STAKEHOLDER ENGAGEMENT MEETING
Electric Vehicle Charger Placement Optimization in Michigan

June 14, 2018
8:30-10:00 AM

Agenda

- Welcome
- Opening Remarks (Michigan Energy Office)
- MSU Project Team Presentation
- Discussion
- Questions

Electric Vehicle Charger Placement Optimization Project

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MICHIGAN STATE UNIVERSITY

June 14, 2018

Acknowledgement

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

MI Energy
Michigan Agency for Energy
Michigan Energy Office

Problem Statement

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

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

- The results presented here do not include tourism and seasonal variation results. Those are the next steps of this study.

System Operational Assumptions

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Battery size: 100 kWh (Average of all EVs in the market)

Confident range = 0.8 [1] (Travelers would recharge when the battery is depleted 80% of its capacity.)

Charging efficiency = 1.3 [1] (Converting energy/power ratio to charging time accounts for waste of energy while charging)

Reduced battery (Reduced battery capacity in Winter temperatures)

Performance = 70% [2]

Value of time = $18/h [1] (Based on users' willingness to pay)

Battery charging limit = 0.8 [1] (Users charge their vehicle up to 80 percent of its capacity as charging speed decreases significantly after this point)

Charger power = 50 kW [3] (Current average power in fast charging facilities)

Total demand = 2,979,998 [4] (Number of intercity trips between major cities in the state of Michigan (per day))

Major city: Any city which has a population more than 50,000.

[1]Source: Ghamami, M., Zockaie, A., & Nie, Y. M. (2016). A general corridor model for designing plug-in electric vehicle charging infrastructure to support intercity travel. Transportation Research Part C, 68, 389-402

[2] Source: https://www.energy.gov/eere/electricvehicles/maximizing-electric-cars-range-extreme-temperatures

[3] Source: Discussion with stakeholders.

[4] Source: Michigan Department of Transportation origin-destination travel data .

Economic Benefit Assumptions

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- Economic benefits are measured in the value of transactions captured at the charging station over a 10-year period (All estimates in 2018 dollars)
  - Fees for charging
    - $0.15 per kWh for DC Fast charging – about $5.40 per connection
  - Expected ancillary expenditures while charging
    - Increasing in-store “dwell time” by 1% equates to a 1.3% increase in expenditures
    - Impacts arise from unplanned (new) stops generated by the DC Fast charger station
    - Average unplanned stop generates about $12.48 in sales (may vary significantly depending on shopping options)
  - Economic Impacts
    - Economic impacts accounts for all direct and secondary transactions (multiplier effects)
    - Ancillary expenditures broken out into retail and food service (50/50). Net values of retail transactions attributed to impacts (only accounts for margins earned)
    - IMPLAN for Michigan used to calculate multipliers (secondary transactions)

Reference Road Network

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- A sketch road network for the state of Michigan.
- Major cities and interstate highways

