MICHIGAN ENERGY OFFICE

Electric Vehicle Charger Placement Optimization in Michigan: Phase 1 - Michigan Highways

MiEIBC EV Convening
December 19, 2018
12:00 – 1:00 PM

Agenda

- Welcome & Introduction
- Background & Stakeholder Process
- Methodology
- Scenarios & Findings
- Results & Discussion
- Next Steps
- Questions

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

Electric Vehicles – Infrastructure

Michigan has limited charging infrastructure.[1]

- <2% of U.S. DC fast charger ports
- 2.2% of U.S. Level 2 ports

However, Michigan has:

- Autonomous vehicle support (PA 332 of 2016)
- Investment in EVs from business sector (GM, Ford, Toyota, etc.), utilities, and others.

Multi-Phase Project for EV Charger Placement.

Phase	Timeline
• Phase I: Intercity EV Trips (Highways)	December 2018
• Phase 1 Supplements	Spring 2019
• Full Tourism Analysis	
• Economic Impacts Analysis	
• Phase II: Urban EV Trips (Select Cities)	Fall 2019

Many Thanks to Participating Stakeholders.

Auto Companies
- General Motors
- Ford Motor Company
- Toyota

Transmission and Utility Companies
- American Transmission Company
- Cherryland Electric Cooperative
- Consumers Energy
- DTE Energy
- Great Lakes Energy Cooperative
- Indiana Michigan Power
- ITC Transmission Company
- Lansing Board of Water and Light
- Michigan Electric Cooperative Association
- Michigan Municipal Electric Association
- Wolverine Power Cooperative

Charging Station Companies
- ChargePoint
- Greenlots

National Organizations
- National Association of State Energy Officials
- Electrify America

State of Michigan Departments
- Michigan Department of Environmental Quality
- Michigan Department of Natural Resources
- Michigan Department of Transportation
- Michigan Economic Development Corporation
- Michigan Public Service Commission

Many Thanks to Participating Stakeholders.

Other

- Corrigan Oil
- 5 Lakes Energy
- Center for Automotive Research
- Clean Fuels Michigan
- Ecology Center
- Michigan Energy Innovation Business Council
- Michigan Environmental Council
- NextEnergy
- Sierra Club

EV Drivers and Owners

Electric Vehicle Charger Placement Optimization Project

December 19, 2018

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Acknowledgement

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MI Energy
Michigan Agency for Energy
Michigan Energy Office

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?

Model Seeks Feasible EV Travel at Least Cost.

Modeling framework considers:

- EV trip feasibility
- Minimizing costs
  - Charging station investment cost
  - Traveler delay cost includes:
    - Charging time
    - Queuing delay time
    - Detour time

