MI Energy

Michigan Agency for Energy

Michigan Energy Office

STAKEHOLDER ENGAGEMENT MEETING

Electric Vehicle Charger Placement Optimization in Michigan

July 23, 2018

9:30-10:15 AM

Agenda

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

Electric Vehicle Charger Placement Optimization Project

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

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July 23, 2018

Acknowledgement

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

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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

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

NOTE: 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 Performance:	70% [2]	(Reduced battery capacity in Winter temperatures)
Value of time:	$18/h [1]	(Based on users' willingness to pay)
Battery charge limit:	0.8 [1]	(Users charge their vehicle up to 80 percent of 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)

Definition: 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

- Major cities and interstate highways
- The focus is on intercity travel
- Travel demand around major cities is aggregated to the city center
- Travel demand within the cities were excluded
- The distance between candidate points is less than 50 miles
- Candidate points may or may not be selected for building charging stations

Four Scenarios Analyzed

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- Scenarios:
  - Focus on 2030 EV market penetration for Michigan
  - Four scenarios focusing on:
    - Two rates of market growth
      - Slow growth: 3%
      - Rapid growth: 6%
    - Two DC fast charger options
      - 50 kW charger
      - 150 kW charger

- Cost data cannot be currently shared because of nondisclosure agreements
  - Instead, scenario cost comparisons are presented as ratios of the base scenario
  - Base scenario is rapid market growth and 50kW charger

Scenario 1: Rapid market growth, 50kw charger

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Assumptions

EV market share: 6%

Charger power: 50kw

Results

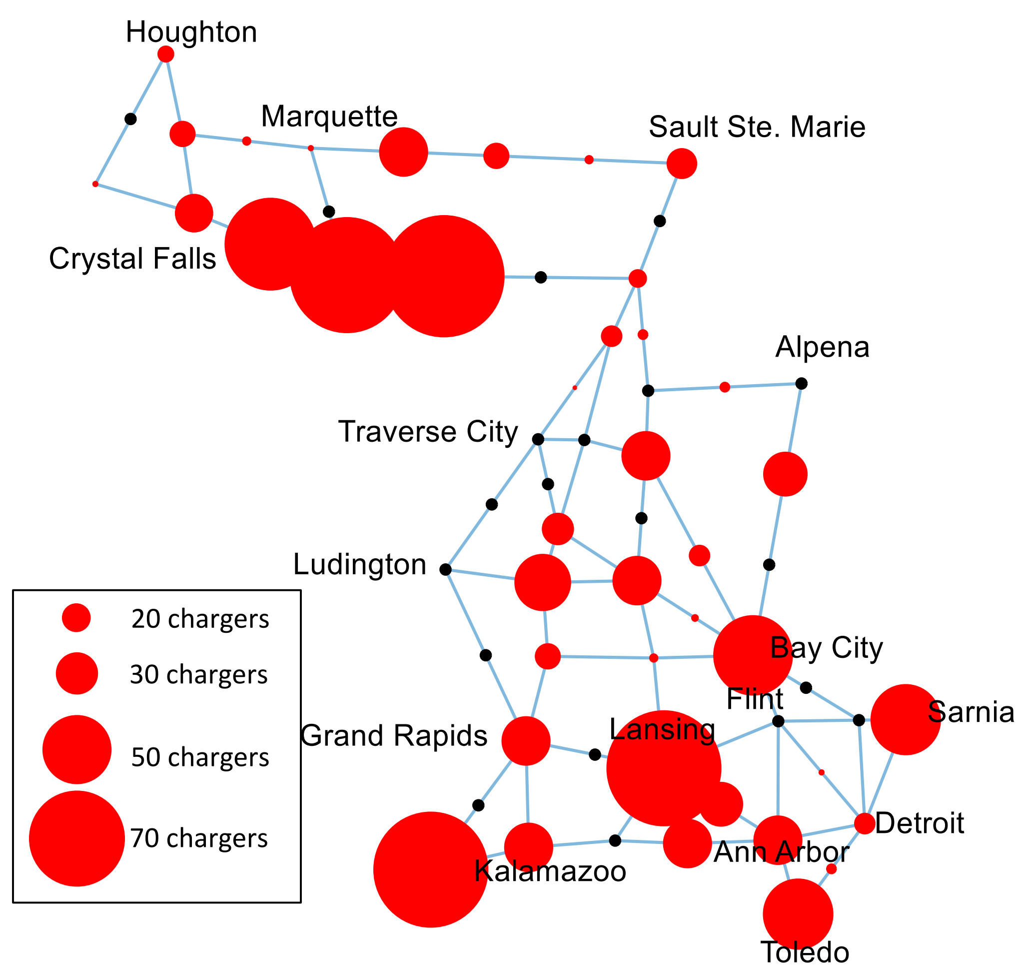
- Total Stations (number): 40
- Total Spots (number): 988