Scenario 1: Rapid market growth

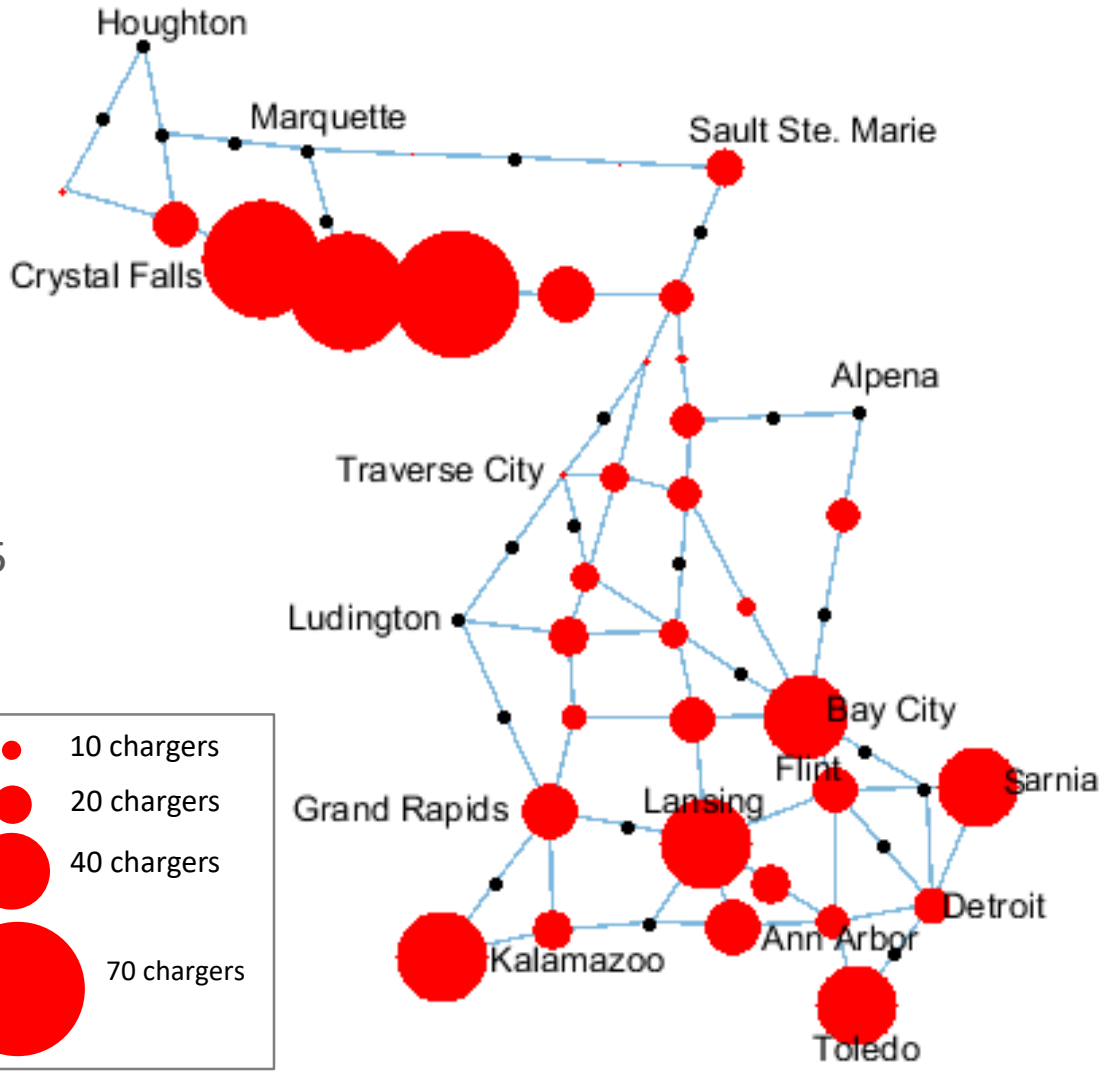
Assumptions

EV market share: 6%

EV trips: 178,784 (per day)

Results

- Number of Stations= 35
- Number of Chargers= 870
- Electricity provision cost= $3,793,695
- Land acquisition cost= $1,640,956
- Cost of chargers= $21,750,000
- Total cost= $27,184,651
- Total locational revenues= $609.12M



Scenario 1: Rapid market growth

Economic Analysis

Daily user visits: 9,369
Daily user hours charging: 6,661 hours
Daily kWh consumed: 333,046.4

10-Year Transactions Impact:
Charge revenues: $182.34M
Ancillary revenues: $426,78M
Total locational revenues: $609.12M

