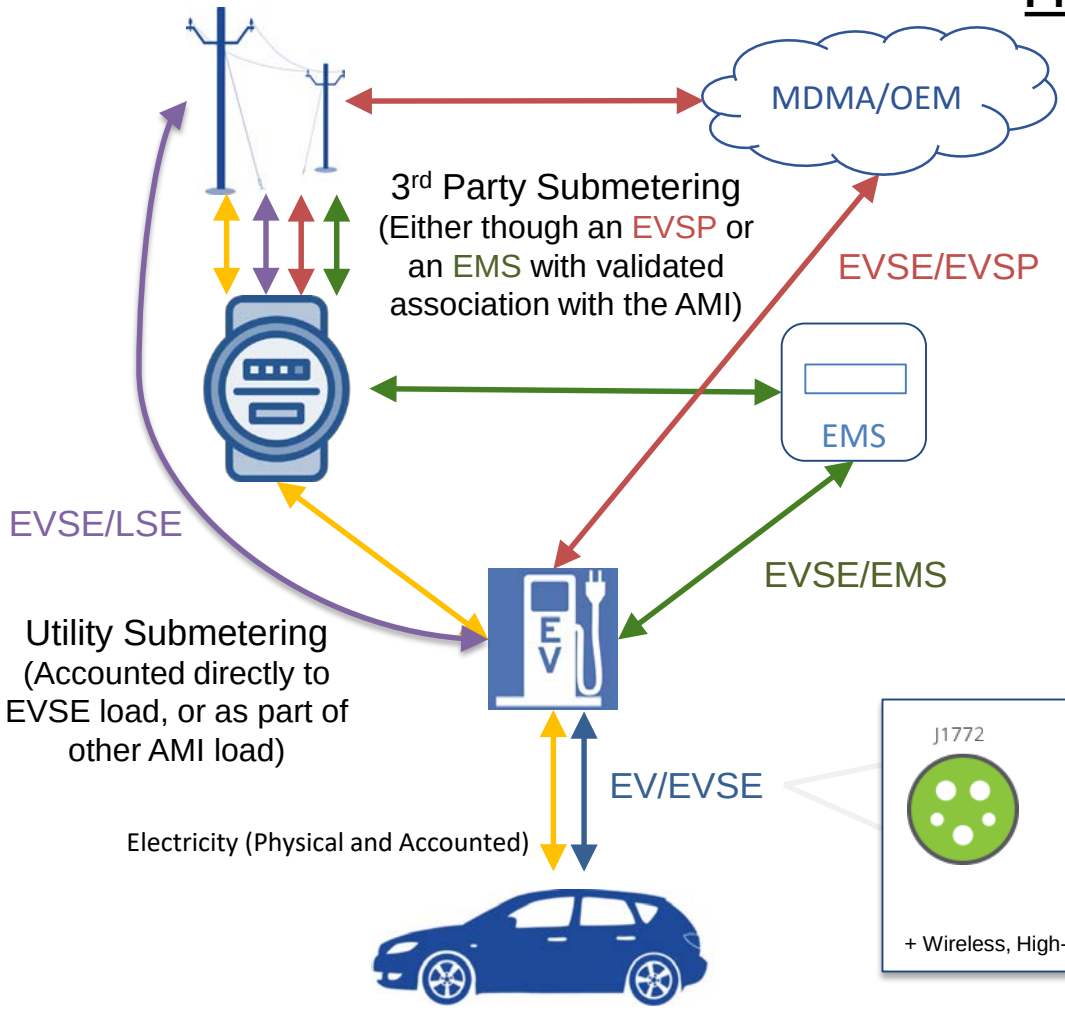
38.4 kW feed:
Both connectors capable of delivering full power
"Two Level 2 EVSEs"

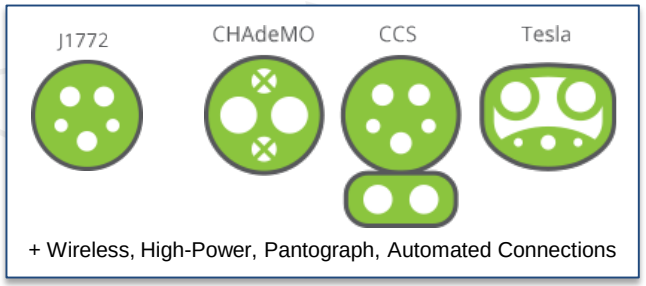
Quantification of need should specify maximum connector capacity and account for: 1) reductions in throughput that delay service, given e.g. parking configurations or power management objectives, and 2) user behaviors.

