Electric Vehicle Charger Placement Project

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November 2019

Acknowledgement

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EGLE

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

Outline

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- Problem Statement
- Data Collection
- Modeling Framework
- Scenarios Analyzed
- Results

Problem Statement

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- Find the optimal infrastructure investment to support electric vehicle travel:
  - **Where** to deploy charging stations?
  - **How many** chargers must be built at each station?

- Phase I- Long Distance (Intercity) Trips of EV Users
- Phase II- Urban Trips of EV Users

Data Collection

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The required inputs to the model include:

- Road network (Michigan Department of Transportation)
- Traffic Analysis zones (Michigan Department of Transportation)
- Travel demand matrix (Michigan Department of Transportation)
- Electricity Provision Costs (Utilities)
- Average Land Cost (MPOs)
- Car Companies
- Charging station and charger costs (Charging Station Companies)

Modeling Framework-Highway Study

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The modeling framework considers:

- EV trip feasibility
- Minimizing charging station investment cost
- Minimizing travelers delay including:
  - Charging time
  - Queuing delay time
  - Detour time

This phase focuses on investing in DC fast chargers for long distance (intercity) trips of EV users.

Innovation in the Highway Study

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Why Phase I- highway study was innovative?

- Considering effects of weather on vehicle performance
- Seasonal variation of travel demand
- Tourism demand
- Simultaneously considering user preference, vehicle requirement and investment cost
- Tested variety of scenarios

Scenarios Analyzed

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Different scenarios focusing on:

- Two seasonal demand and battery performance variations
  - Summer with 100% battery performance
  - Winter with 70% battery performance
- Two types of battery
  - 70 kwh
  - 100kwh
- Three rates of market growth for different years
  - 2020
  - 2025
  - 2030
- Three DC fast charger options
  - 50 kw charger
  - 150 kw charger
  - 350 kw charger

Scenario: 2030 Market Growth, Mixed-Tech

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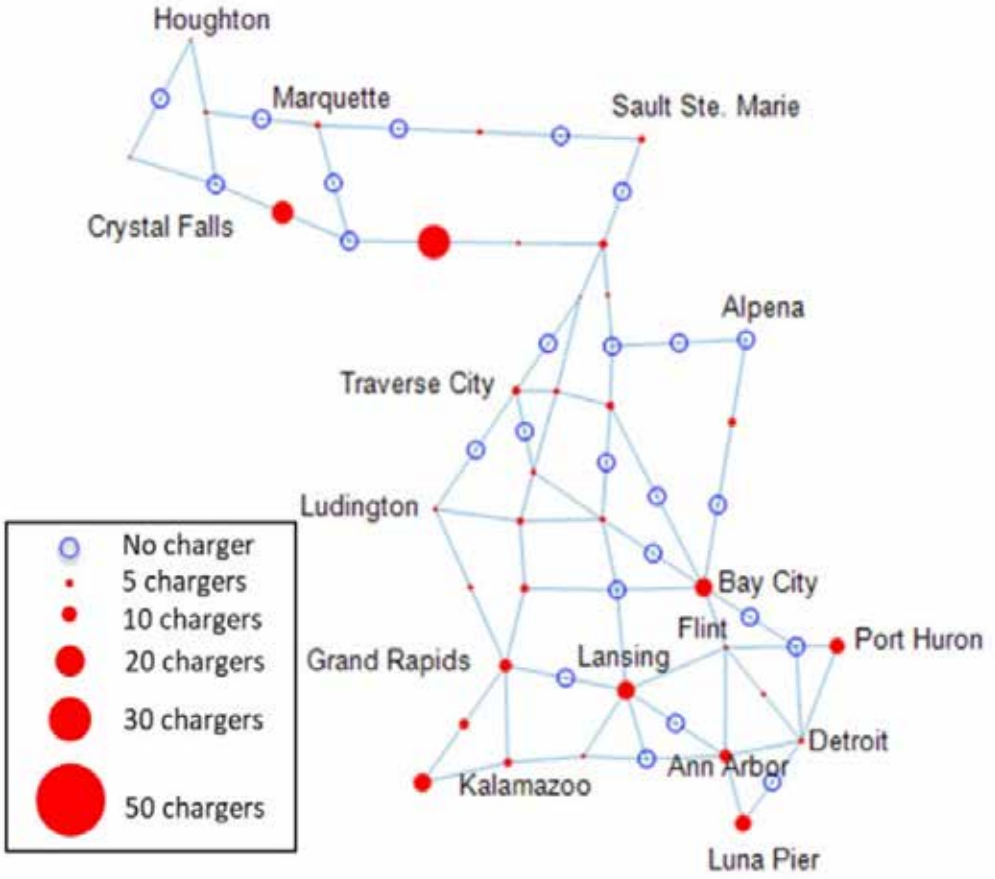
Assumptions
Battery: 70 kWh
Charger: 150 kw
Season: Winter

Infrastructure
Total Number of Stations= 35
Total Number of Chargers= 196

Cost
Station Investment Cost (million $)= 6.47
Land Investment Cost (million $)= 0.37
Charger Investment Cost (million $)= 15.0
Total Cost (million $)= 21.84



Charger Placement Project a BIG Success

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Source: https://www.wlns.com/news/this-morning-study-identifies-ideal-locations-for-electric-vehicle-chargers-in-michigan/

Source: https://insideevs.com/news/341948/research-study-where-to-install-public-ev-charging-stations/

Source: https://www.energycentral.com/c/gr/how-new-york-maryland-michigan-are-overcoming-looming-electric-vehicle-charging

Source: https://www.crainsdetroit.com/energy/state-utilities-sketch-out-areas-need-future-ev-charging-network

Source: https://www.nrdc.org/stories/home-big-auto-going-electric

Source: https://mibiz.com/sections/energy/electric-vehicle-study-maps-optimal-statewide-charging-network

Source: http://evworld.com/focus.cfm?cid=399

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Conference Presentations and Invited Talks

- University of Michigan, Transportation Seminar Series, November 2018
- Transportation Research Board, January 2019, Washington DC
- Second International Conference on Energy Research and Social Science, June 2019
- Midcontinent Transportation Electrification Collaborative, July 2019, Detroit, MI
- E-Mobility Charging Infrastructure Conference, December 2019, Detroit, MI
- MIT CEEPR, October 2019
- Transportation Research Board, January 2020, Washington DC

Journal Publications

- Ghamami, et al., Refueling Infrastructure Planning In Intercity Networks Considering Route Choice And Travel Time Delay For Mixed Fleet Of Electric And Conventional Vehicles, *Transportation Research Part C*
- Fakhrmoosavi, et al., Electric Vehicle Charger Placement Optimization in Michigan Considering Monthly Traffic Demand and Battery Performance Variations, *Transportation Research Record*
- Kavianipour, et al., Impacts of Technology Advancements on Electric Vehicle Charging Infrastructure Configuration: A Michigan Case Study, *Energies*

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Thank You

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