2019 EPRI Electric Transportation

CPUC EV Workshop

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I. What do we know? Quick facts about the US Electric Vehicle market

More than 1.19M EVs on the road in the US

361,000 EVs sold in 2018 (up 81% over 2017 sales; Q4 up 120%)

2018 EV-related annual energy sales: 2.1 TWh (up 35% from 2017)

41 EV models today in the US, anticipated ~130 by 2023 (1/3 SUVs or crossovers)

$300B+ being invested globally by automotive industry

Each EV is about 2,500 kWh each year in additional, largely flexible load

Notes: assumes a conservative 2,500 kWh per EV per year. Actual is closer to 2,800 kWh. See SRP report: Electric Vehicle Driving, Charging, and Load Shape Analysis: A Deep Dive Into Where, When, and How Much Salt River Project (SRP) Electric Vehicle Customers Charge
There are 1.19M EVs on the road in the US (through April 2019)
Cleaner air, decreased GHG, and lower rates via 2.1 TWh (through Dec 2018) from EVs

Notes: assumes a conservative 2,500 kWh per EV per year. Actual is closer to 2,800 kWh. See SRP report:
CA’s EV market share > 8.2% (Feb. 2019)
Top 20 counties by market share

- Napa [8.1%]
- Sonoma [10.1%]
- Marin [16.0%]
- San Francisco [12.4%]
- San Mateo [8.6%]
- Santa Cruz [11.3%]
- Santa Barbara [6.9%]
- Ventura [7.2%]
- Orange [10.2%]
- Yolo [7.6%]
- Solano [6.0%]
- Placer [6.6%]
- El Dorado [7.1%]
- Sacramento [5.8%]
- Contra Costa [11.3%]
- Alameda [11.3%]
- Santa Clara [22.3%]
- Los Angeles [6.7%]
- San Diego [7.6%]

9 counties in CA have EV market shares > 10% and Santa Clara has a EV market share > 22%
Here come the electric crossovers, SUVs, buses, and trucks

Source: Dan Bowermaster, Los Angeles, December 2017; Louisville 2016, Rob Schurhoff New York 2019
Customer choice increasing with ~130 EVs on market by 2023
Average BEV driving range increasing to 264 miles
The bulk of EV charging will be done at home and work (AC). Public charging is largely DC fast charging.

**Public (DC) charging (~5-10%) – SRP, 2018 3%**
- Necessary for adoption
- Four challenges:
  1. Separate networks
  2. Different plugs
  3. Infrastructure costs, rates, utilization
  4. Increasing power levels

**Workplace charging (~15%) – SRP, 2018 16%**
- Extends electric range of PHEVs, short-range BEVs
- Minimal distribution grid impacts
- One plug
- Challenges with parking and accessibility

**Home charging (75-80%) – SRP, 2018 81%**
- Many customers charge at 120V AC or use an existing 240V dryer outlet
- Minimal distribution grid impacts
- Existing infrastructure companies serve this market
- Opportunities for TOU rates, smart charging, and further customer study
- ~2,800 kWh/residential EV/year

The EPRI Charging pyramid, M. Duvall, EPRI, circa 2007

Public DC fast charging infrastructure increasing across California
Utilities are proposing ~$3.7B in EV charging infrastructure

<table>
<thead>
<tr>
<th>utility</th>
<th>Make-ready / rebate</th>
<th>Utility-owned</th>
<th>Hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hawaiian Electric</td>
<td>$1.2M (0/12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seattle City Light</td>
<td>$2.8M (0/2)</td>
<td></td>
<td></td>
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<tr>
<td>AVISTA</td>
<td>$4.2M (245/5)</td>
<td></td>
<td></td>
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<tr>
<td>PUGET SOUND ENERGY</td>
<td>$2.5M (~5,000/0)</td>
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</tr>
<tr>
<td>PGE</td>
<td>$3.4M</td>
<td></td>
<td></td>
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<tr>
<td>PACIFIC POWER</td>
<td>$4.6M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDG</td>
<td>$130M $253M $22M $573M $760M $45M $244M $15M $10.2M $10M $13M $10M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend [Budget $ (L2/DCFC)]
- Make-ready / rebate
- Utility-owned
- Hybrid

Key Challenges
- EV awareness
- Customer education
- Easy and reliable public charging infrastructure (to find, access, use, and pay)
II. Five principle cost tests used in energy efficiency
How do they apply to Electric Transportation?

