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Electric Vehicle Infrastructure Projection Tool (EVI-Pro)

California Energy Commission (CEC)
Integrated Energy Policy Report (IEPR) Workshop
August 6, 2020

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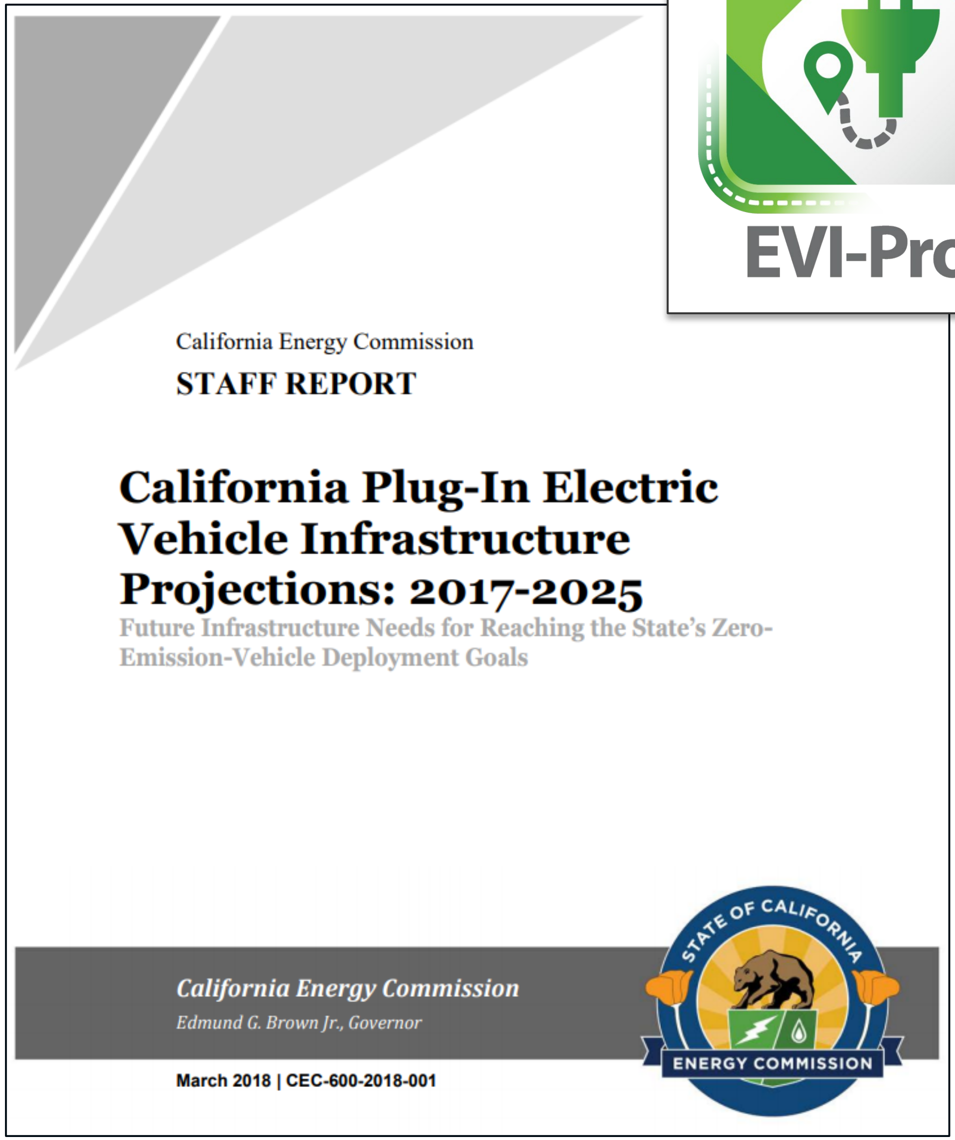
What is EVI-Pro?

- Simulation model to:
    - Estimate 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


