



Benchmarking the Costs of Charging Infrastructure and Services



Noel Crisostomo

Fuels and Transportation Division
California Energy Commission

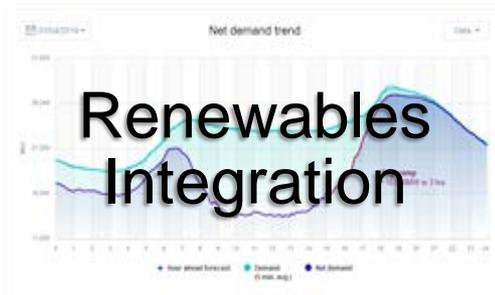
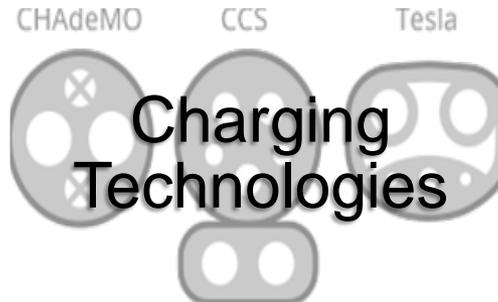
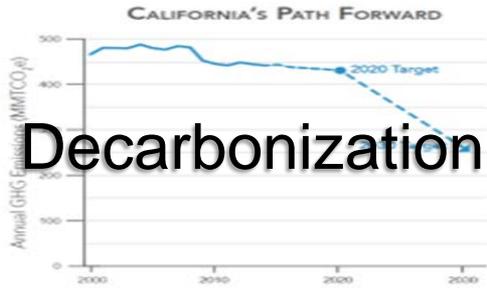
TE Program Evaluation Metrics Workshop
California Public Utilities Commission
May 9, 2019

Outline and Summary

- Goal
 - Identify ways to measure successes from public investment in charging infrastructure for transportation electrification
 - Enable market signals for scaled private sector investment
- Challenges: metrics are subject to uncertainty
 - Location-specific build costs, timing of EV need, charger utilization
 - Systemic changes: innovative charging technologies and models
- A solution: Concept for efficient infrastructure deployment
 - Encourage enablement of charging services, *not just charger counts*
 - How to monitor programs in preparation for scaled need