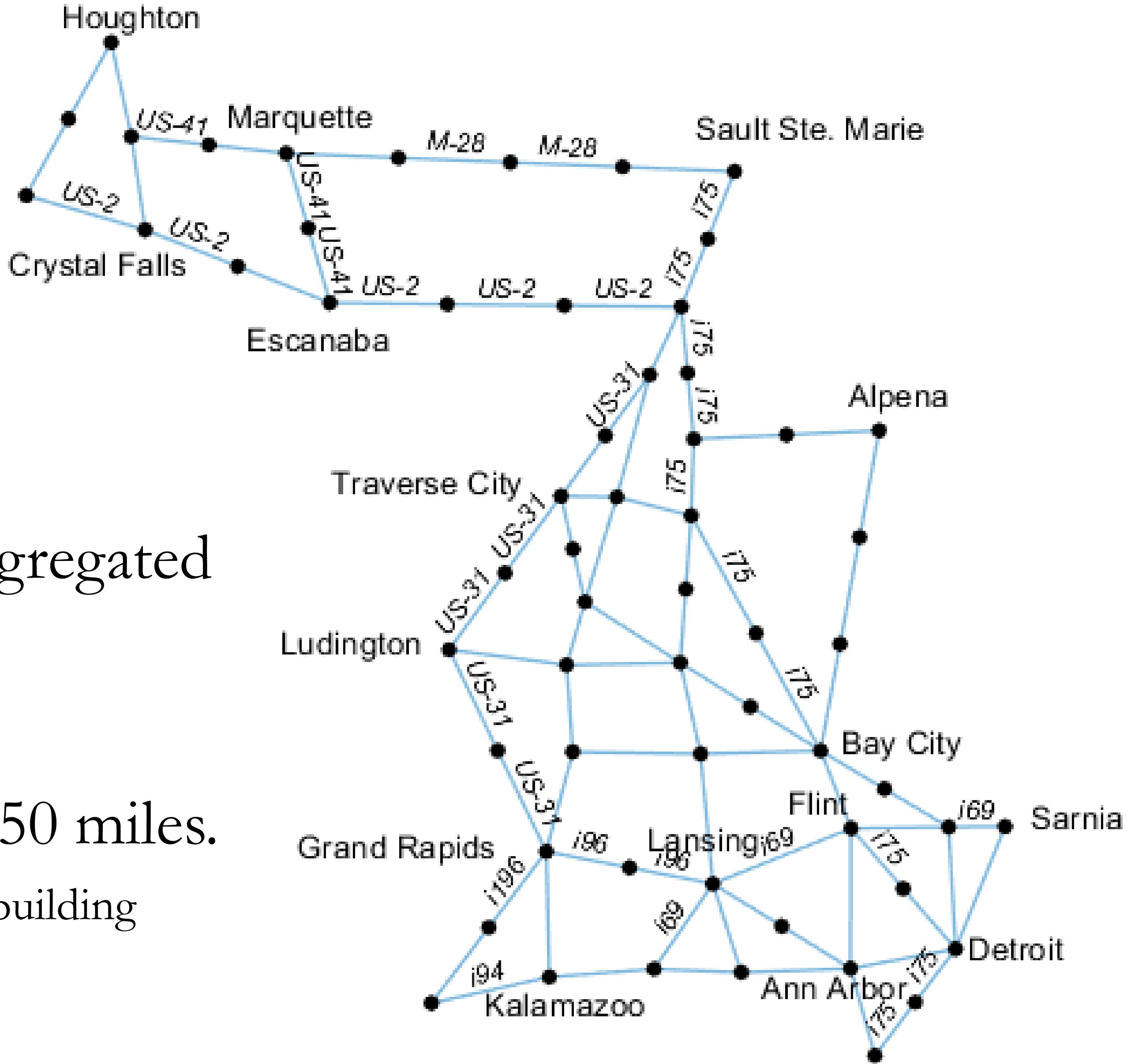
Simplified Reference Road Network

Reference road network:

- Includes major cities & interstate highways.
- Focuses on travel between cities.

Simplification Process:

- Travel demand around major cities aggregated to city center.
- Travel demand within cities excluded.
- Distance between candidate points < 50 miles.
  - Candidate points may or may not be selected for building charging stations



Conservative MI EV Market Projections Used.