California Energy Commission
STAFF REPORT

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

STATE OF CALIFORNIA ENERGY COMMISSION

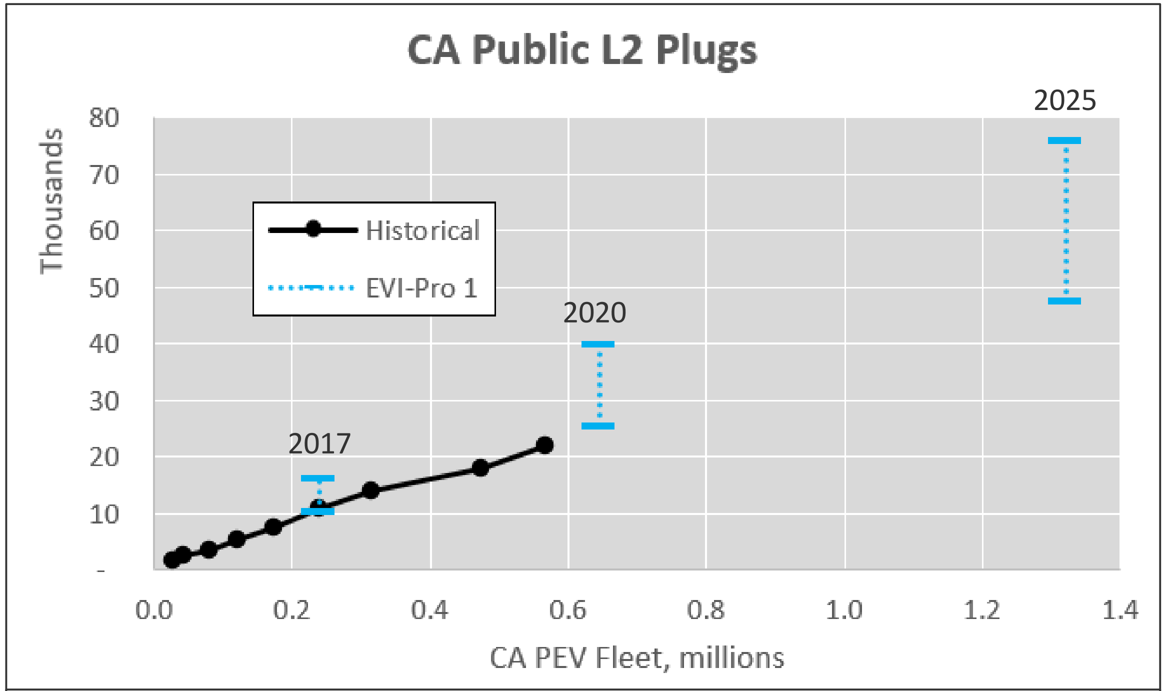
March 2018 | CEC-600-2018-001

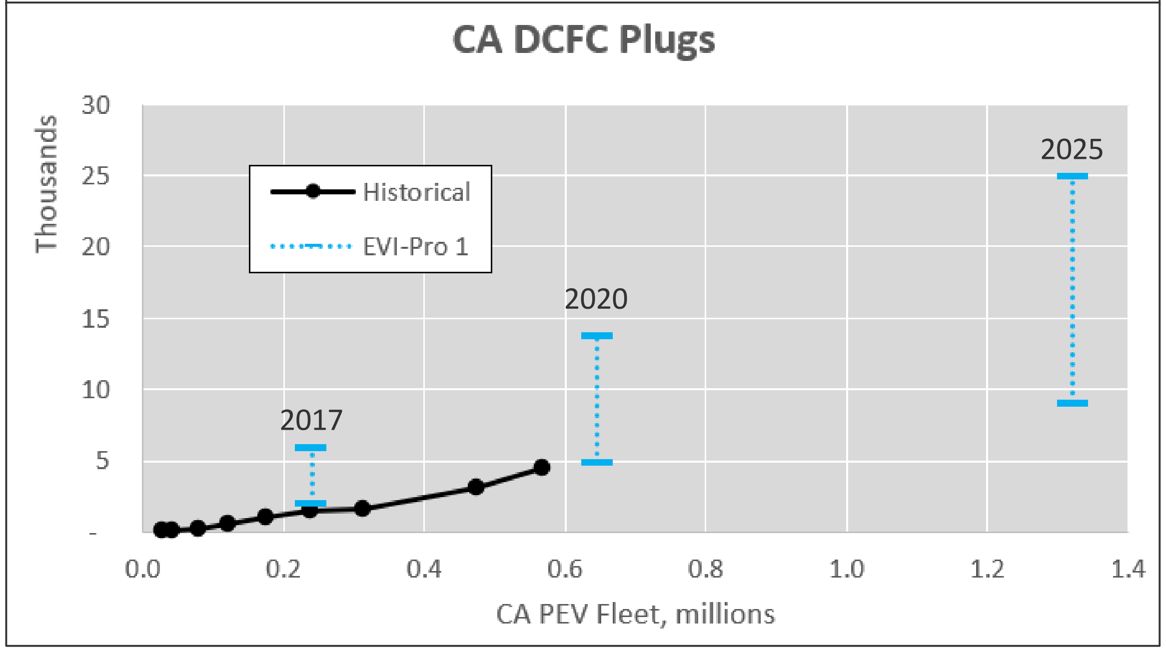
EVI-Pro

PEV = plug-in electric vehicle
ZEV = zero emission vehicle

EVI-Pro 1

- In 2018, **EVI-Pro 1** was applied to three scenarios to estimate infrastructure necessary to enable CA drivers to maximize eVMT
- Pursuant to AB2127, evolving market and technology conditions warrant updated assessments at least every two years
- CEC, with support from NREL, UC Davis, and other state agencies, set out to refine **EVI-Pro 2** to reflect:
  - Increasing PEV market size
  - Evolving vehicle/charging technology
  - Observed charging behavior





EVI-Pro 1 vs EVI-Pro 2

Preliminary values. Subject to review.

	EVI-Pro 1 (2025)	**EVI-Pro 2 (2030)**
Zero emission vehicles	1.5M	5.0M
Charging Behavior Objective	Maximize eVMT	Mirror observed behavior
PHEV/BEV Split	45%/55%	32%/68%
Avg BEV Range	210 miles	280 miles
PEVs w/ home charging	92%	82%
Infrastructure utilization	Assumed	Observed
Long-distance travel	No	Simulated **(EVI-Pro RoadTrip)***
Transportation network companies	No	Simulated **(UC Davis' WIRED)***
Medium/heavy-duty vehicles	No	Simulated **(LBNL's HEVI-Pro)***

To be shown in subsequent presentations

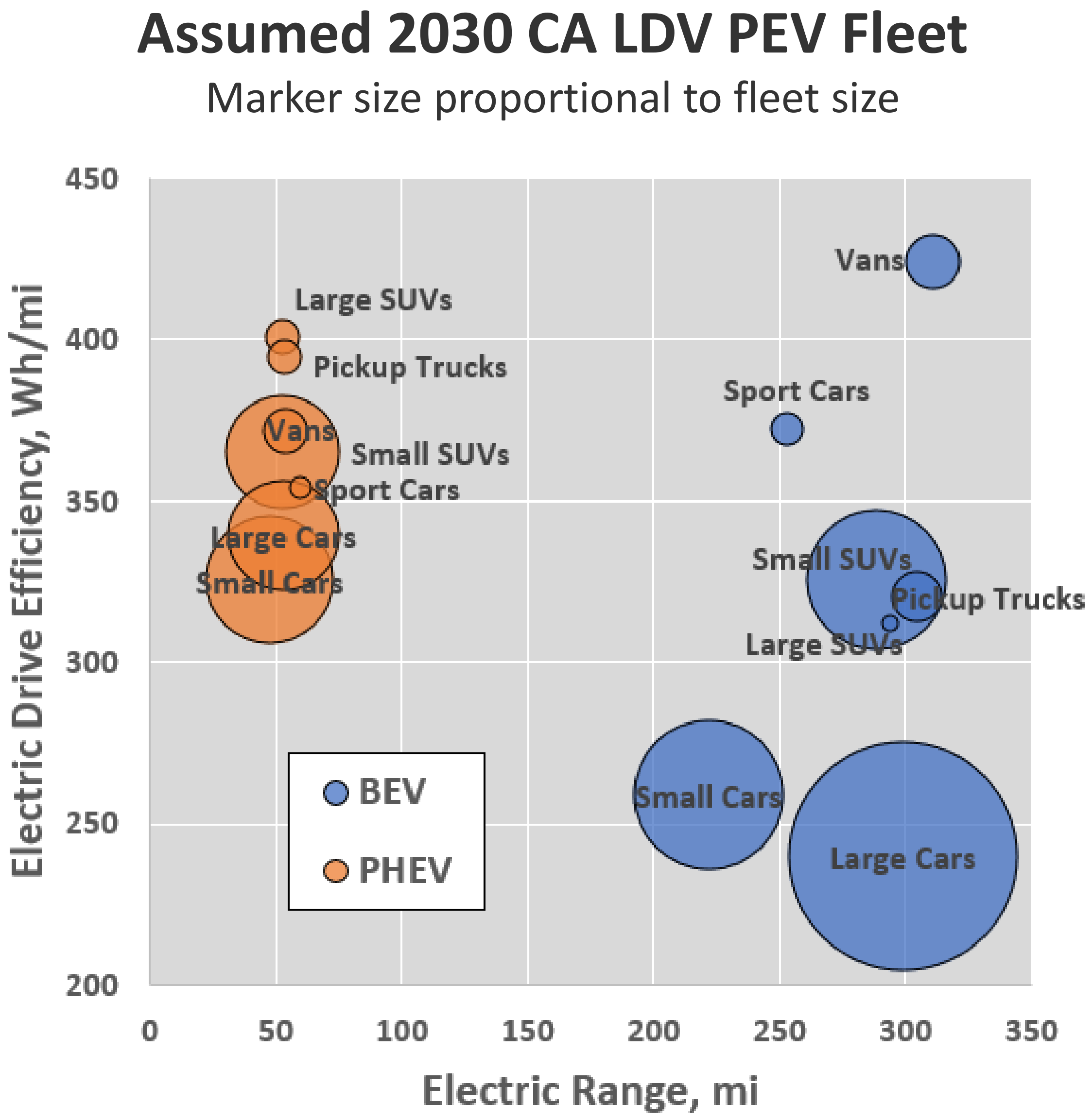
PHEV = plug-in hybrid electric vehicle
BEV = battery electric vehicle
eVMT = electric vehicle miles traveled

PEV Fleet Forecast

Preliminary values. Subject to review.

- Combination of forecasts from CEC's Energy Assessments Division and CARB's Mobile Sources Strategy used to determine primary scenario for CA LDV PEV fleet composition in 2030

	EVI-Pro 1	EVI-Pro 2
CA Fleet Size	1.3M PEVs	5.0M PEVs
PHEV/BEV ratio	45%/55%	32%/68%
Sedan Share	100%	71%