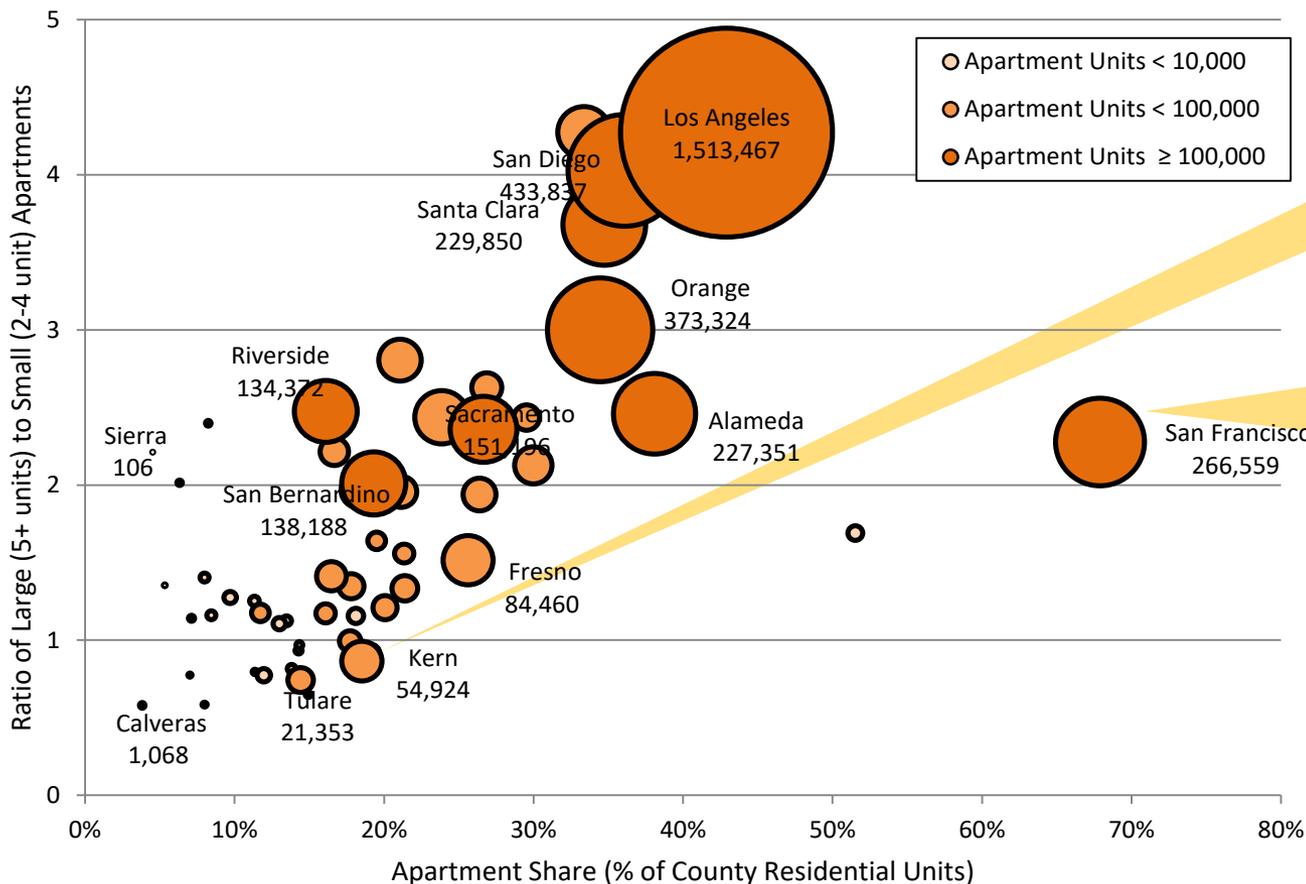


By 2025, CA needs 250,000 EV chargers, including 10,000 DCFCs. Many factors affect demand and cost.



For chargers to be accepted and installed by customers, charging programs must reflect the diversity of the local built environment.

Apartment Units, segmented by Market Size



Kern

- 55k Apartment Units
- 10% small, 9% large
- 19% of all Residential

San Francisco

- 267k Apartment Units
- 47% large, 21% small
- 68% of all Residential

Statewide and utility-class averages do not capture local variation.

New policy, technology, and market-based solutions are needed.



CEC analysis of CA Department of Motor Vehicles and Department of Finance data

The market has not yet grown to support the goal that *any PEV can plug into any EVSE, anywhere, any time.*

Global interoperability requires ...

Interoperability will provide standardized devices that are capable of functioning as intended with each other — without special effort by the user.

Codes & standards are *essential* for:

Interoperable PEVs, EVSE, and communication networks

Sending industry *predictable investment requirements* for them to achieve scale economies

Harmonized Standards & Test Procedures ▶



Key Standards

- > AC L1&L2 charge communication
- > DC communication
- > Interoperability
- > Wireless charging