Costs

- Station Cost (ratio): base value
- Land Cost (ratio): base value
- Charger Cost (ratio): base value
- Total Cost (ratio): base value

Time

- Average Delay (min): 47.16



Scenario 2: Rapid market growth, 150kw charger

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Assumptions

EV market share: 6%

Charger power: 150kw

Results

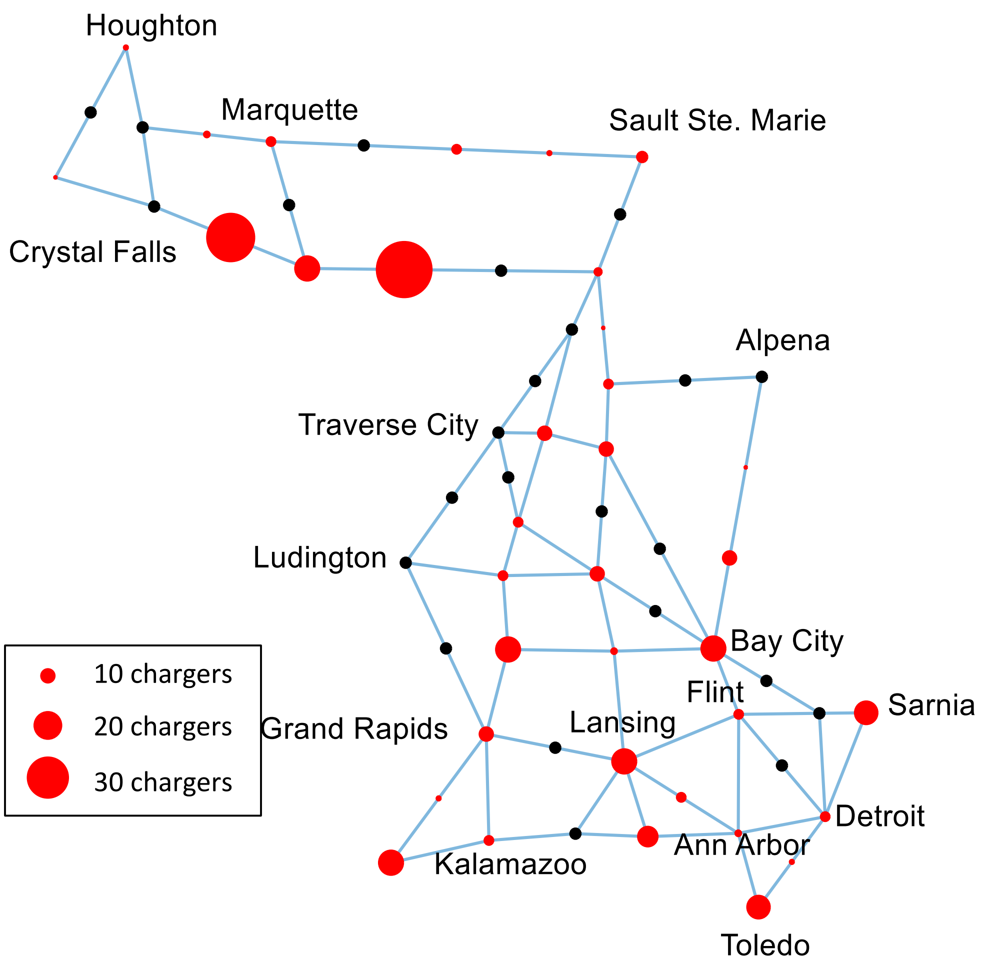
- Total Stations (number): 36
- Total Spots (number): 295

Costs

- Station Cost (ratio): 1.04
- Land Cost (ratio): 0.30
- Charger Cost (ratio): 0.83
- Total Cost (ratio): 0.85