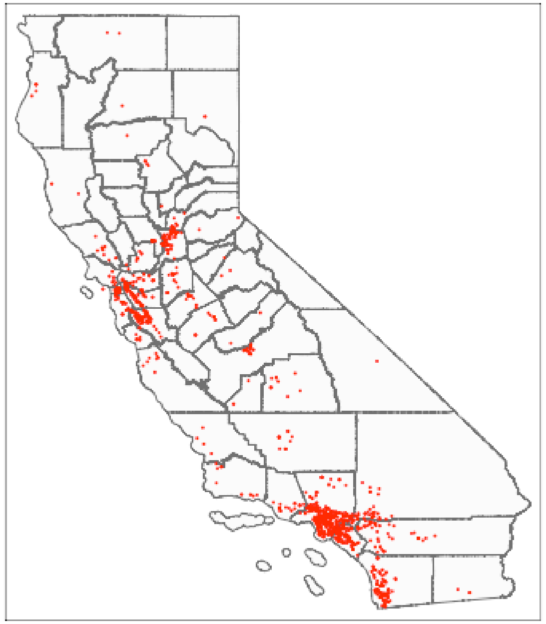


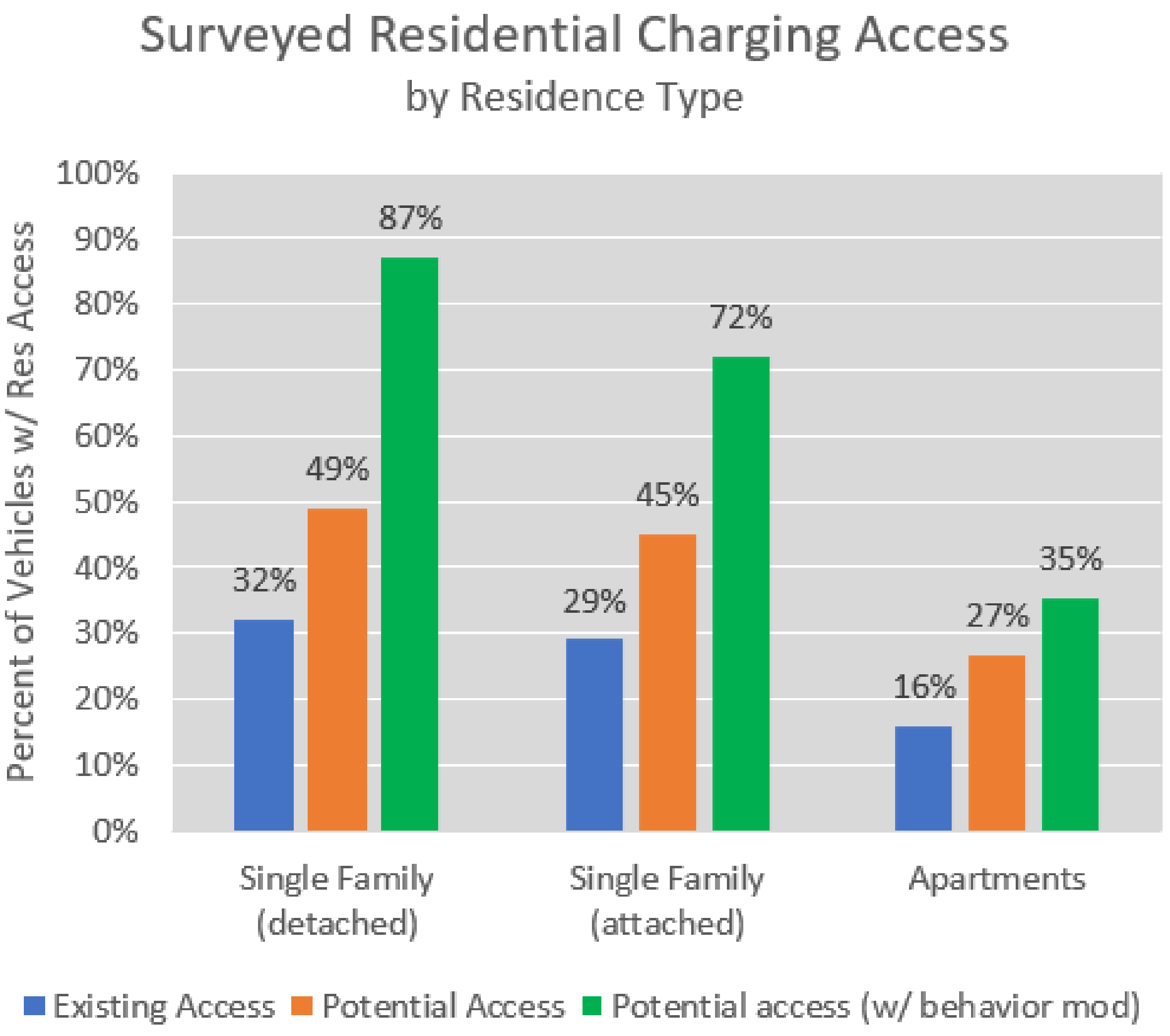
CA Residential Charging Survey

Using an online panel, NREL administered a survey to CA residents asking for information on:

- Vehicle ownership
- Electrical access by parking option
- Residential parking options

Results from 1,252 respondents indicate that residential charging access is a strong function of residence type and behavior





Additional survey info in Appendix

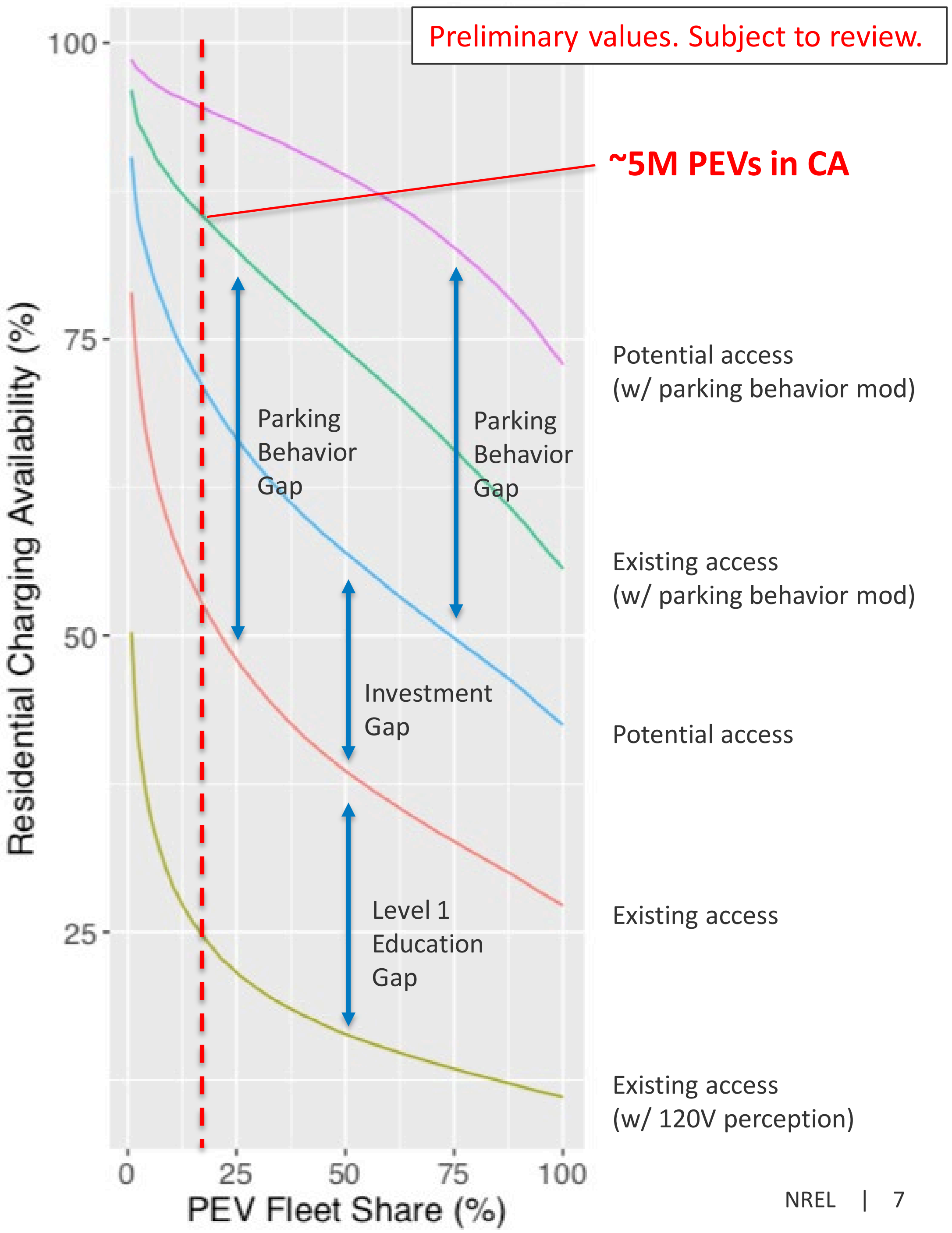
Estimating Residential Charging Access

- Using survey results, a PEV likely adopter model is applied to estimate evolution of residential access as a function of PEV fleet size (at right)
- Based on these results, the following assumptions are applied in EVI-Pro 2:

CA PEV Fleet Size	Res Access
1,000,000	88%
2,800,000	87%
5,000,000	82%

*EVI-Pro 1 assumed 92% from 2017-2025

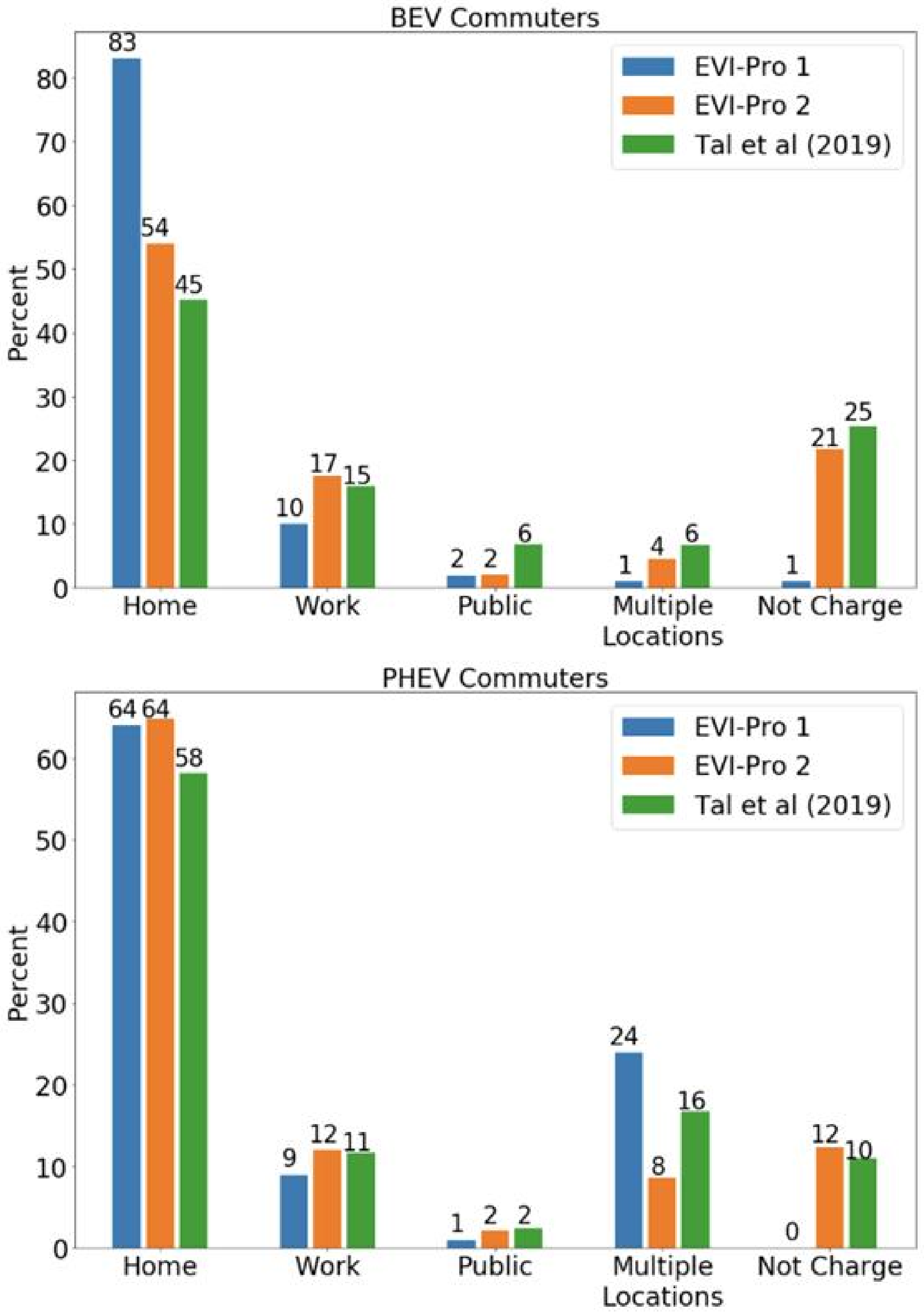
- Gaps between scenarios (at right) suggest that education, investment, and behavior modification all play a role to play in improving residential charging access



EVI-Pro 2 Simulations

Preliminary values. Subject to review.

- Charging behavior logic in EVI-Pro 2 has been calibrated based on revealed preference survey data from UC Davis*
- Relative to EVI-Pro 1:
  - Less “home-only” charging
  - More “work-only” charging
  - More “no charge” days



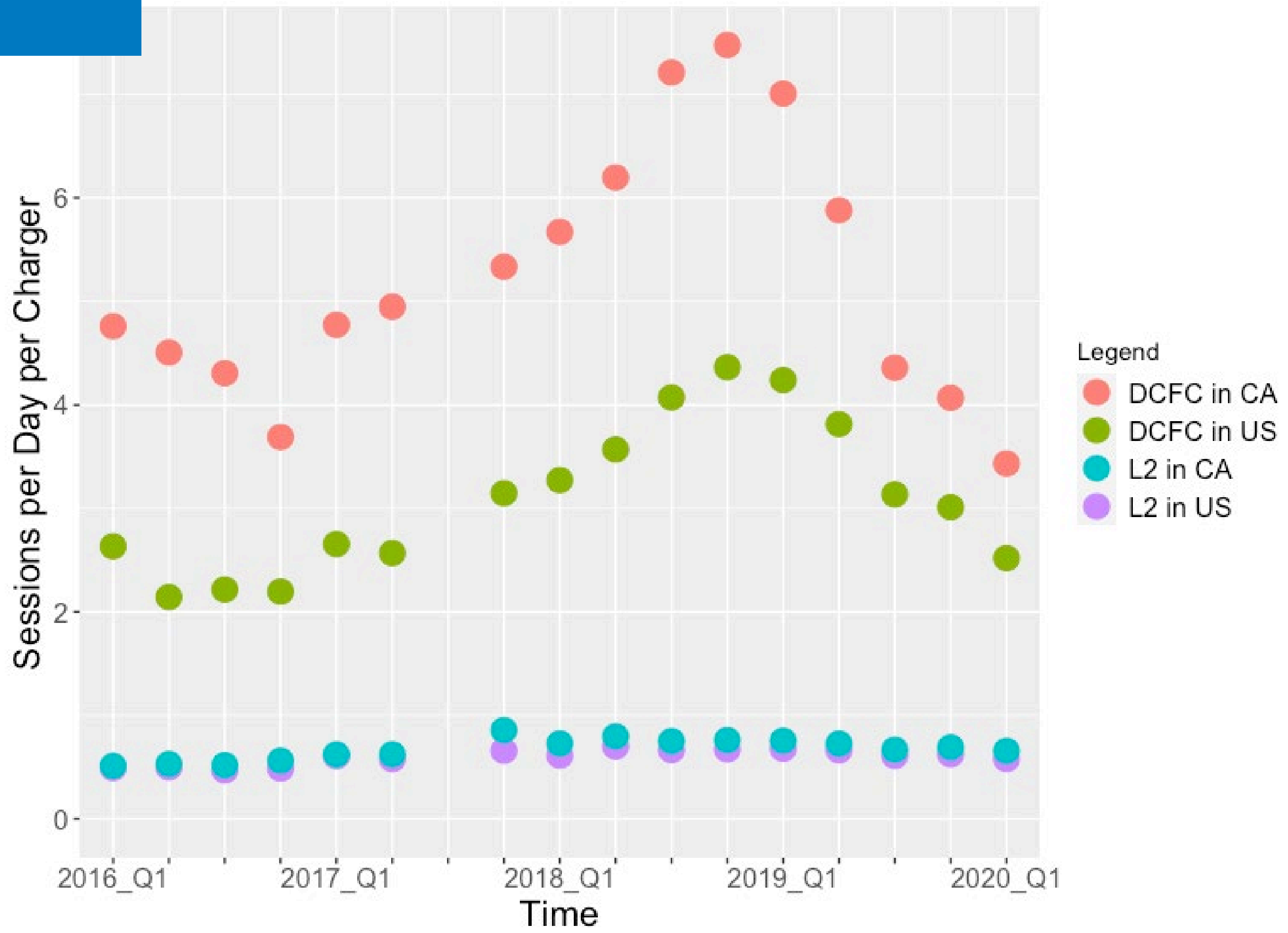
*Tal et al (2019) “Factors Affecting Demand for Plug-in Charging Infrastructure: An Analysis of Plug-in Electric Vehicle Commuters”

Recent EVSE Utilization
Jan 2016 to March 2020

Preliminary values. Subject to review.