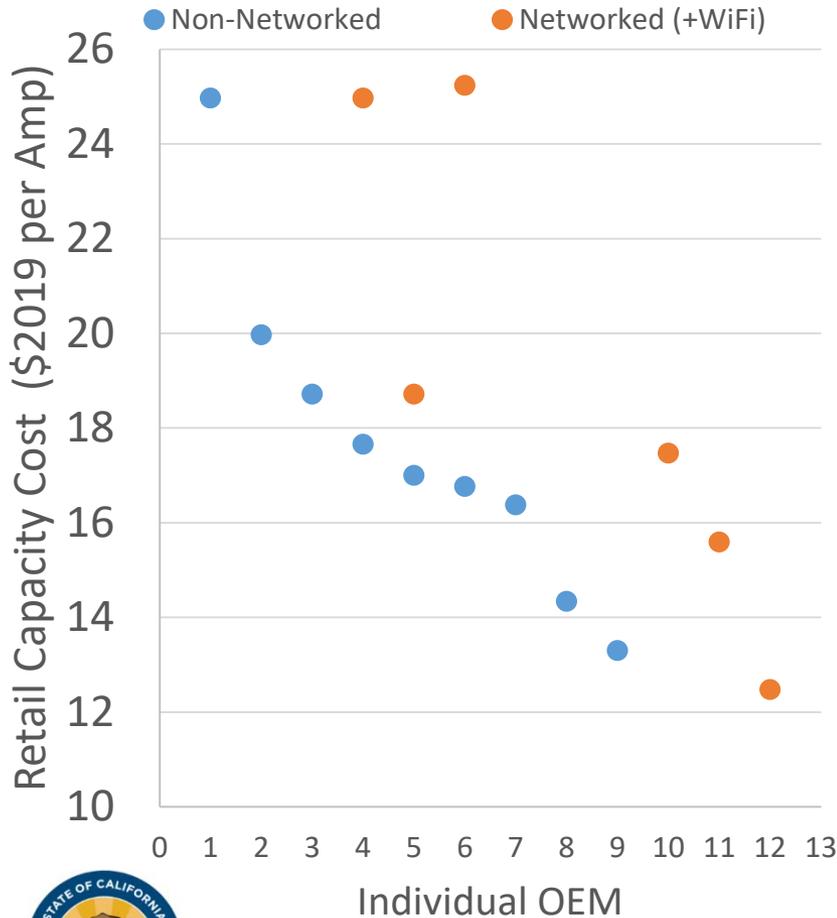
Compatible Enabling Technologies ▶



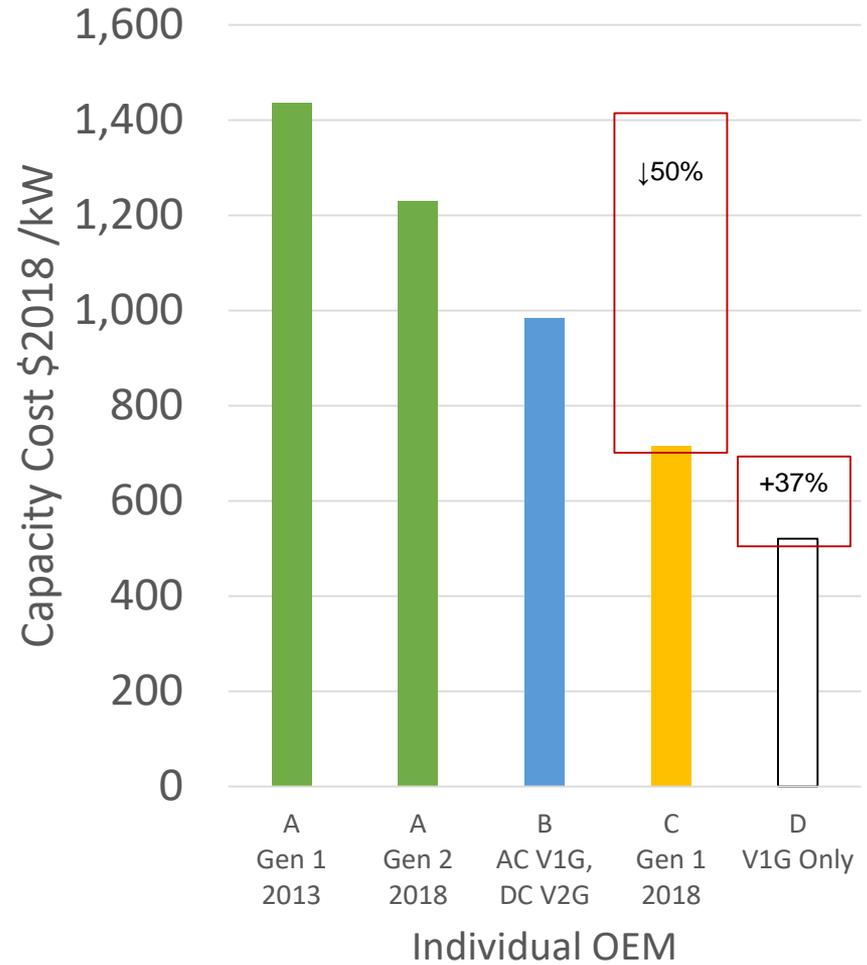
European Commission Joint Research Center / U.S. DOE - Argonne National Lab, EV-Smart Grid Interoperability Centers

Competitiveness and readiness of smart and vehicle-to-grid chargers is improving.