Time

- Average Delay (min): 13.76



Scenario 3: Slow market growth, 50kw charger

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Assumptions

EV market share: 3%

Charger power: 50kw

Results

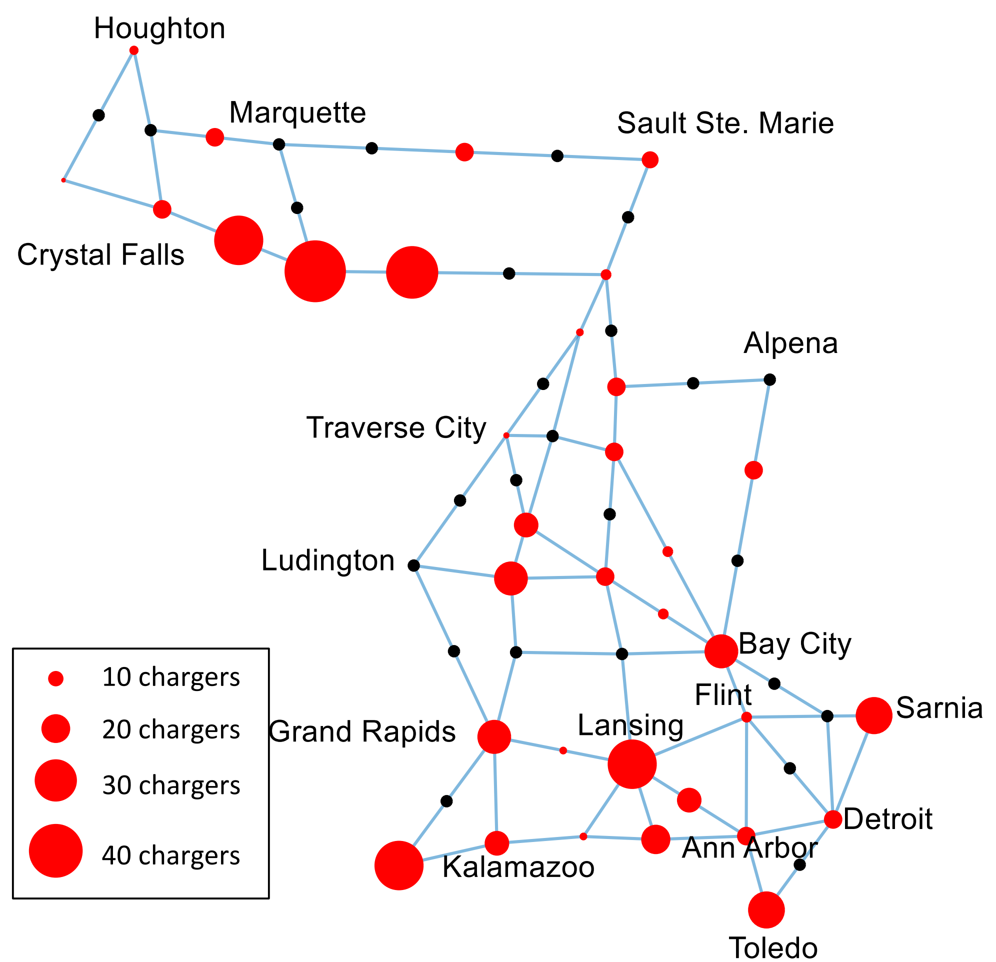
- Total Stations (number): 34
- Total Spots (number): 458

Costs

- Station Cost (ratio): 0.84
- Land Cost (ratio): 0.46
- Charger Cost (ratio): 0.46
- Total Cost (ratio): 0.53

