Charging Infrastructure: What, Where, and How Many?

• Moderator:
  • Miles Muller, Clean Energy Legal Fellow, NRDC

• Speakers:
  • Zachary Owens, Program Manager, Transportation Fuels and Technology, Colorado Energy Office
  • Annie Schneider, Program Specialist, Utah Governor’s Office of Energy Development
  • Matt Nelson, Director of Government Affairs, Electrify America
  • Matteo Muratori, Ph.D., Engineer, Integrated Transportation and Energy Systems, NREL
Charging Infrastructure: What, Where, and How Many?

Zachary Owens, Program Manager, Transportation Fuels and Technology, Colorado Energy Office
Electric Vehicle (EV) Charging
In Colorado

Zach Owens, Program Manager
Transportation Fuels and Technology
NGA Western EV Workshop
April 4, 2019
Charge Ahead Colorado
Charge Ahead Colorado

- Eligible applicants include local governments, school districts, State agencies, and non-profits.
- Apartment/condo complexes and private businesses are also eligible. Workplace and multi-family locations are a priority!

<table>
<thead>
<tr>
<th>Charge Ahead Colorado</th>
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</thead>
<tbody>
<tr>
<td><strong>Funding Source</strong></td>
</tr>
<tr>
<td>RAQC</td>
</tr>
<tr>
<td>Federal Highway Admin - CMAQ and Volkswagen settlement</td>
</tr>
<tr>
<td>CEO</td>
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<tr>
<td>EV Fund and Volkswagen settlement</td>
</tr>
<tr>
<td><strong>Geographic Area</strong></td>
</tr>
<tr>
<td>7 County Denver Metro Area</td>
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<tr>
<td>Outside the 7 County Denver Metro Area</td>
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<tr>
<td><strong>Eligible Equipment</strong></td>
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<tr>
<td>Level 2, DC fast-chargers, Electric Vehicles</td>
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<tr>
<td>Level 2 and DC fast-chargers</td>
</tr>
<tr>
<td><strong>Funding Level</strong></td>
</tr>
<tr>
<td>80% up to:</td>
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<tr>
<td>Level 2</td>
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<tr>
<td>DC Fast-Chargers</td>
</tr>
<tr>
<td>EV</td>
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<tr>
<td>Level 2</td>
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<tr>
<td>DC Fast-Chargers</td>
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<tr>
<td>$9,000</td>
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<tr>
<td>$30,000</td>
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<tr>
<td>$8,260</td>
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<tr>
<td>$9,000</td>
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<td>$30,000</td>
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Ribbon cutting for the new level 2 charging station @pueblolibrary Pueblo West Library. Thanks to our partners @SanIsabelElec @PuebloCounty @PuebloWestMetro @COEnergyOffice @natlcarcharging
Electrifying Our Highway Corridors
Colorado DC Fast-Charging Corridors

• $10.3 million award made to ChargePoint to build 33 DCFC across six corridors

• 2-4 chargers at each site; capable of providing at least 50 kW and up to 150 kW charging

• Statewide network ensures a consistent driver experience at every station

• Committed site hosts: retail, grocery, c-stores, and local governments

• State-of-the-art modular technology allows for expansion
Regional Electric Vehicle West
Colorado Electric Vehicle Plan
Station Needs

- **Medium Scenario**: 204 stations (817 fast-charging ports)
- **High Scenario**: 632 stations (2,530 ports)
Future Needs in Denver in 2025:
1,133 workplace; 1,287 Public L2; 176 DCFC
Charging Infrastructure: What, Where, and How Many?

Annie Schneider, Program Specialist, Utah Governor’s Office of Energy Development

#WeTheStates
Mission

Advance Utah’s energy and minerals economies for the provision of affordable, reliable, and sustainable outcomes that provide significant and lasting value to the state.
State EV Data

- BEV total: 4,258
- ~3.45% of U.S. light duty advanced technology vehicle market share (FCEV, BEV, PHEV, HEV)
- L2 chargers: 144
- DC fast chargers: 24

Utah EV Programs

- Rocky Mountain Power West Smart grant
  - Corridor chargers, many partners
- Volkswagen (VW) Settlement
  - $35,177,506
- State EV Working Group
- 8 State Memorandum of Understanding (MOU)
Charging Infrastructure: What, Where, and How Many?

