Electric Vehicle Charger Placement Project



November 2019



This study is commissioned and funded by the Michigan Department of Environment, Great Lakes, and Energy.



MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY







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



- 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



The required inputs to the model include:

Stakeholder Meetings

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- 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)



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.

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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



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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



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Assumptions

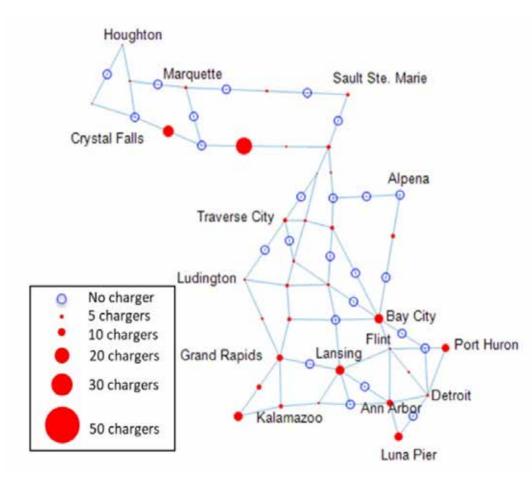
Battery: 70 kWh Charger: 150 kw Season: Winter

Infrastructure

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

<u>Cost</u>

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





MICHIGAN STATE **Charger Placement Project a BIG Success** UNIVERSITY News Communities+ industry+ Scomors Schoolbe Parlicipate MARKET MARKY MARKY MARKY MARKY DAMAGEN MARKY INSIDEEVA Research Knoby Where To Install-Public by Charging Statutes This Morning: Study identifies ideal locations for electric vehicle chargers in Michigan AUTHOR PROFILE 000000 How New York, Maryland, Michigan Are **Overcoming The Looming Electric Vehicle Charging Infrastructure Gap** 6 News This Morning: ev chargers 2 Energy Innovation hiley and Sectioning Analysis Amountain R Fuller IN Contact ABOUT NO -- I COMM We are a planet are and disease policy like Inits' dellard stattly manufacture UDY DENTITIES (DEAL LOCATION) manufaction and address that B there make informacontract App Informative Bound without dimensi of the lowers opening which where an Mundan since 2018 Personal March 4, 2019 (19/87 AM COT) Contacted March 4, 2019 (19/48 AM COT https://insideevs.com/news/341948/research-studythis terms solded with tesewaters at the Madagan Energy Office finished the first phase of a study showing where they where-to-install-public-ev-charging-stations/ belowe electric sehicle chargers should be placed in our state. Source: https://www.energycentral.com/c/gr/how-new-yorkthe study is the first of its land. maryland-michigan-are-overcoming-looming-electric-vehiclebenear hers looked at factors like batters performables and driving in initial weather could like charging The purpose was to determine how state officials can appropriately one \$10 million it provised through a Source: https://www.wlns.com/news/this-morningstudy-identifies-ideal-locations-for-electric-vehicle-Is the Home of Big Auto Going chargers-in-michigan/ Electric? State, utilities sketch out areas of need for and book one programs for computers. Multiplet may know the mean fur-inciding IV infrastructure plan in the Mahanat future EV charging network At According to the According owners and the owner of the owner. the of the Automatical states and a state water of the state steaked Server and Trainable Sills, find have a strip count from the signating from the same change in two and incide for a place in this The sub-large dations him finite serie. The dist instant or it is sing frank where three of the file story on - a sheet (inside terroling of all any local (see and the second fits and and to be at and other to a of the late and write a title of other for 12 to 12 minutes when the function to 22 aman 6.8 Manuna make on other country ins a fear to investor in-Source: https://www.nrdc.org/stories/home-big-SIL auto-going-electric Source: https://www.crainsdetroit.com/e Source: <u>https://mibiz.com/sections/energy/electric-</u> nergy/state-utilities-sketch-out-areasvehicle-study-maps-optimal-statewide-charging-network need-future-ev-charging-network vworld.com/focus.cfm?cid=399

Source: http://

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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



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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*



Thank You



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