Home Level 2 (30-40A) AC EVSE



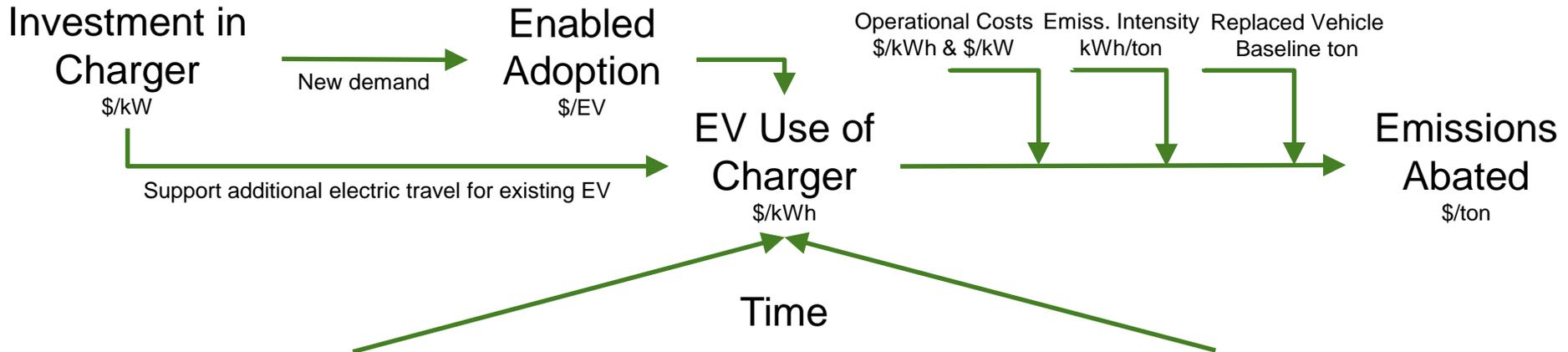
Bidirectional (V2G) DC EVSE



CEC analysis of EVSE product pages, work papers, and OEM interviews.

Investing in capabilities that improve utilization or decrease overall costs is critical to enabling benefits.

P.U. Code 740.12: "programs...shall seek to minimize overall costs and maximize overall benefits"

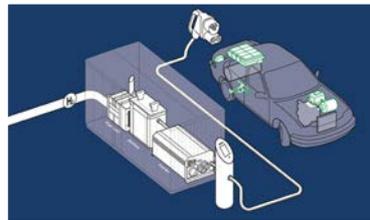
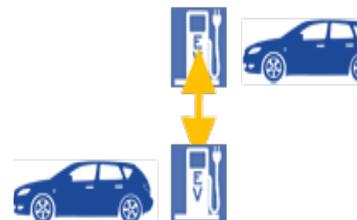


Theoretical Use (100% Load Factor)	Estimated or Measured Use
Simplifies utilization growth likely over time and different types of installations (home, work, public)	Differentiates across types (home, work, public) and access management
Can overstate benefits from residential chargers. E.g. most are currently used by one car a few times/week.	Normalizing benefit potential to projected or actual use encourages business model innovation & interoperability, reducing buildout costs.
Does not adjust for the savings in network capacity from sharing the charging supply (when capacity is not needed coincidentally).	Requires data to segment use across locations (particularly challenging for public and workplace) and geo-temporal analysis.



Note: The above \$/kWh figures do not intend to represent retail charging costs to end-use drivers. Charging services are not subject to regulated pricing, nor does charging function as a commodity due to drivers' schedules, value of time, and subsequent effect on how parking is used.

Given local built conditions, diverse solutions - each with cost and benefit tradeoffs - compete as substitutes.



L→R: DCFC plaza, shared residential, pantograph, wireless, robotic connectors, automated garage, smart adapter, circuit switch, street lamp or utility pole-mount, intra-site storage, inter-site storage, V2G transactive charging, PV/storage-backed, H2 fuel cell-backed, wireless + self-repairing.



How could advanced charging technology and high utilization improve the efficiency of serving 5 PEVs?

Case 1

Case 2

Case 3

Case 4

V1G BEV

V1G BEV

V2G BEV

V2G BEV

One BEV using one \$500 Level 2 EVSE installed for \$1,500 at home: \$2,000



BAU

Dual Port

V2G Off-Grid

V2G + Wireless +
Level 4 Autonomy

Four PHEVs at work

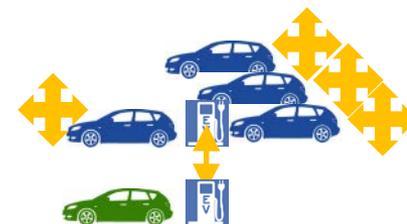
4 PHEVs + 1 BEV orchestrated at work

(4) \$5,000 Level 2s
(4) \$5,000 Upgrade
(4) \$5,000 Install

(2) \$5,000 Level 2s
(2) \$5,000 Upgrade
(2) \$5,000 Install

(1) \$7,000 V2G L2
(2) \$5,000 L2s
(2) \$5,000 Install

(1) \$7,000 V2G L2
(1) \$7,000 Wireless
(1) \$5,000 Install



Total Capital Expenditure (Indexed to Case 1)

