Electric Vehicle Fast Charging in Michigan Communities: EV Charging Placement Optimization

7109 W. Saginaw Hwy
Lansing, MI 48917

December 19, 2018
8:00 AM – 12:00 PM
Agenda

• Welcome & Introductions
• Background
• EV Charger Placement Optimization in Michigan
• Next Steps
• Questions
Electric Vehicle - Terminology

**Plug-in Hybrid EV (PHEV)** – Powered by internal combustion engine and electricity from external power source

**Hybrid (HEV)** – Powered by ICE and alternator or regenerative braking

**Battery EV (BEV)** – Powered 100% by electricity from an external power source

Three common EV charging levels:\(^1\)

- **Level 1 (AC):** 2 – 5 miles of range per 1 hour of charge
- **Level 2 (AC):** 10 – 20 miles of range per 1 hour of charge
- **DC Fast Charging:** 60 – 80 miles of range or more per 20 minutes of charge

---

Electric Vehicles - Markets

EV sales increased substantially in recent years. In 2017, compared to 2016, new EV sales increased by:²

- World 54%
- U.S. 31%⁶
- Michigan 11%⁶

EV sales projected to increase globally and in electric vehicle sales projected.²

- In 2030: 125 – 220 million light duty electric vehicles
- In 2017: Over 1 million EVs globally

More EV makes and models will be available.

- Ford will launch 40 new EVs by 2022.³
- GM will have 20 new zero emissions vehicles launched by 2023.⁴
- Toyota will have all Toyota and Lexus models available as dedicated EV/electrified option by 2025⁵
Electric Vehicles - Benefits

Can improve public health and reduce ecological damage

- BEVs have zero tailpipe emissions
  - The cleaner electricity production, the greater the public health and ecological benefit from driving EVs
- Average EV in US produces less emissions than a gas car with 26 mpg (MI: 38 mpg equivalent).\(^6\)
  - Conventional vehicles contribute 83% of emissions in transportation sector.\(^7\)

Diversifies transportation fuel and reliance on foreign energy sources.\(^8\)

- U.S. electricity largely produced from domestic sources
Electric Vehicles – Motivation for Adoption

• Michigan autonomous vehicle legislation (PA 332 of 2016)
• Council on Future Mobility support for EVs and autonomous vehicles.
• Light Duty Zero Emissions Equipment Supply Program
• DTE’s EV rate filing with the MPSC
• Consumers Energy EV filing with the MPSC
• Michigan Electric Cooperative Association Membership support
• Michigan Municipal League interest
Electric Vehicles – Infrastructure

Currently, limited EV makes and models with high costs

Michigan has limited charging infrastructure.\(^9\)

- <2% of US DC Fast Charger ports
- 2.2% of US Level 2 ports

Michigan ranks 4th in U.S. for plug-in EV sales, but 25th for battery EV sales.\(^9\)

- 15.4 EVs sold/L2 port vs. 15.2 BEVs sold/DC fast charger port

Data suggests increased charging events in the future.
Electric Vehicles – Planning for the Future

Michigan Energy Office initiated steps towards developing an effective DC fast charging network ensuring worry-free EV travel through Michigan by 2030.

• Develop bare-bones system
• Provide complete connectivity
## Multi-Phase Project for EV Charger Placement.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase I:</strong> Intercity EV Trips (Highways)</td>
<td>December 2018</td>
</tr>
<tr>
<td>• Phase 1 Supplements</td>
<td>Spring 2019</td>
</tr>
<tr>
<td>• Full Tourism Analysis</td>
<td></td>
</tr>
<tr>
<td>• Economic Impacts Analysis</td>
<td></td>
</tr>
<tr>
<td><strong>Phase II:</strong> Urban EV Trips (Select Cities)</td>
<td>Fall 2019</td>
</tr>
</tbody>
</table>
Stakeholder Input is Vital

Allowed adaptation of optimization model to Michigan and to reflect Michigan specific needs.

Phase 1 inputs informed by stakeholders include:

- EV ranges (battery sizes assumed),
- EV market share penetration,
- DC fast charger power and costs,
- Electricity provision costs,
- Battery performance in winter, and
- Intercity traffic demand and seasonal variation.

Community stakeholder input is vital to Phase 2.
Electric Vehicle Charger Placement Optimization Project: Phase 1 & 2

December 19, 2018

Dr. Mehrnaz Ghamami
Dr. Ali Zockaie
Dr. Steven Miller
Acknowledgement

This study is commissioned and funded by the Michigan Energy Office.

[MI Energy logo]
Problem Statement

Find the optimal DC fast charging infrastructure investment to support electric vehicle travel in Michigan to ensure travel continuity:

• **Where** to deploy charging stations?
• **How many** charging outlets must be built at each station?
• **What** is the approximate investment cost?

Phase I- Intercity EV Trips (Highways)
Phase II- Urban EV Trips (Select Cities)
Phase 1: High & Low-Tech Scenarios Analyzed.

Two technology scenarios analyzed for 2020, 2025, & 2030:

- **Low-Tech**: 70 kWh battery with 50 kW charger
- **High-Tech**: 100 kWh battery with 150 kW charger
Phase 2 Model for Urban Trips.

Modeling framework considers:

- Origin-Destination travel demand (input)
- Simulated trip trajectories
- Minimizing charging station investment cost
- Minimizing travelers’ detour

This phase focuses on investing in DC fast chargers for urban trips of EV users.
- Initial state of charge
- Amount of charge gained
- Chain of trips is unknown
Select Focus Areas will be Examined in Phase 2.

- Ann Arbor
- Detroit
- Flint
- Grand Rapids
- Lansing
- Marquette
- Traverse City
Community Stakeholder Questions

- Are there any limitations related to placing charging infrastructure in your community currently? Should there be areas where DCFC is not allowed?
  - *Example: No DCFC in single family residential areas, municipal streets, etc.*

- What type of EV charging are you anticipating in your community?

- What should be the configuration of the charging stations?
  - *Consolidated (similar to gas stations) or a few charging outlets in public or store parking lots*

- What should be the assumed initial state of charge?

- What should be assumed about the amount of charge gained at each charging event?
  - *Get to destination or fully charged*

- What percent of the population lives in multi-family housing?

- What is the average land cost of each area?

- What is the existing electrical grid infrastructure along your transportation network?
  - *Utilities assistance is needed to obtain this data*
Community Stakeholder Questions

- What battery size should be assumed for urban trips?
  - 70 and 100kWh for intercity trips

- What is the city vs. highway battery efficiency?

- City tourism data availability?
  - Is there any data on the number of visitors and their possible overnight stay destinations?

- What other parameters should be considered in making EV charging infrastructure investments?

- What are the main concerns of EV users for their urban trips? Any suggestions?

- Are there any additional variables that should be considered?

- Any recommendations on who we should talk to next to gather information?
Thank you!

**Michigan State University**

**Mehrnaz Ghamami**
Email: ghamamim@egr.msu.edu
Phone: (517) 355-1288

**Ali Zockaie**
Email: zockaica@egr.msu.edu
Phone: (517) 355-8422

**Steven Miller**
Email: mill1707@anr.msu.edu
Phone: (517) 355-2153

**Michigan Energy Office**

**Robert Jackson**
Email: jacksonr20@michigan.gov
Phone: (517) 930-6163

**Joy Wang**
Email: wangj3@michigan.gov
Phone: (517) 284-6894
References


