Electric Vehicle Infrastructure: Where, How Many and Why?

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Why do We Need Charging Infrastructure?

- Demand for EVs
- Charging Supply
  1. Home charging
  2. Public charging
- Driving Patterns
- Demand for Charging Infrastructure

Scenario Focus

Policy input / Scenario testing
Terminology

Chargers

<table>
<thead>
<tr>
<th>Type</th>
<th>Cost</th>
<th>Speed</th>
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</thead>
<tbody>
<tr>
<td>L1 = Level 1</td>
<td>$-$$</td>
<td>20 Hours for full charge (Leaf)</td>
</tr>
<tr>
<td>L2 = Level 2</td>
<td>$$</td>
<td>3-8 Hours for full charge</td>
</tr>
<tr>
<td>QC = Quick Charger or DC Fast</td>
<td>$$$</td>
<td>30 Minutes for 80% Charge</td>
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- VMT – Vehicle miles traveled. If 1 car travels 2 miles = 2 VMT
Highlights

• For those with home charging, 60%-80% of travel could be accommodated with no public charging

• Public charging accommodates more travel even as battery sizes increase

• QC would accommodate 10-15% more EV driving
  – Coverage: 100-200 QC locations statewide in the beginning will give good coverage to EV drivers. 1-2 QC per 100 vehicles
  – Capacity: For 1,000,000 vehicles 1000-3000 QC outlets. 1-2 QC per 1000 vehicles

• Workplace charging accommodates 5-7% more EV travel
  – About 70-80% of workplace chargers could be low power level
Our Data Set: Caltrans Travel Survey 2001. 31,898 persons
130 Mile Tour
130 Mile Tour
130 Mile Tour
Demand May Peak at a Location
More Than One Charger per Location

Dublin, CA Location Detail. 30,000 Veh.

Total Events = 40
Point of Diminishing Returns is Reached After 200 QC Locations

60 Miles Range Vehicle - Percent of Miles Enabled by Charging Type

Unserved
3 Charge Events or More
2 Charge Events or Fewer
Home Charging Miles

Public = 41% VMT
Home = 59% VMT

Point of Diminishing Returns is Reached After 200 QC Locations
What Role Can Different Charging Types Play?

- **Home Charging VMT**
  - 60 Mile Veh. = 59%
  - 80 Mile Veh. = 71%
  - 100 Mile Veh. = 79%

- **L1 Work Charging** is sufficient for ~5%

- **L2 Work Charging** is needed for ~2%

- **QC** accommodates up to 10% additional

![Bar Chart](chart.png)

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% of Statewide VMT Enabled by Ch. Type
80 Mile Range Vehicle, 200 QC

- Unserved: 2.7%
- 3 or More Fast Charge Events: 4.2%
- 2 Fast Charge Events: 5.9%
- 1 Fast Charge Event: 5.7%
- Public 6.6kW (L2): 4.8%
- Work 6.6kW (L2): 3.7%
- Work 3.3kW (L2): 2.7%
- Work 1.2kW (L1): 0.7%
More Charger Estimations: 1,000,000 Vehicles. Work L2 Available.

- Example: 19 charges at location per day = 4 chargers at a 5 charge/day threshold

![Graph showing the relationship between the number of charger areas (coverage) and the number of chargers (capacity) for 1,000,000 vehicles. The graph indicates how many chargers will be required based on a threshold in charges per day, with a reduction due to aversion to stopping.]

- Threshold in charges per day:
  - 5 chargers
  - 10 chargers
  - 15 chargers
  - 20 chargers
  - 25 chargers

- Number of charger areas (coverage):
  - 12,000
  - 11,000
  - 10,000
  - 9,000
  - 8,000
  - 7,000
  - 6,000
  - 5,000
  - 4,000
  - 3,000
  - 2,000
  - 1,000
  - 0

- Number of charger (capacity):
  - 1,000,000 vehicles

(Will be reduced based on aversion to stopping)
Final Thoughts

• Charging while parked (L1&L2) at a destination is the most convenient, but we are unlikely to be able to install charging everywhere it is needed.
• Quick charging can “fill the gaps” where L1 and L2 are not available.
• Even with the maximum L2 available at work and other public places, QC enables additional EV travel.
• Actual Customer behavior and preferences need to be studied to make more accurate estimates.