Scenario 2: Slow market growth

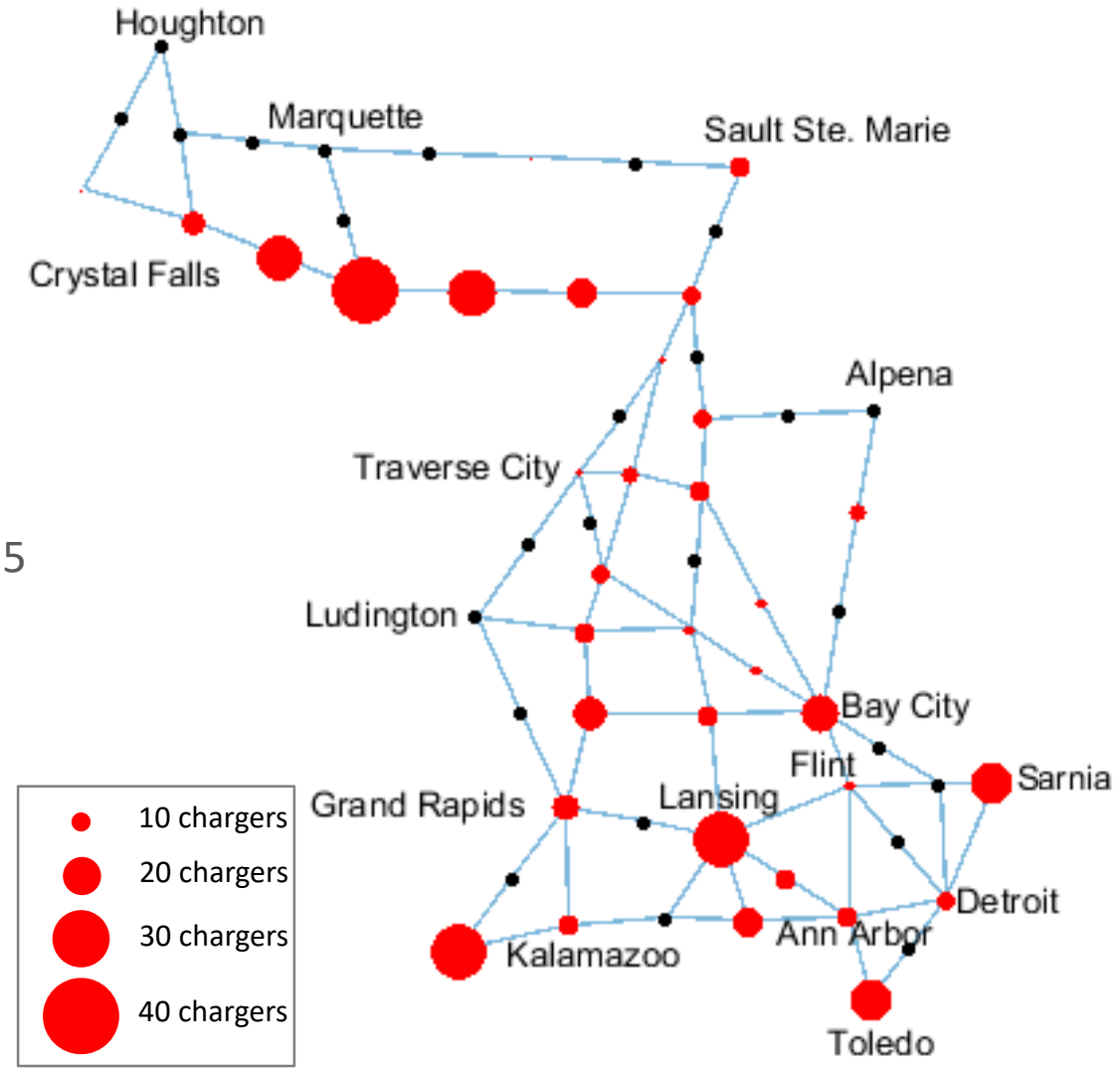
Assumptions

EV market share: 3%

EV trips: 89,392(per day)

Results

- Number of Stations= 34
- Number of Chargers= 434
- Electricity provision cost= $3,622,025
- Land acquisition cost= $816,923
- Cost of chargers= $10,850,000
- Total cost= $15,288,947
- Total locational revenues= $306.75M



Scenario 2: Slow market growth

Economic Analysis

Daily user visits: 4,703
Daily user hours charging: 3,380 hours
Daily kWh consumed: 168,976

10-Year Transactions Impact:
Charge revenues: $92.51M
Ancillary revenues: $214.23M
Total locational revenues: $306.75M