<table>
<thead>
<tr>
<th>Test</th>
<th>Acronym</th>
<th>Key Question Answered</th>
<th>Summary Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant cost test</td>
<td>PCT</td>
<td>Will the participants benefit over the measure life?</td>
<td>Comparison of costs and benefits of the customer installing the measure</td>
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<tr>
<td>Program administrator cost test</td>
<td>PACT</td>
<td>Will utility bills increase?</td>
<td>Comparison of program administrator costs to supply-side resource costs</td>
</tr>
<tr>
<td>Ratepayer impact measure</td>
<td>RIM</td>
<td>Will utility rates increase?</td>
<td>Comparison of administrator costs and utility bill reductions to supply-side resource costs</td>
</tr>
<tr>
<td>Total resource cost test</td>
<td>TRC</td>
<td>Will the total costs of energy in the utility service territory decrease?</td>
<td>Comparison of program administrator and customer costs to utility resource savings</td>
</tr>
<tr>
<td>Societal cost test</td>
<td>SCT</td>
<td>Is the utility, state, or nation better off as a whole?</td>
<td>Comparison of society’s costs of energy efficiency to resource savings and non-cash costs and benefits</td>
</tr>
</tbody>
</table>

TRC Example – Is EV Charging Infrastructure Good or Bad for Ratepayers?

The larger this box is, the more the program’s benefits outweigh the costs.

Source: The Value of Transportation Electrification: Three Preliminary Case Studies of Impacts on Utility Stakeholders
Adoption - What does it take for a customer to buy an EV?

- Automotive OEMs need to design, build, and market EVs
- Dealers need to stock and market EVs
- Customers need to be aware of, consider, and be able to buy EVs
  - Does it meet my needs?
  - Do I like it?
  - Can I afford it today?
  - How do I fuel it?

Of the top 25 best-selling cars, only one has a plug-in option today
Workplace charging as a market enabler
How to scale EV charging infrastructure at lowest possible cost?
What else have we seen so far?
Key research observations on valuing utility actions, including EV charging infrastructure

1. Numerous factors affect the overall cost/benefit comparison for utility EV programs
2. Decreasing battery costs and gasoline prices have a large impact in addition to being highly variable
3. Potentially significant ratepayer benefits across the country, but more detailed analysis based on local market data required
4. In thinking about utility program design, the main difficulties are estimating the effect of utility programs on the market
5. It is also difficult to estimate the magnitude of social costs and benefits especially in markets without supporting policies
6. Traditional approaches to regulatory justification may not capture the value of EVs

Correlation does not mean causation
III. Key Questions for EV charging infrastructure and utility actions

Actions range from basic customer education, to facilitating easy, seamless grid connection, to rate-basing infrastructure deployment

1. What is the optimal long-term approach to deploying and operating EV charging infrastructure?
2. Transportation electrification could represent a net benefit to all utility customers. How is this calculated?
3. How can utilities’ work that speeds up the EV market and amplifies these benefits be measured?
4. How can safety and reliability be ensured for all customers, especially for EV drivers outside of metro areas?
5. What lessons were learned from previous electrification efforts?
Looking ahead to 2040
Numerous key questions remain

- What will the transportation market of 2040 look like?
- What is the utility's role in transportation in 2040?
  - Education? Fueling? Infrastructure?
- Will individual car ownership be the prevailing model?
- How much will individual EVs comprise the market?
- What will the impact of autonomous EVs be?
- Will buses evolve into smaller electric shuttles?
- What about last-mile technologies such as scooters?
- How will these electric vehicles of all sizes fuel?
- How can utilities speed up this transition?
Together...Shaping the Future of Electricity