\$62,000

\$32,000

\$29,000

\$21,000

1

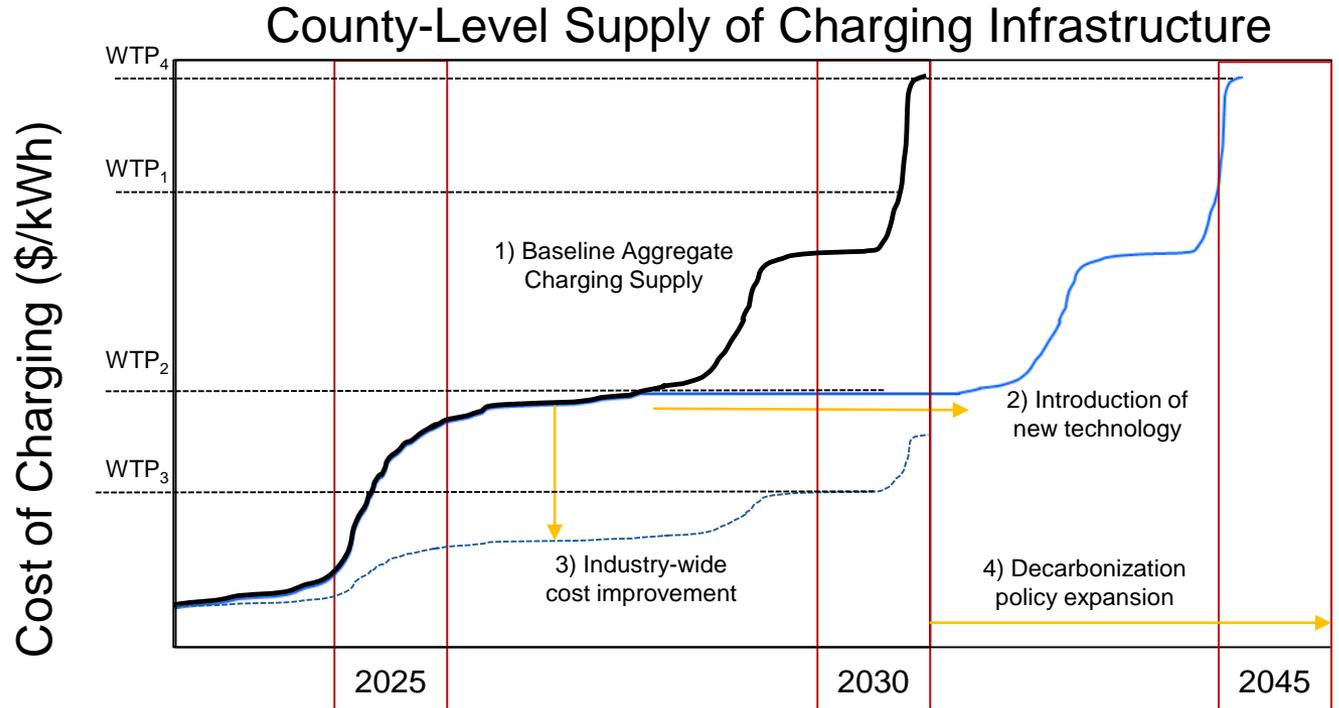
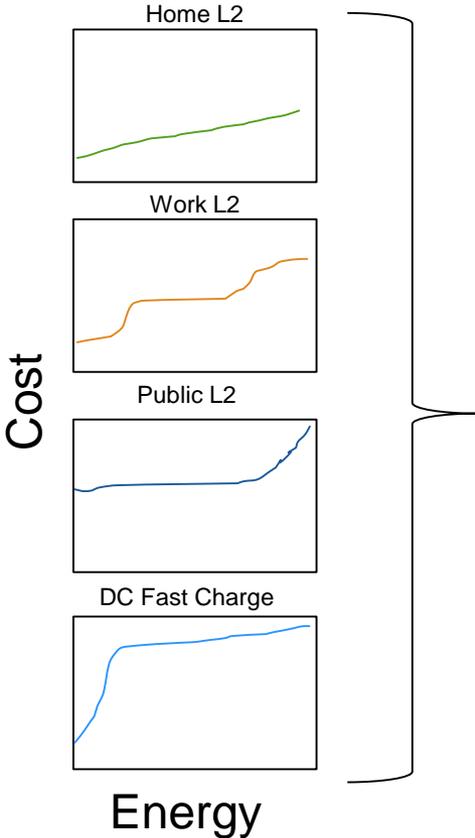
0.52

0.47

0.34

A consistent market signal should enable efficient substitution between types of installations and reflect market and policy changes.

Cost of supplying energy via given charger type



Ranges of Total PEV Charging Needed by Year (kWh)

WTP = Willingness To Pay





For questions, please contact:

Noel Crisostomo

Air Pollution Specialist

Noel.Crisostomo@energy.ca.gov

916-653-8625

Thank you!