Land Price Distribution

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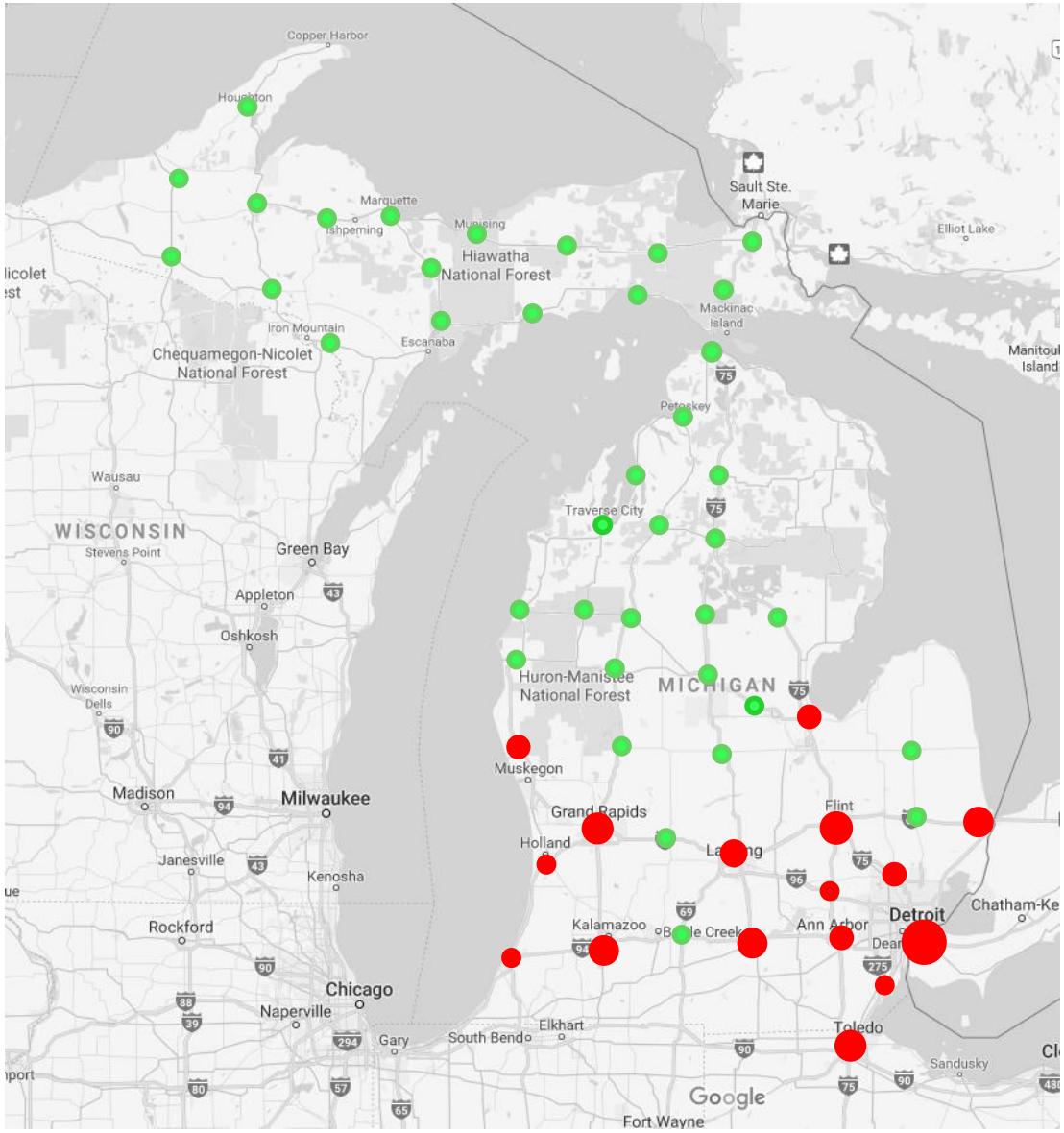
- Average price: 168,292 $/acre
- Lowest price: 162,410 $/acre
- Highest price: 250,175 $/acre