- EVI-Pro 1 relied on a theoretical approach to estimating sharing potential of public chargers
- EVI-Pro 2 will rely on observed utilization rates to inform forward-looking assumptions
- EVSPs have provided CEC/NREL with event-level data from networked L2 and DCFC units across the US (including in CA)
- Fluctuations in CA DCFC utilization are believed to stem from evolving use of BEVs in ride-hailing fleets

	US (incl CA)	CA only
Station Count	3,036	1,151
Plug Count	6,372	3,524
Unique ZIP Codes	1,703	529
Individual Charge Events	~7.2M	~5.2M



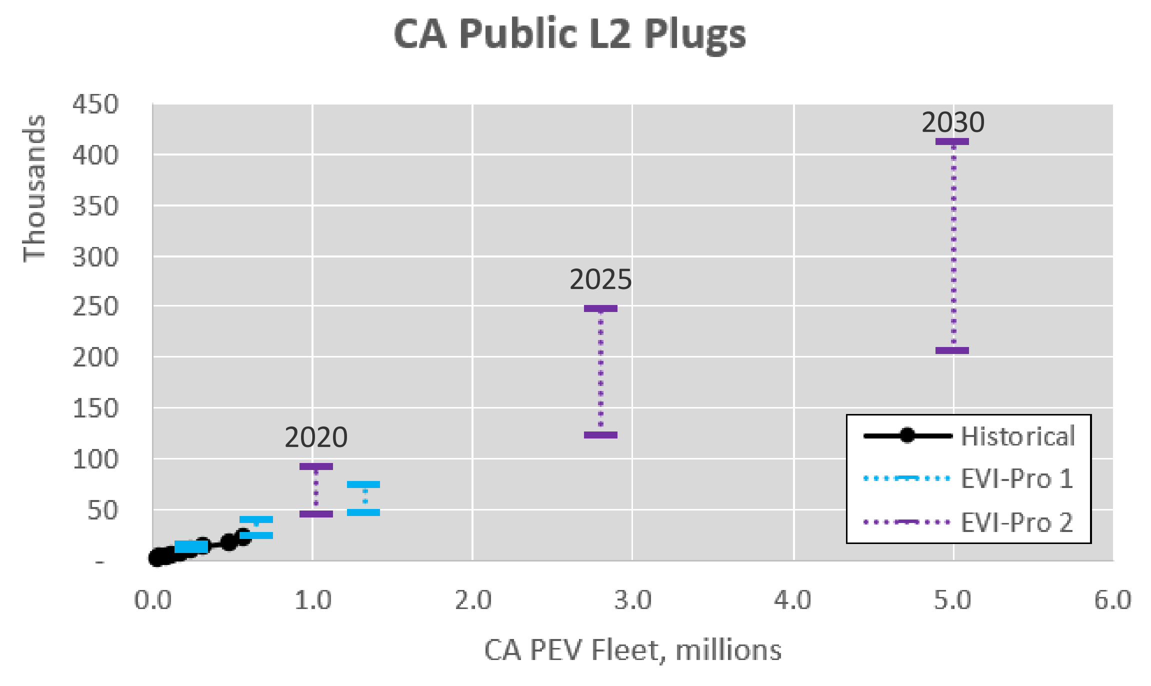
*2017 Q3 intentionally omitted (inconsistent reporting)

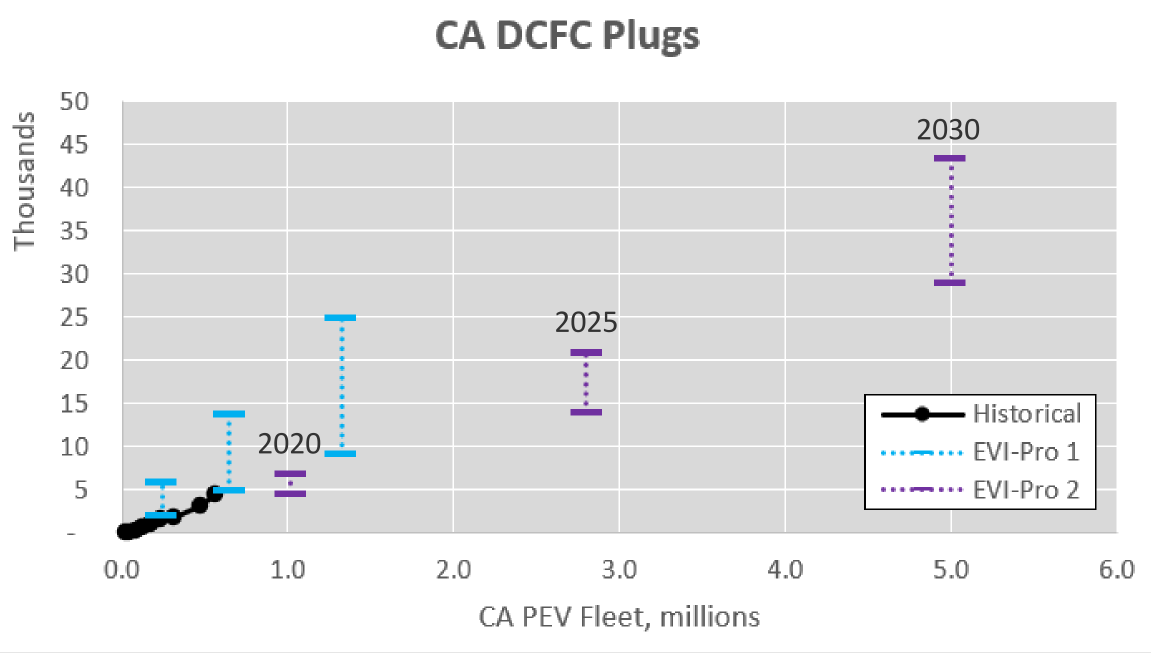
2030 Infrastructure Estimates (5M PEVs)

Preliminary values. Subject to review.		Plug Lower Bound	Plug Upper Bound
While-at-home	Single Family (L1 + L2)	3,461,285	3,807,413
	Apartments (L2)	150,144	300,289
While-at-work	Level 2	178,954	357,907
While-in-public	Level 2	206,671	413,341
	DCFC	28,924	43,386
Total	**(w/o Single Family)**	**564,693**	**1,114,923**

- 82% of PEVs w/ residential access
- PEV share by residence type
  - Single family detached = 77%
  - Single family attached = 8%
  - Apartments = 15%
- Non-residential EVSE utilization
  - Level 2 (workplace, public) = 1-2 events/plug/day
  - DCFC = 6-9 events/plug/day

Key Assumptions





In Conclusion

Uncertainty persists…

- **Preliminary results** presented today; refinement on-going and feedback welcome!
- **Charging behavior** continues to co-evolve with **technology** maturation. On-going research remains necessary.
- While **residential charging access** may remain high in the near-term, in the long-term residential charging gaps could be addressed through education, investment, and behavior modification (nudges).
- **Ride-hailing** electrification can bring about sudden and dramatic charging demand, but the market remains fluid.
- Impacts of **COVID-19** have not been addressed thus far. What effects of the pandemic will "stick" in the long-term? And how should they be reflected in this analysis?

… but the takeaway is consistent.

- Significant infrastructure growth remains paramount to meeting ZEV goals.
- Investment is needed in residential, destination, and fast charging infrastructure.
- An infrastructure gap could limit California's ability to achieve 5 million ZEVs by 2030.

Thanks! Questions?