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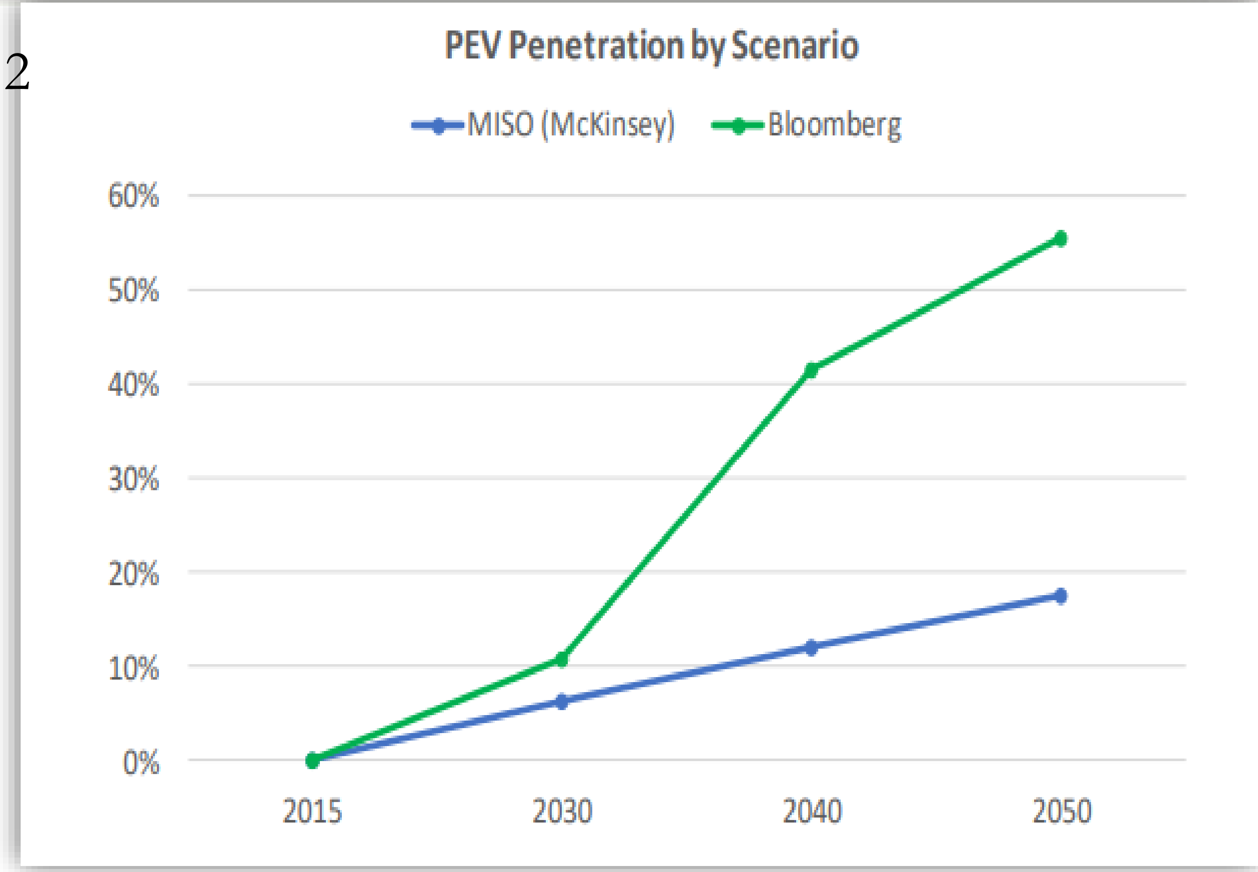
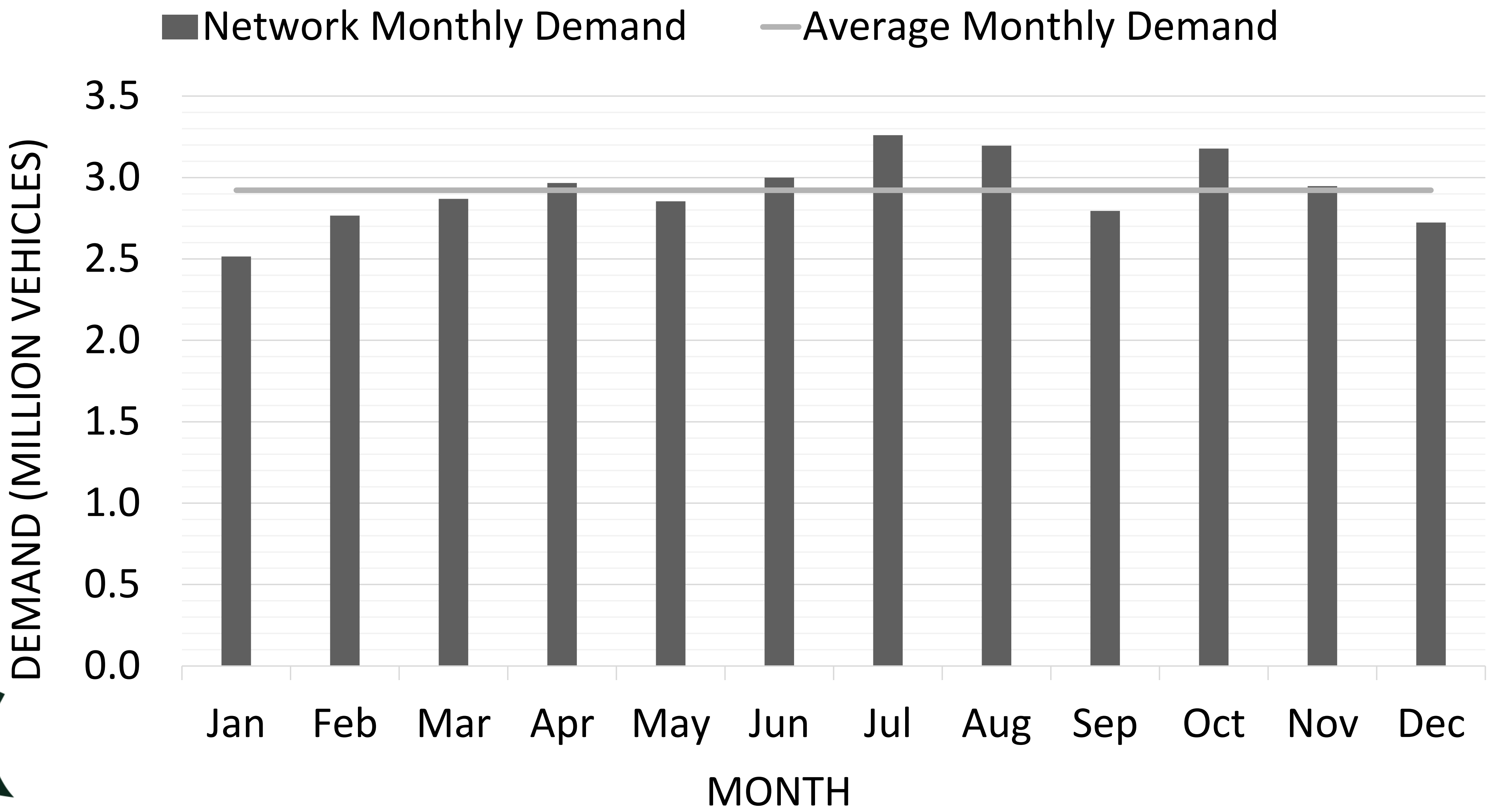
Two sources for MI EV projections:[2]