Green: price below the average

Red: price above the average

Circle size:

Relative price to the average value



Project Data Requirements

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- Seasonal variation of the origin-destination travel demand
  - *Currently estimating using traffic counts at 130 locations statewide*
- Electric vehicles market share
  - *Currently based on*

    Electric Vehicle Cost-Benefit Analysis- Plug-in Electric Vehicle Cost-Benefit Analysis: Michigan M.J. Bradley & Associates, LLC (MJB&A), July 2017
  - *Is there any other source or estimation available?*
- Grid specification data
  - *Inquire with utility companies*

Project Data Requirements

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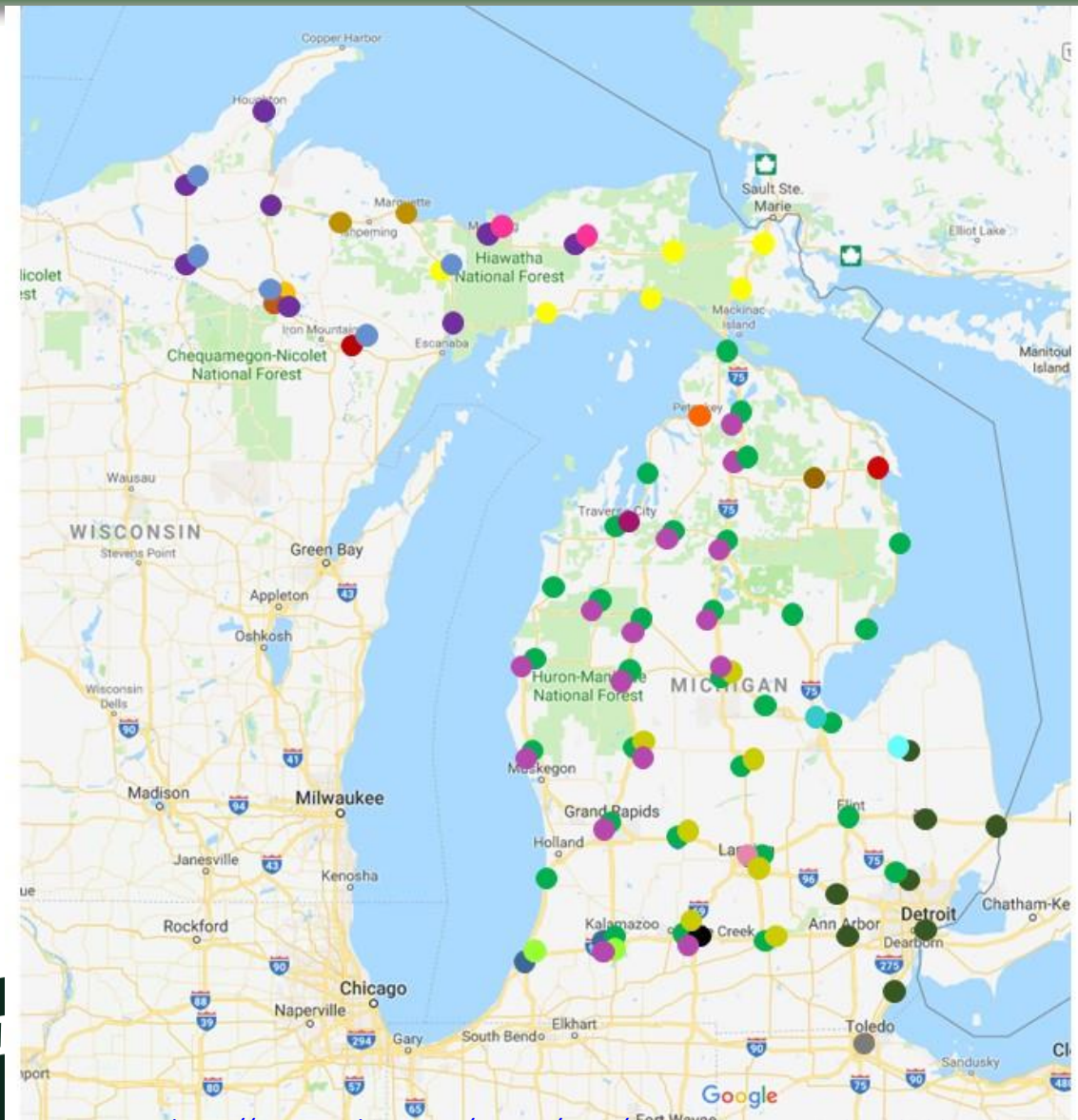