Matt Nelson, Director of Government Affairs, Electrify America

#WeTheStates
Seattle Transportation Electrification Workshop
National Governors Association
April 4, 2019
Our transformational opportunity: the largest single investment ever made in infrastructure, education and awareness, and access to drive ZEV adoption

<table>
<thead>
<tr>
<th>Our Mission</th>
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<tbody>
<tr>
<td>Electrify America will be a catalyst for promoting ZEV adoption by offering transformative, customer-centric infrastructure and energy management solutions.</td>
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<thead>
<tr>
<th>Our Company</th>
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<tr>
<td>Electrify America is a subsidiary of Volkswagen Group of America created to implement the $2 billion ZEV Investment Commitment. We have recruited talent from across diverse industries.</td>
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<tr>
<th>Our Approach</th>
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<tr>
<td>Electrify America is a data-driven company committed to increasing the use of ZEV technology.</td>
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</table>
Cycle 1 investment will create a robust DC charging network linking U.S. highways and major metropolitan areas

- 42 states
- 17 large metros
- 86 metros*
- 484 stations
- 2000+ DCFC
- 2800+ Level 2s

**Station spacing:**
- Average: 70 miles*
- Maximum: 120 miles

**Chargers per site:**
- Average: 5
- Minimum: 4 Maximum: 10

**Charging speed**
- 3 to 20 miles per minute

* Highway sites in MSAs with more than 500,000 population

*48 miles in California
Network expansion will concentrate in 29 markets through 2021
Challenges to investment persist

1. **Permitting Delays**

   Current construction bottlenecks in many areas of the country, especially California, are due to lengthy permitting durations.

2. **Lack of ZEV Vehicles and Users**

   The higher purchase cost of EVs and lack of charging stations associated remain barriers to wider ZEV adoption.

3. **Need for Education & Awareness Efforts**

   Focused investment to raise consumer education and awareness is needed by all sectors to educate and encourage ZEV adoption.

4. **ZEV Consideration Remains Low**

   The higher purchase cost of EVs and lack of charging stations associated remain barriers to wider ZEV adoption.

   - Data for 2014 and 2017 shows:
     - **Haven’t; won’t**
     - **Haven’t; maybe some day**
     - **Idea occurred; no steps taken**
     - **Info gathered; not serious**
     - **Actively shopped**
     - **Already own; lease**

   - Graph indicates a persistent need for investment and education.
States and cities can create policy environments to encourage ZEV adoption and investment

Analysis by NASEO and Cadmus found sending a long-term signal to the market and reducing upfront costs were the most powerful policy tools to drive ZEV adoption.

PEV Policy Evaluation Rubric: [https://naseo.org/Data/Sites/1/pevpolicyrubricmethodology_naseo.pdf](https://naseo.org/Data/Sites/1/pevpolicyrubricmethodology_naseo.pdf)
We look forward to continued collaboration to drive ZEV adoption

Thank you
Charging Infrastructure: What, Where, and How Many?

Matteo Muratori, Ph.D., Engineer, Integrated Transportation and Energy Systems, NREL

#WeTheStates
National Renewable Energy Laboratory (NREL)

Spearheads transportation research, development, and deployment to accelerate the widespread adoption of high-performance, low-emission, energy-efficient passenger and freight vehicles.

✓ **Infrastructure** to support vehicle electrification
EV Charging Requirements

While the majority of plug-in electric vehicle (PEV) charging is expected to come from residential plugs, a network of non-residential chargers is required to:

- Support adopters that cannot charge at home
- Enable long-distance travel
- Cope with range anxiety (safety net)

Infrastructure plays a big role in enabling and supporting EV adoption

NREL’s EVI-Pro

NREL, in collaboration with California Energy Commission, developed the Electric Vehicle Infrastructure Projection (EVI-Pro) tool to simulate charging behavior and estimates charging requirements and charging load profiles to support PEV adoption, including interstate corridors.