Time

- Average Delay (min): 47.36



Scenario 4: Slow market growth, 150kw charger

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Assumptions

EV market share: 3%

Charger power: 150kw

Results

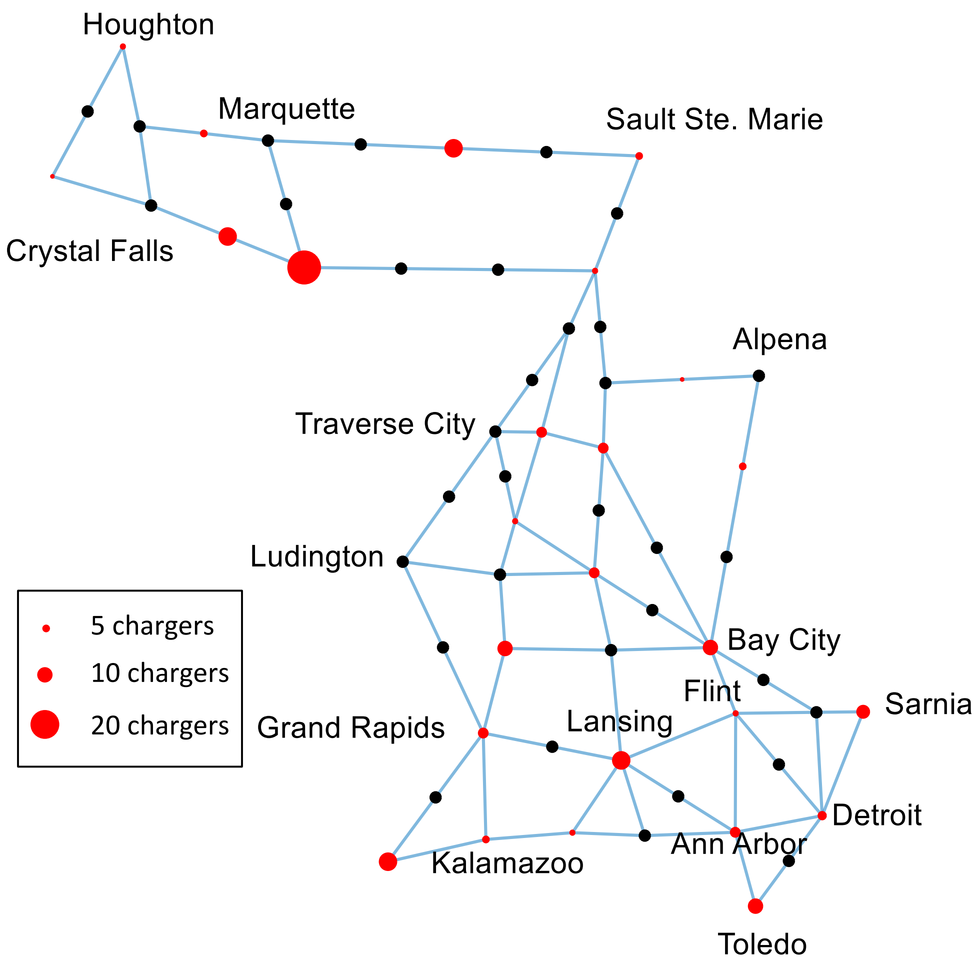
- Total Stations (number): 26
- Total Spots (number): 144

Costs

- Station Cost (ratio): 0.72
- Land Cost (ratio): 0.15
- Charger Cost (ratio): 0.41
- Total Cost (ratio): 0.45

Time

- Average Delay (min): 14.38



Project Data Requirements & Questions

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- Economic benefit assumptions
  - *Fees for charging*

- 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 & Questions

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- What EV charging station investments are going to be made in your service territory through pilots, demonstrations, or other opportunities?
- What are your actual or anticipated demand charges for EV charging?
- Is the current model for 2030 sufficient or should we look at five year projections (e.g. 2020, 2025, 2030)?