- MISO scenario:
  - 2020: 1.49%
  - 2025: 3.74%
  - 2030: 6%
- Bloomberg scenario:
  - 2020: 2.46%
  - 2025: 6.56%
  - 2030: 12%



where EV market share is the proportion of EVs to all vehicles on the road.

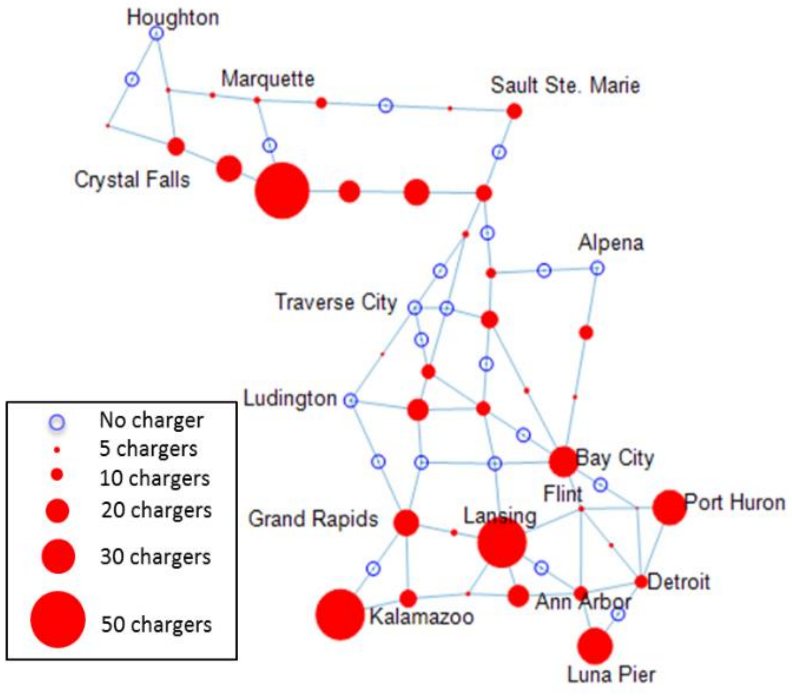
Average Travel Demand/Month Used.