EVI-Pro Lite

A free simplified online version of EVI-Pro to assist state and local governments and make insights from recent studies accessible to public and private organizations investing in PEV charging infrastructure.

Your Results

In Colorado, to support 250,000 plug-in electric vehicles you would need:

- **5,590** Workplace Level 2 Charging Plugs
- **3,693** Public Level 2 Charging Plugs
- **550** Public DC Fast Charging Plugs

Where Do I Start?

Planners may want to prioritize installation of fast charging infrastructure above Level 2 charging.

**Build DC Fast First:** Establishing fast charging networks that enable long-distance travel, serve as charging safety nets, and provide charging for drivers without home charging is critical to support all-electric vehicles that have no other alternative for quickly extending their driving range.

**Build Level 2 Second:** EVI-Pro typically simulates the majority of Level 2 charging demand coming from plug-in hybrid electric vehicles, which have the ability to use gasoline as necessary for quickly extending driving range.

Change Assumptions

- Plug-in Electric Vehicles (as of 2016): 8,600
- Light Duty Vehicles (as of 2016): 4,974,900
- Number of vehicles to support: 250,000

<table>
<thead>
<tr>
<th>Vehicle Mix</th>
<th>Plug-in Hybrids 20-mile electric range</th>
<th>15%</th>
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<tbody>
<tr>
<td></td>
<td>Plug-in Hybrids 50-mile electric range</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td>All-Electric Vehicles 100-mile electric range</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>All-Electric Vehicles 250-mile electric range</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>100%</td>
</tr>
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</table>

How much support do you want to provide for plug-in hybrid electric vehicles (PHEVs)?

- **Full Support**
  - Most PHEV drivers wouldn’t need to use gasoline on a typical day.

- **Partial Support**
  - Calculate using half of full support assumption.

- **Do not count**
  - PHEVs in charging demand estimates.

**Percent of drivers with access to home charging:** 100%
Mitigate DC Fast Charging Cost

Cost of fast charging can be high, due to **low utilization & demand charges**

**Technology solutions** can be used to reduce cost, including batteries and PV

Impact on Power Systems

PEV charging can have significant impact on power systems and provide opportunities for optimizing integrated systems (e.g., “smart” charging).

Charging infrastructure determines charging options and impacts PEV loads.
Thanks!

Looking forward to the panel discussion

Matteo.Muratori@NREL.gov
NREL’s EVI-Pro

The Electric Vehicle Infrastructure Projection (EVI-Pro) tool developed in collaboration with California energy commission estimates PEV charging requirements and charging load profiles.

**Foundational Assumptions**
- Future PEVs will be driven in a manner consistent with today’s gasoline vehicles
- Consumers prefer to perform the majority of charging at their home location
- Charging at non-residential stations will be used to maximize eVMT
Consumers demand for PEV charging is coverage-based:

“Need access to charging anywhere their travels lead them”

Infrastructure providers make capacity-driven investments:

“Increase supply of stations proportional to utilization”

A “utilization gap” persists in a low vehicle density environment making it difficult to justify investment in new stations when existing stations are poorly utilized (aka: chicken & egg)

We quantify non-residential PEV charging requirements necessary to meet consumer coverage expectations (independent of PEV adoption level) and capacity necessary to meet consumer demand in high PEV adoption scenarios
L1 Vs. L2 Charging

With 12% of the population of the United States, California has 24% of the public PEV charging stations and 30% of the outlets for charging PEVs.

159 BEV owners and 156 PHEV owners responded to questions in the 2016 California Vehicle Survey about where and when they charged their vehicles on a typical weekday:

**Typical Weekday Charging**

<table>
<thead>
<tr>
<th>Location</th>
<th>BEV</th>
<th>PHEV</th>
</tr>
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<tbody>
<tr>
<td>Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td></td>
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</tbody>
</table>

**Home Charging**

<table>
<thead>
<tr>
<th>Level</th>
<th>BEV</th>
<th>PHEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td></td>
<td></td>
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<tr>
<td>Level 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
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<td></td>
</tr>
<tr>
<td>Unknown</td>
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Share of Respondents
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