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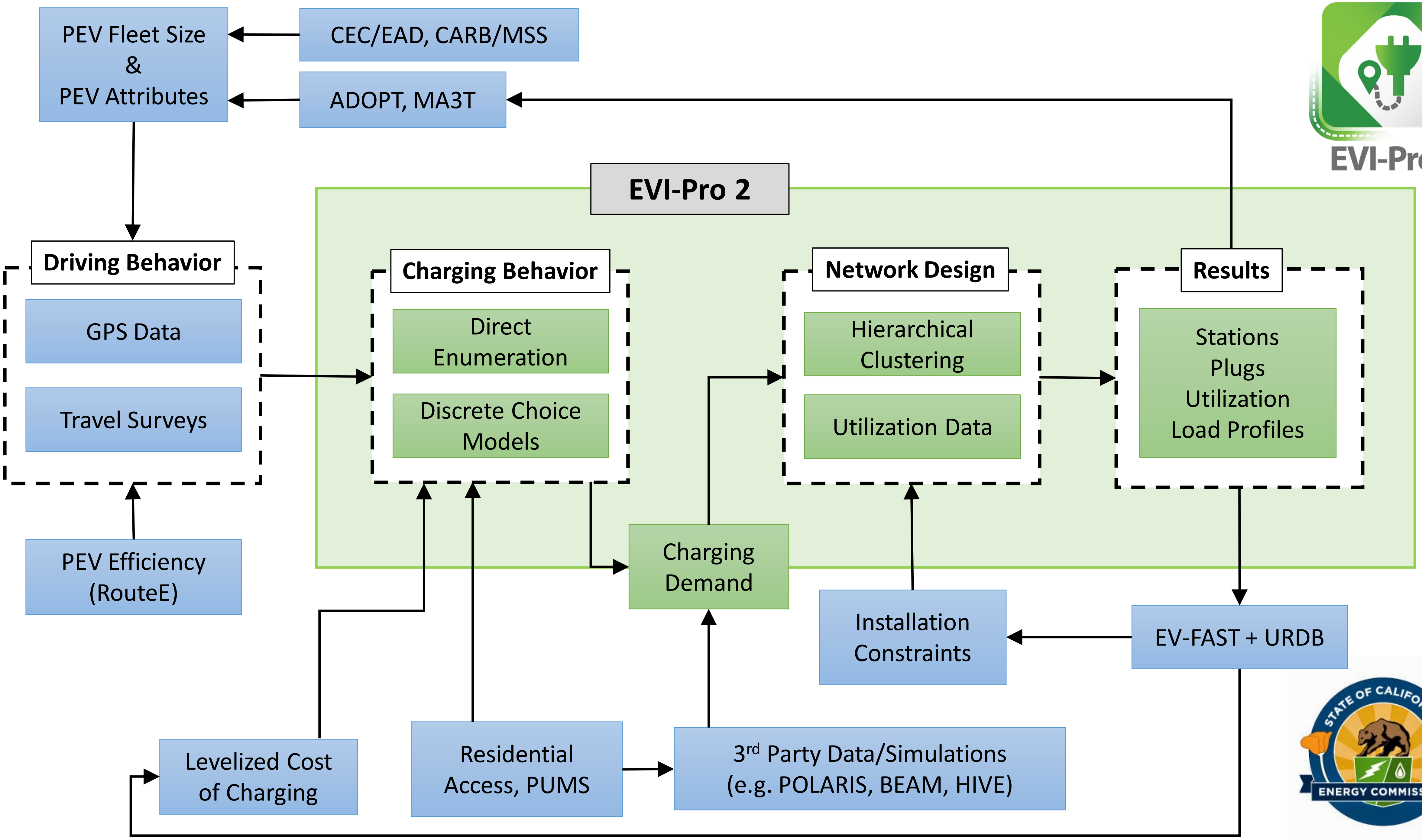

EVI-Pro

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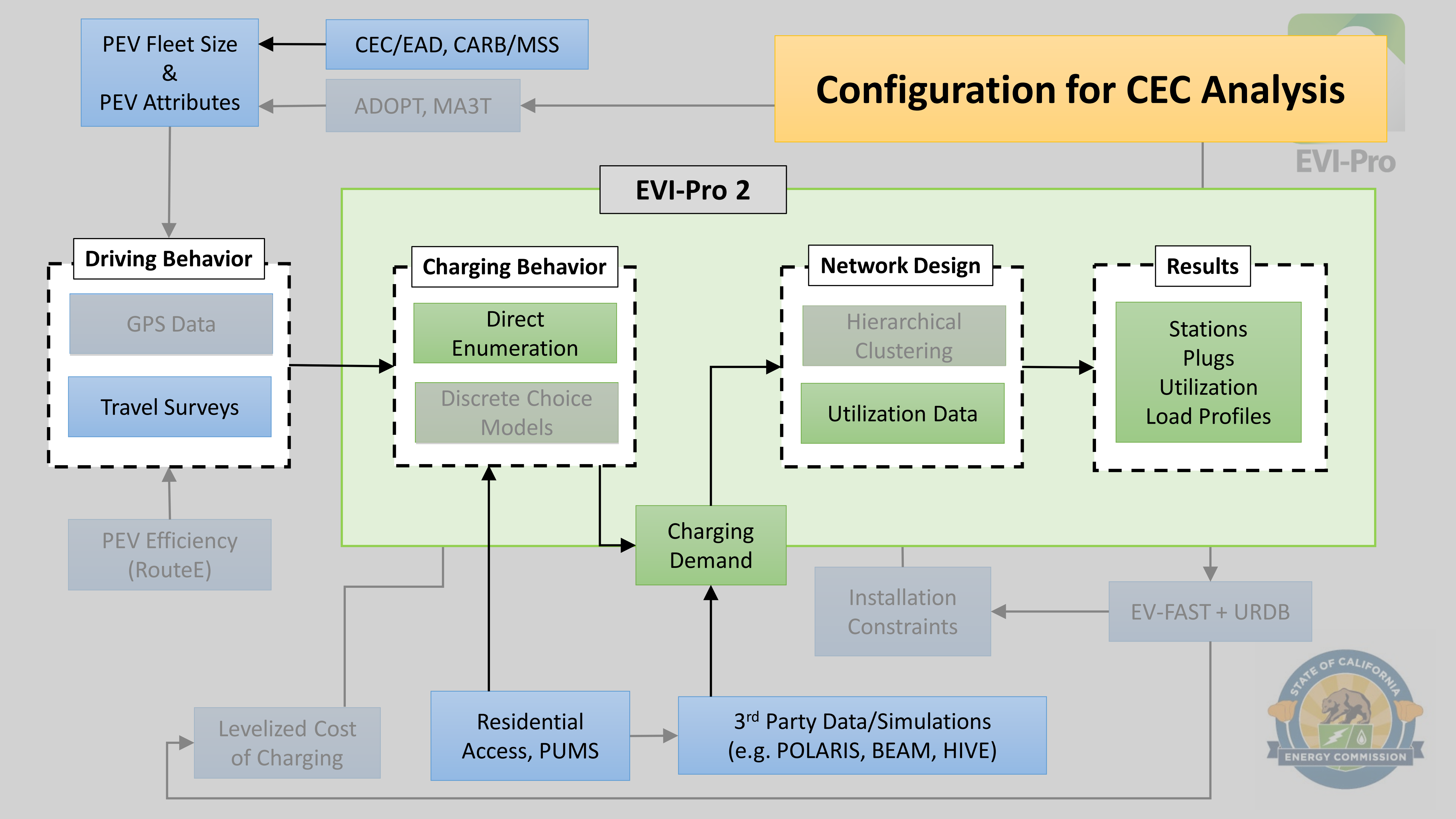
Configuration for CEC Analysis
EVI-Pro
PEV Fleet Size
&
PEV Attributes
CEC/EAD, CARB/MSS
ADOPT, MA3T
EVI-Pro 2
Driving Behavior
GPS Data
Travel Surveys
Charging Behavior
Direct Enumeration
Discrete Choice Models
Network Design
Hierarchical Clustering
Utilization Data
Results
Stations
Plugs
Utilization
Load Profiles
Charging Demand
PEV Efficiency (RouteE)
Installation Constraints
EV-FAST + URDB
Levelized Cost of Charging
Residential Access, PUMS
3rd Party Data/Simulations
(e.g. POLARIS, BEAM, HIVE)
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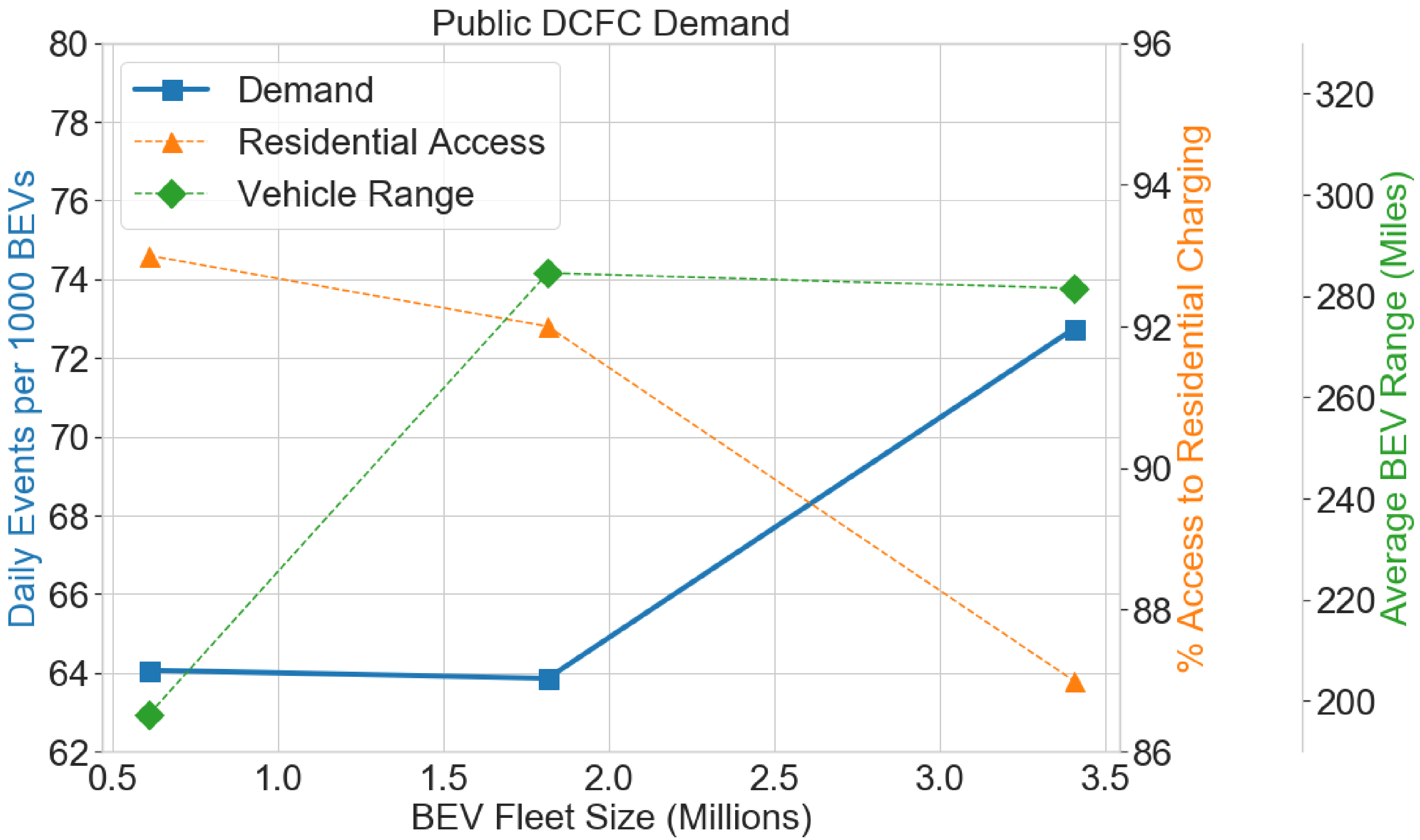
EVI-Pro 2 Simulations

