Factors Driving Community-Based EV Infrastructure Requirements: Lessons from Modeling Efforts

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Mid-Atlantic Electric Vehicle Charging Infrastructure Summit
Major U.S. National Laboratories

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Plug-In Electric Vehicle (PEV) Charging Analysis – NREL Objective

Inform regional/national stakeholders on plug-in electric vehicle (PEV) charging infrastructure, focusing on non-residential applications to:

- Reduce range anxiety as a barrier to increased PEV sales
- Enhance charging options to maximize electric miles traveled and enable greater PEV adoption
- Ensure effective use of private/public infrastructure investments

Some key questions related to investment in PEV charging stations...

Recent Studies

California (2014)
Seattle, WA (2015)
Massachusetts (2017)
Colorado (2017)
Columbus, OH (2017)
National PEV Infrastructure Analysis (2017)
Maryland (2018)
Columbus Yellow Cab (April 2019)
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

**PEV**: Plug-in Electric Vehicle  
**eVMT**: Electric Vehicle Miles Traveled  
**EVSE**: Electric Vehicle Supply Equipment

Developed through collaboration with the California Energy Commission and support from the U.S. Department of Energy’s Vehicle Technologies Office.
DCFC is Not Exclusively a Corridor Problem

NREL analysis estimating infrastructure requirements at the national level

- EVI-Pro utilized to produce community-based requirements
- Corridor analysis used to estimate requirements to support long-distance travel

Substantially more direct current fast charge (DCFC) stations needed in communities than along highways!
Multivariable Problem – More Than Just Fleet Size!

Community-level sensitivities from the National Plug-In Electric Vehicle Infrastructure Analysis

PHEV: Plug-in Hybrid Electric Vehicle
BEV: Battery Electric Vehicle
Strong Demand Shown for Workplace Charging

Demand shown for nearly **twice** as many workplace chargers as public chargers.
EV Load is Highly Flexible

- Projected charging sessions used to inform EVSE counts also aggregated into load profiles
- Uncoordinated charging produces undesirable peaks!

High flexibility demonstrated in response to dynamic pricing, even while travel constraints are enforced!
Future Research

Model improvements planned to support more realistic charging behavior and corridor modeling

Clustering improvements of charge events for community-based DCFC station siting

Explicit corridor modeling for DCFC station siting using travel data

EVI-Pro primarily utilized to estimate infrastructure requirements to support personal travel

- Increasing penetration of ride-hailing vehicles
- Stated goals by communities & mobility companies to electrify ride-hailing vehicles
- Additional infrastructure will be needed to support these services!

Governor Signs Senator Skinner’s Electrify California Ride-hailing (E-CAr) Bill

Lyft sets goal of 1 billion autonomous electric rides per year by 2025

Uber’s plan to get more electric cars on the road

The ride-hailing giant will work with seven cities to increase EV adoption and add more charging stations.
Future Work, HIVE: Agent Based Electric Vehicle Modeling

**Fleet level:** quality of service, congestion impacts, prevalence of empty miles, aggregate power demand, fleet sizing, pooling opportunities & limitations

**Vehicle level:** miles traveled, component sizing tradeoffs, battery lifetime analysis

**Station level:** station utilization, economics, fully resolved load profiles, pricing impacts
Thanks! Questions?

This work was funded by the US Department of Energy Vehicle Technologies Office.
### Driving/Charging Simulations

<table>
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<tr>
<th>Destination</th>
<th>Departure</th>
<th>Arrival</th>
<th>Drive Miles</th>
<th>Dwell Hours</th>
<th>Simulated Charging</th>
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**Simulated charging behavior for a BEV100 under an example travel day**

**Bottom-up simulations** based on travel behavior are used to produce a variety of charging scenarios. **Optimal charging behavior** is assumed to investigate spatial and temporal charging demand and to estimate:

- non-residential infrastructure requirements
- aggregate load profiles
GPS Travel Data