Legend

- Alger Delta Cooperative
- Cloverland Electric Cooperative
- Crystal Falls Electric department
- Norway L.D.
- Upper Michigan Energy Resources Corp
- Upper Peninsula Power Company
- Marquette Board of Light and Power
- Utility billing Office
- Wisconsin Electric Power Company
- Alpena Power Company
- Bay City utility department
- Indiana Michigan Power Company
- Cherryland Electric Cooperative
- Consumers Energy
- Detroit Edison company (DTE)
- Great Lakes energy cooperative
- Lansing Board of water and light
- Marshall C.W & E.W.
- Midwest Energy Cooperative
- Petoskey E.D.
- Presque Isle electric and Gas Co-op
- Thumb Electric Cooperative
- Tri-county Electric Cooperative

Source: https://www.michigan.gov/images/mpsc/serviceareaUPDATE20110120_599009_7.gif

Source: http://w1.lara.state.mi.us/cgi-bin-mpsc/mpsc/electric-gas-list.cgi?townsearch=c*

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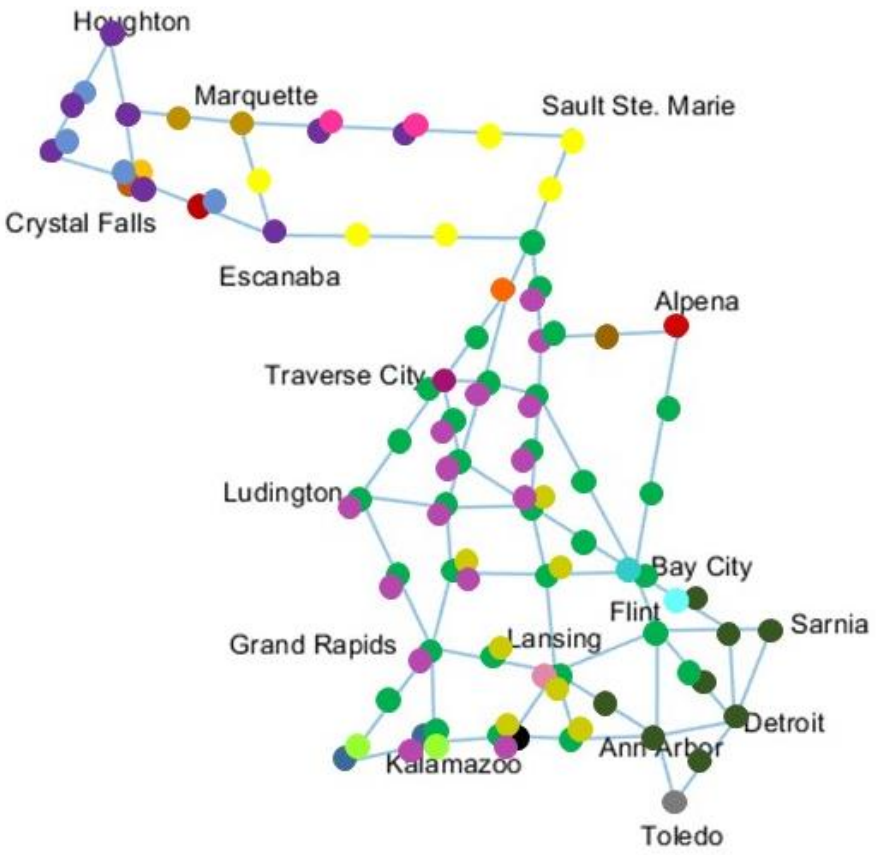

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Thank you!

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