Preliminary values. Subject to review.

Competing factors

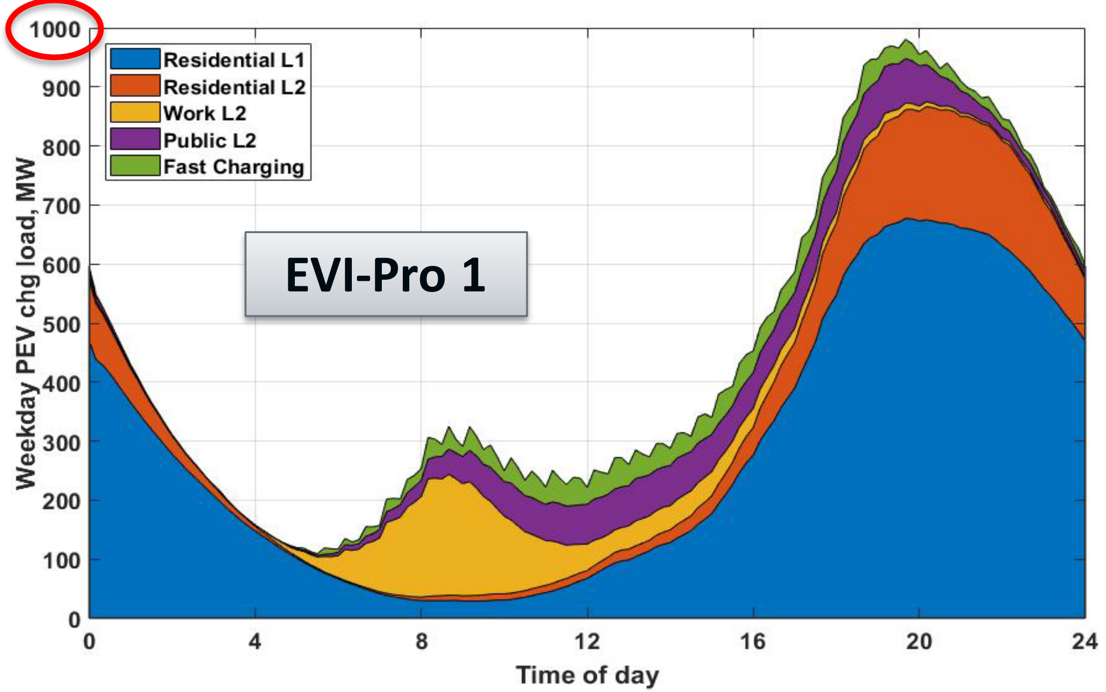
- BEV electric range is forecasted to increase while residential access decreases… how does this impact demand for fast charging?
- EVI-Pro 2 simulations suggest that as the BEV fleet grows, residential charging access drives increased demand for fast charging, despite increases in electric range

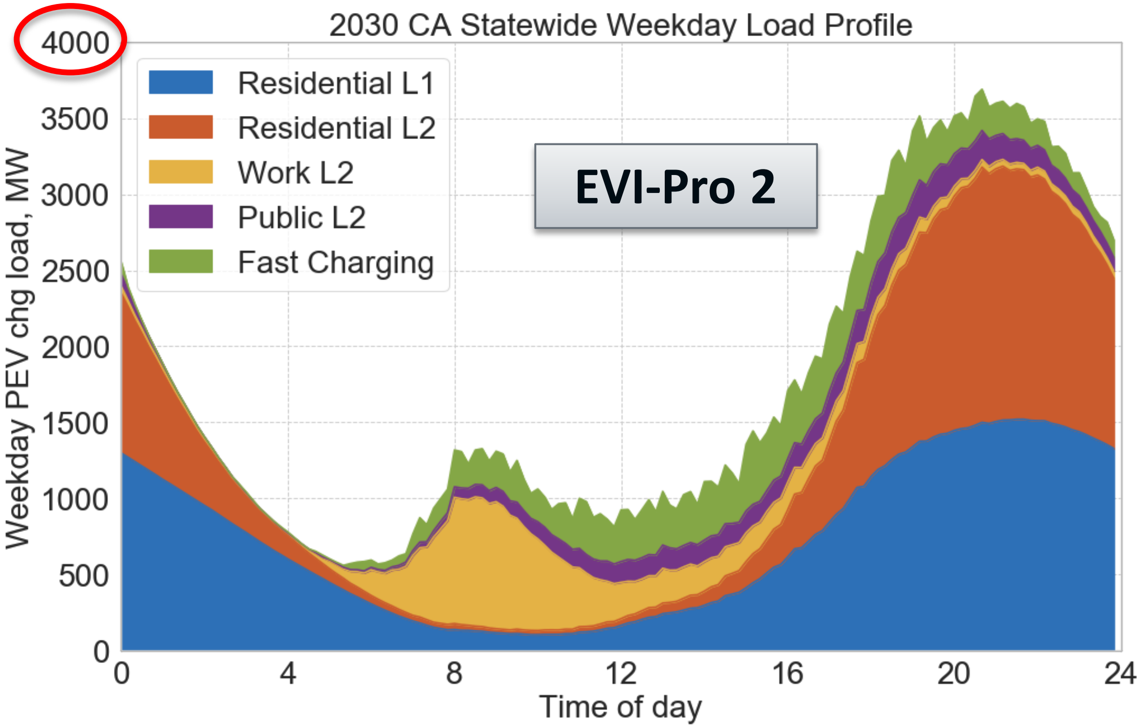


Residential access to be explored further via sensitivity analysis

EVI-Pro 2 Simulations

- While magnitude of simulated load has increased significantly between EVI-Pro 1 and 2, load shape remains relatively consistent
- Fleet projections shifting towards more BEVs elevates significance of:
  - **<u>Home L2</u>** (multi-day charging for those with residential access) and
  - **<u>DCFC</u>** (for those without residential access)
- Note that as of now, no scenarios have been developed to shift load to favorable times of day
  - Plots represent “ASAP” charging
  - Future work will explore load flexibility opportunities