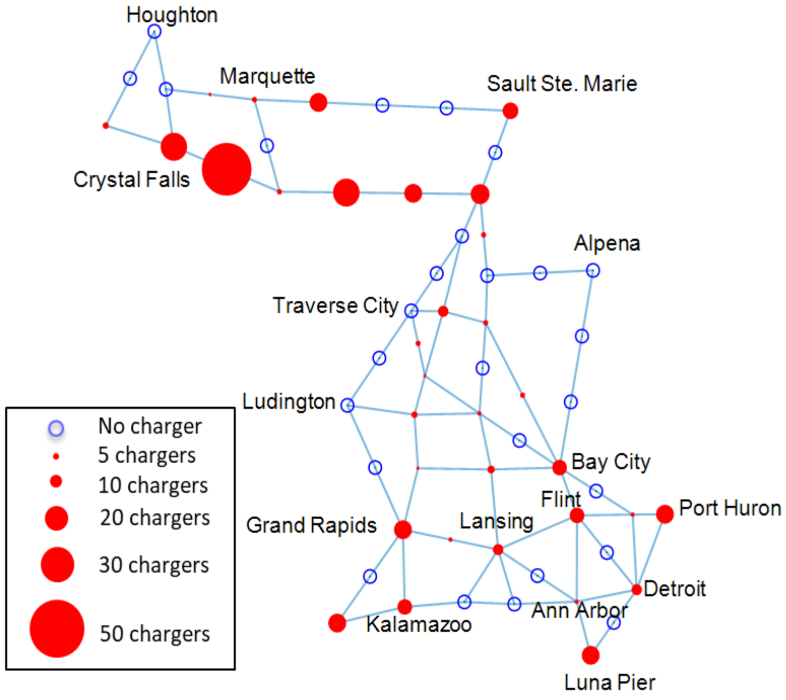
Seasonal Demand & Performance Examined.

Two scenarios examined impact of winter battery performance and seasonal travel demand.

- Summer travel demand with 100% battery performance
- Winter travel demand with 70% battery performance



(a) Winter Scenario - Charger Placement



(b) Summer Scenario - Charger Placement

Winter Scenario Allows EV Travel Year Round.

Optimization Model Outputs	Winter Scenario	Summer Demand in Winter Scenario	Summer Scenario
Number of Stations	38	38	33
Number of Charging Outlets	551	551	312
Total Delay (hr)	3642	2314	2078
Total investment cost (million $)	25.57	25.57	16.1

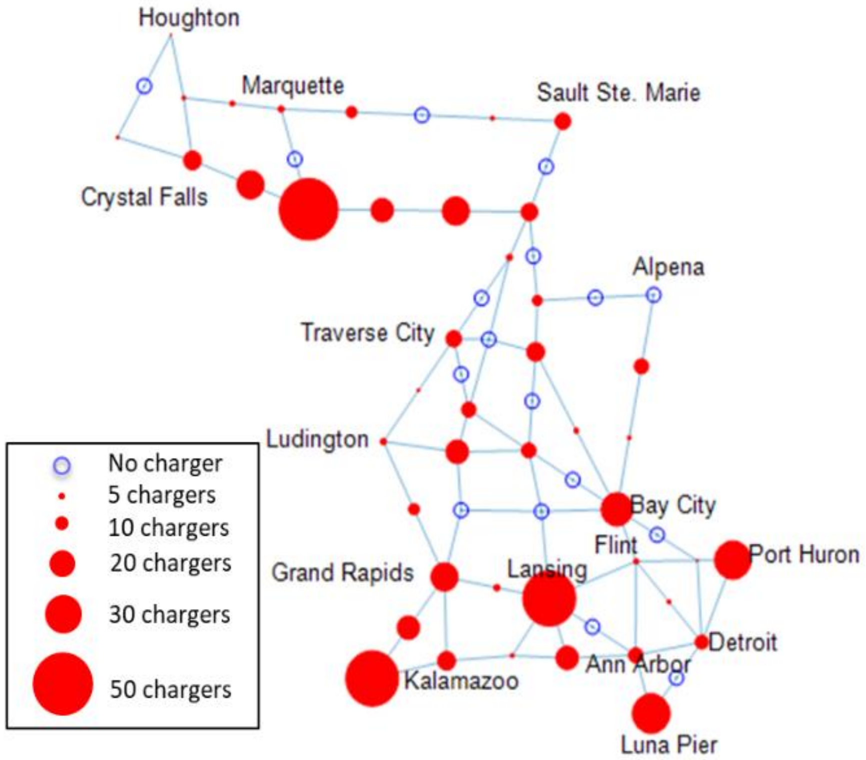
- Winter demand is not feasible with summer solution.
- Summer demand is feasible with winter solution.