Make-Ready Electrical Equipment



Hardware and Software





Physical & Transactional

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

+ Others…

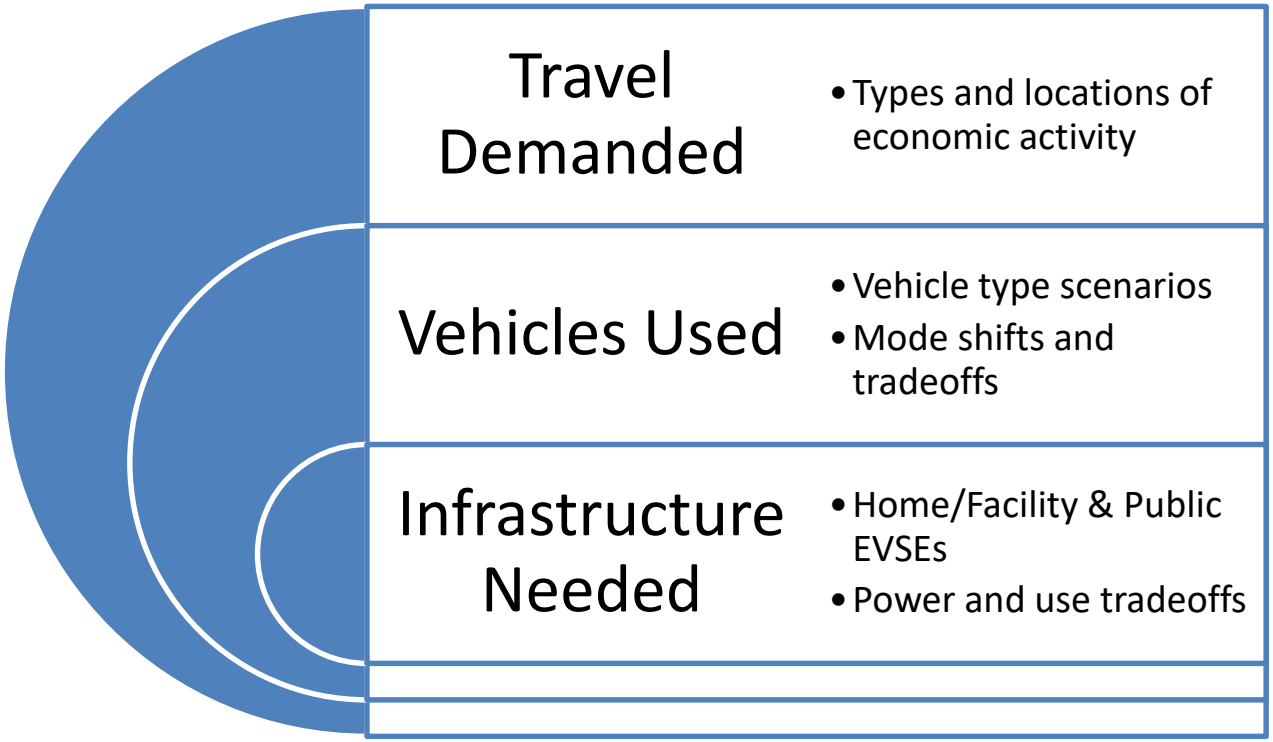
* = Vehicle-grid integration related hardware and software requirements

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



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…"

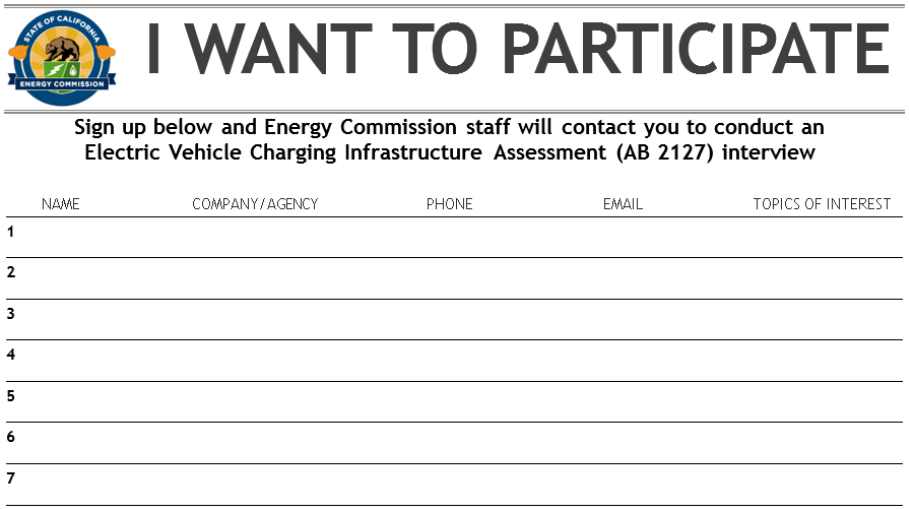
  - Emerging charging paths: distributed energy resources, storage, fuel cell, etc.
- Track the pace and breadth of ***other programs***, including existing infrastructure incentives

PUBLIC COMMENTS

- 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

	NAME	COMPANY/AGENCY	PHONE	EMAIL	TOPICS OF INTEREST
1					
2					
3					
4					
5					
6					
7					

  - 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)

Assessment Objectives			(Insert Vehicle Sector)	
	Data Requirements	① Availability? Y: List sources / N: Means to collect	② Distinct parameters as input for analysis	③ Considerations: limited information, high uncertainty, site-specificity, off-model analysis required
Chargers	Regulations affecting demand for new electric vehicles			Account for use differentiation
	Baseline Vehicle populations, by type			
	Travel schedule (time-resolved origins and destinations)			Identify relation to travel demand-specific regulations
	Time-resolved energy consumption (EV or conventional)			Identify efficiency improvements
	Electric Vehicle Populations		Battery Electric Vehicles Plug-In Hybrid Electric Vehicles Plug-In Fuel Cell Electric Vehicles	Account for relative production costs and operational costs
	Electric Vehicle battery ranges, by type		Battery Electric Vehicles Plug-In Hybrid Electric Vehicles Plug-In Fuel Cell Electric Vehicles	Account for vehicle classes
	Charging Capacity (conductive)		Level 1 Level 2 DC Fast Charging	
	Charging Capacity (non-conductive)		Inductive Dynamic Pantograph	
	Existing charging infrastructure			
	Manufacturer production capacity		Automotive Electric Vehicle Service Equipment	
	Regulations affecting rate of installation		Permitting Certification	
		④		

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:
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Noel.crisostomo@energy.ca.gov
916-653-8625