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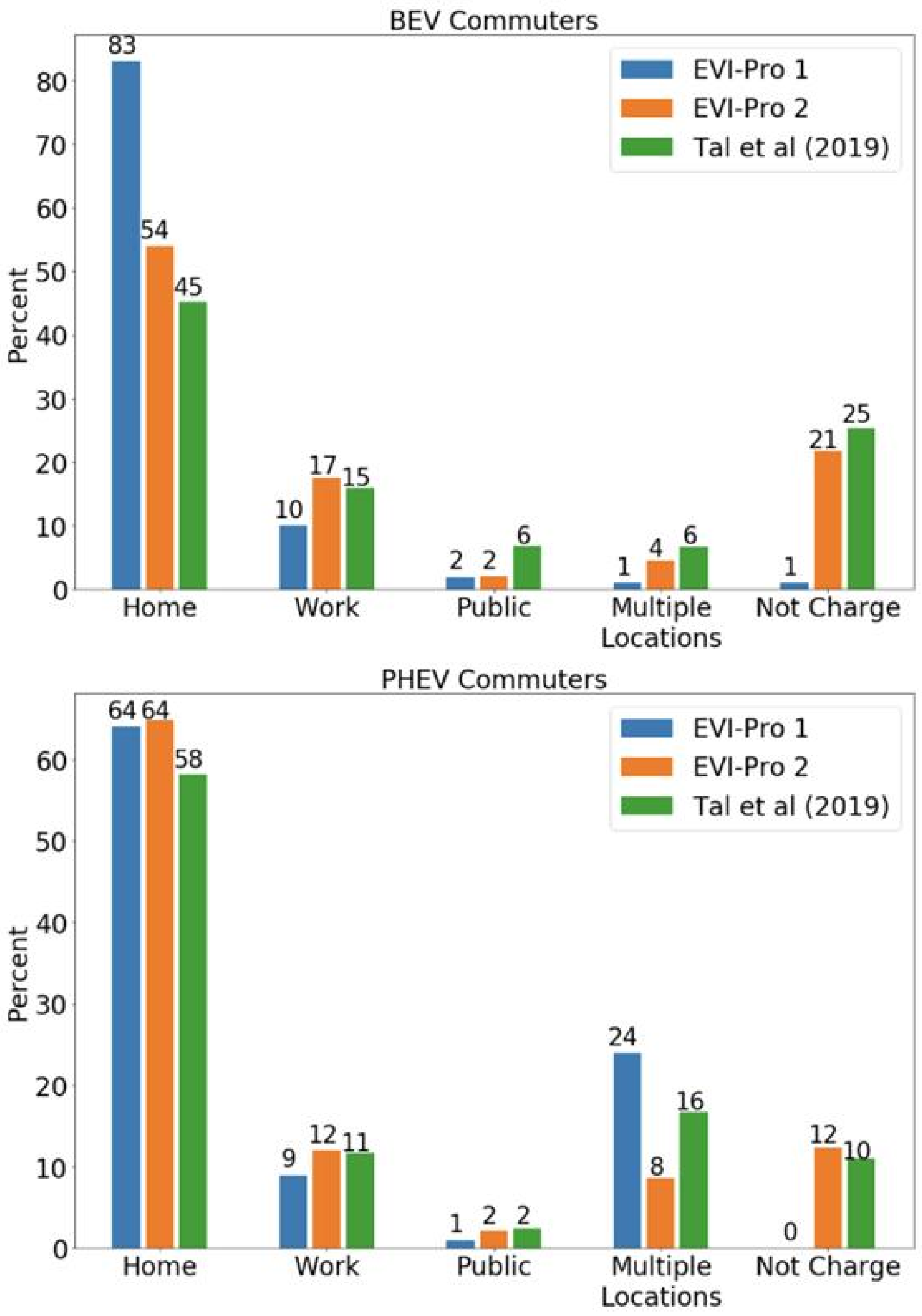

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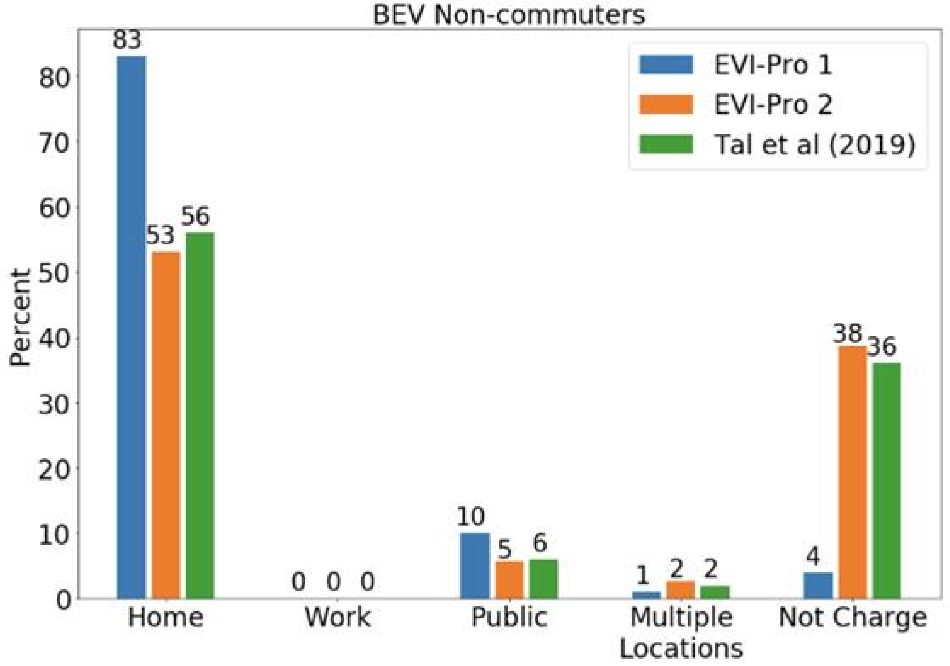

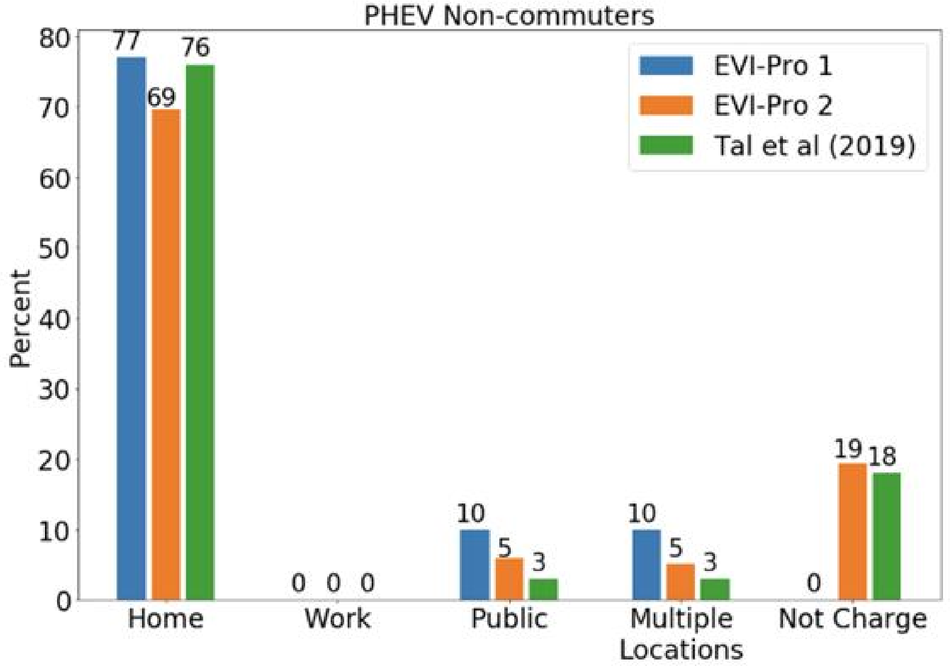

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