→ All main scenarios use the winter season.

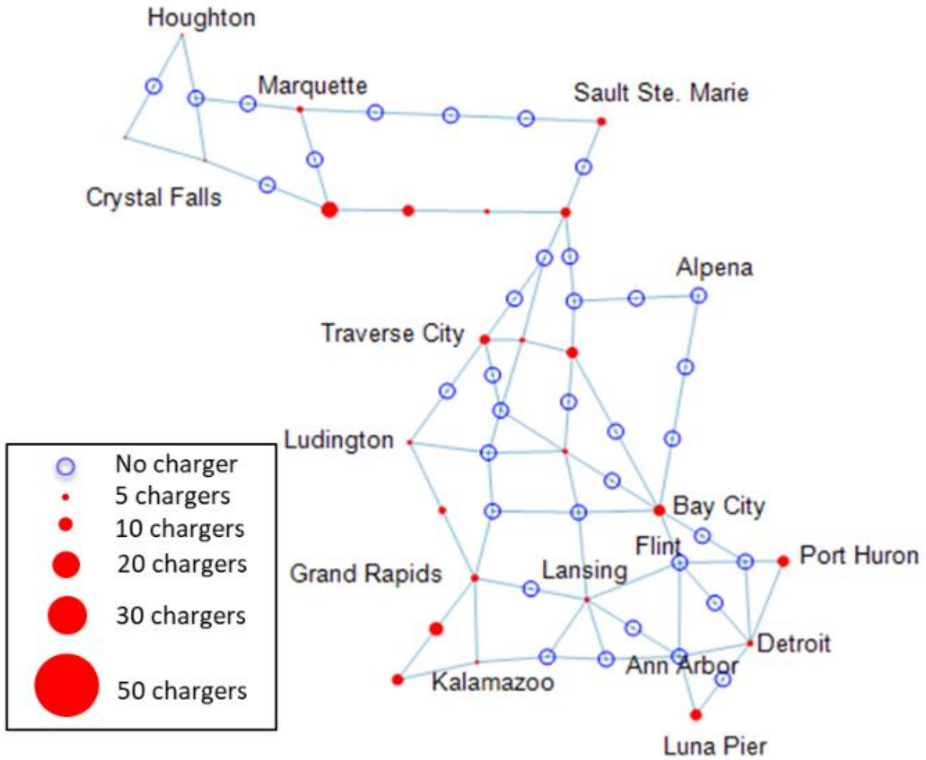
High & Low-Tech Scenarios Analyzed.

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



(a) 2030: Low-Tech Scenario



(b) 2030: High-Tech Scenario

2030 High Tech Scenario is Lower Cost.

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High-tech scenario is lower cost with less EV user delay.

- Though 150 kW stations more expensive, less are required.
- User delay from 30.67 to 12.38 minutes by moving to 150 kW chargers.

2030 Scenario Outputs	**Low-tech: 70 kWh Battery & 50 kW Charger**	**High-tech: 100 kWh Battery & 150 kW Charger**
Optimum Charger Placement		
Number of charging stations	43	24
Number of chargers	598	128
Investment cost		
Charging station cost (million dollars)	6.64	4.37
Land cost (million dollars)	1.13	0.24
Charger cost (million dollars)	20.18	9.76
Total cost (million dollars)	27.95	14.37
Delay time		
Average delay (min)	30.67	12.38

Mixed Technology Scenario is Recommended.

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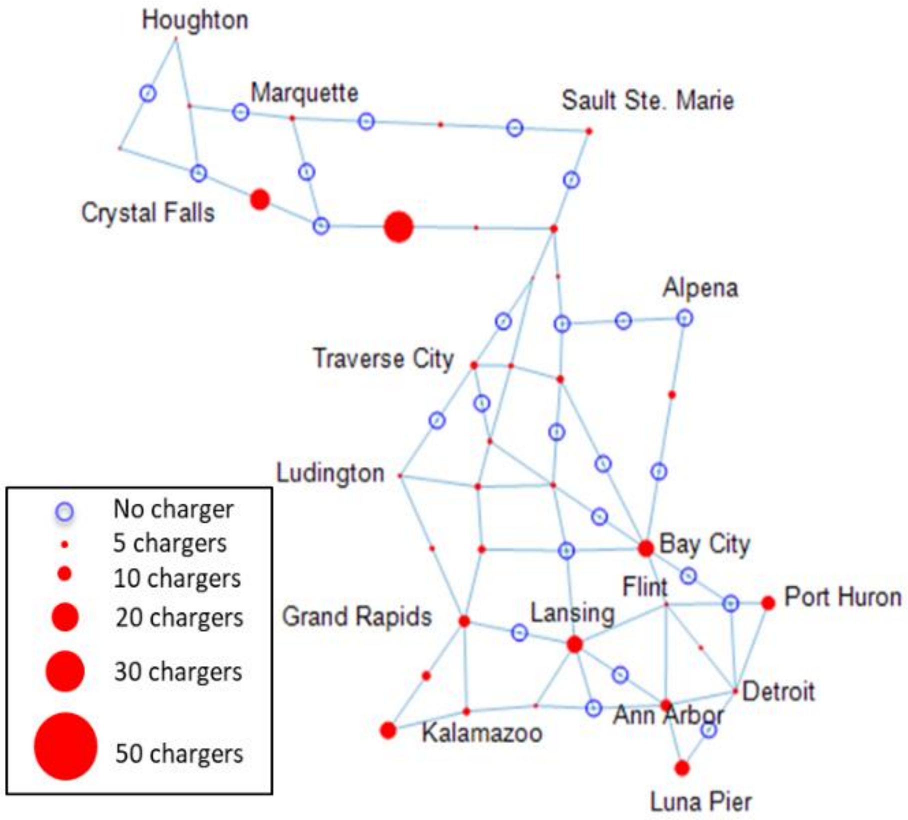
Mixed scenario considered: 70 kWh battery, 150 kW charger

- Vehicles with smaller batteries or degraded batteries will be on road.



2030: Mixed Scenario

	Low-tech	High-tech	Mixed
Scenario Specification			
EV market share (%)	6	6	6
Charging power (kW)	50	150	150
Battery energy (kWh)	70	100	70
Optimum Charger Placement			
Number of charging stations	43	24	35
Number of charging outlets	598	128	193
Investment Cost			
Charging station cost (million dollars)	6.64	4.37	6.47
Land cost (million dollars)	1.13	0.24	0.36
Charging outlet cost (million dollars)	20.18	9.67	14.72
Total cost (million dollars)	27.95	14.37	21.55

Next Steps

- Finalize EV Charger Placement Optimization Report and post in January 2019;
- Implement Light Duty Zero Emission Vehicle Supply Equipment Program with help from DEQ and partners;
- Post RFP for Round 1 VW funding for DC EV charging infrastructure in early 2019; and
- Host second EV readiness meeting with local government and economic development groups in February.
- For further information, please see our website.

Thank you!

Michigan State University

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References

1. Atlas EV Hub. (2018). Retrieved from: https://www.atlasevhub.com/materials/market-data/

2. Electric Vehicle Cost Benefit Analysis. (2017). Retrieved from: https://www.nrdc.org/sites/default/files/mi-pev-cb-analysis.pdf.