Project Data Requirements

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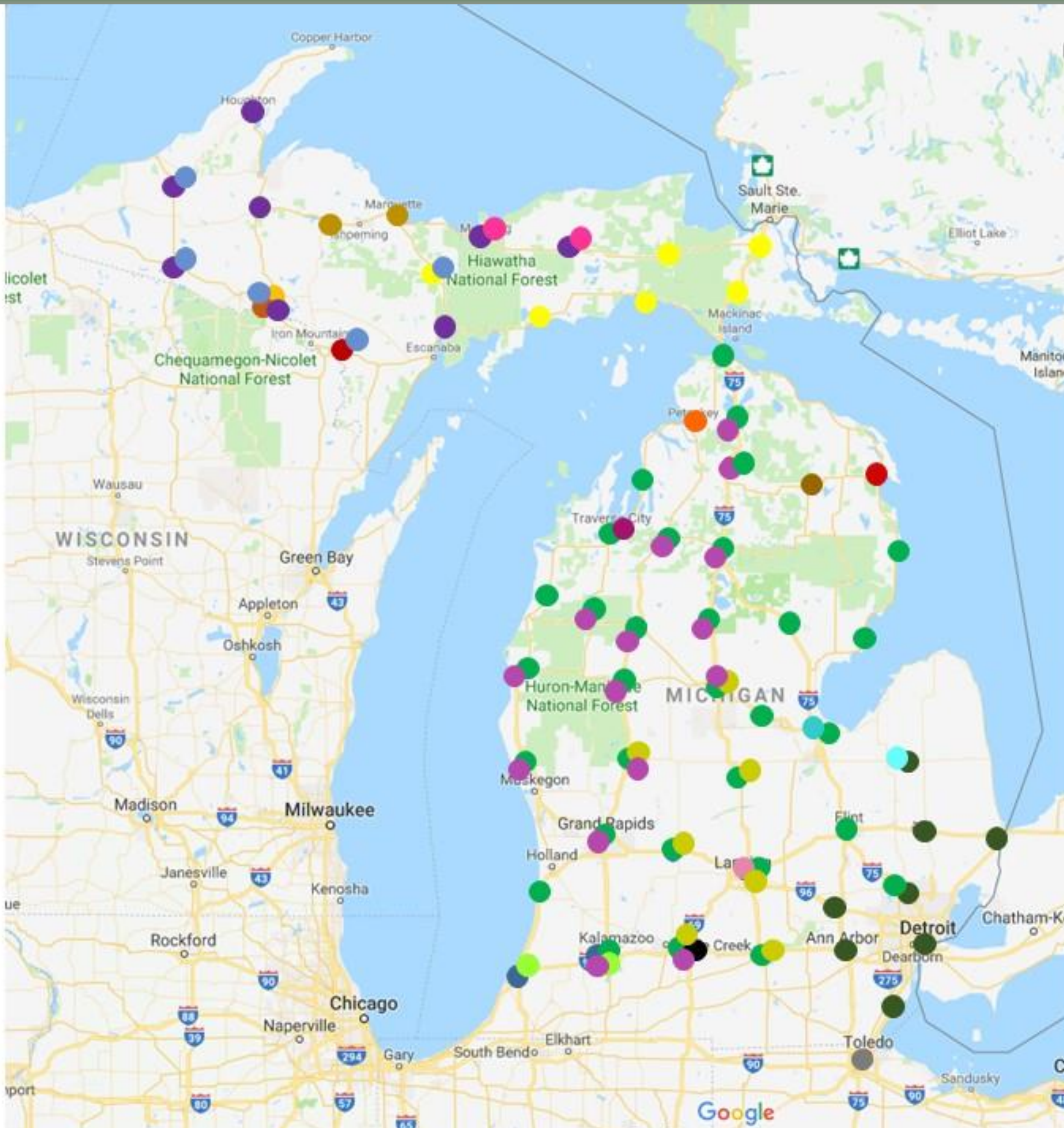

Legend

- 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*

Project Data Requirements

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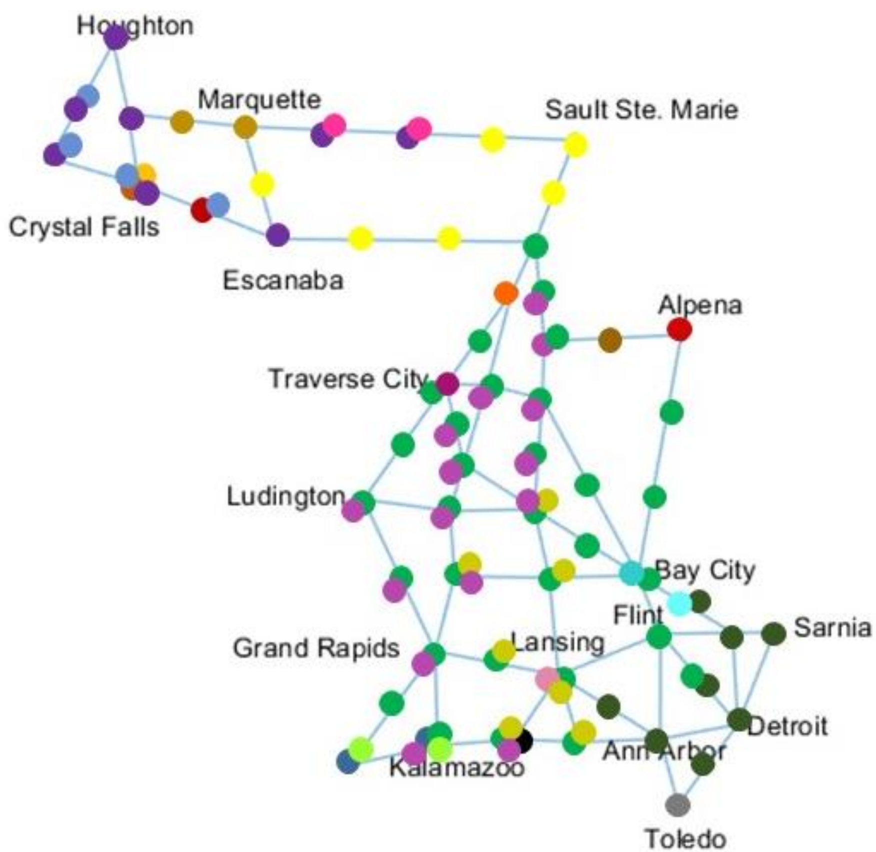

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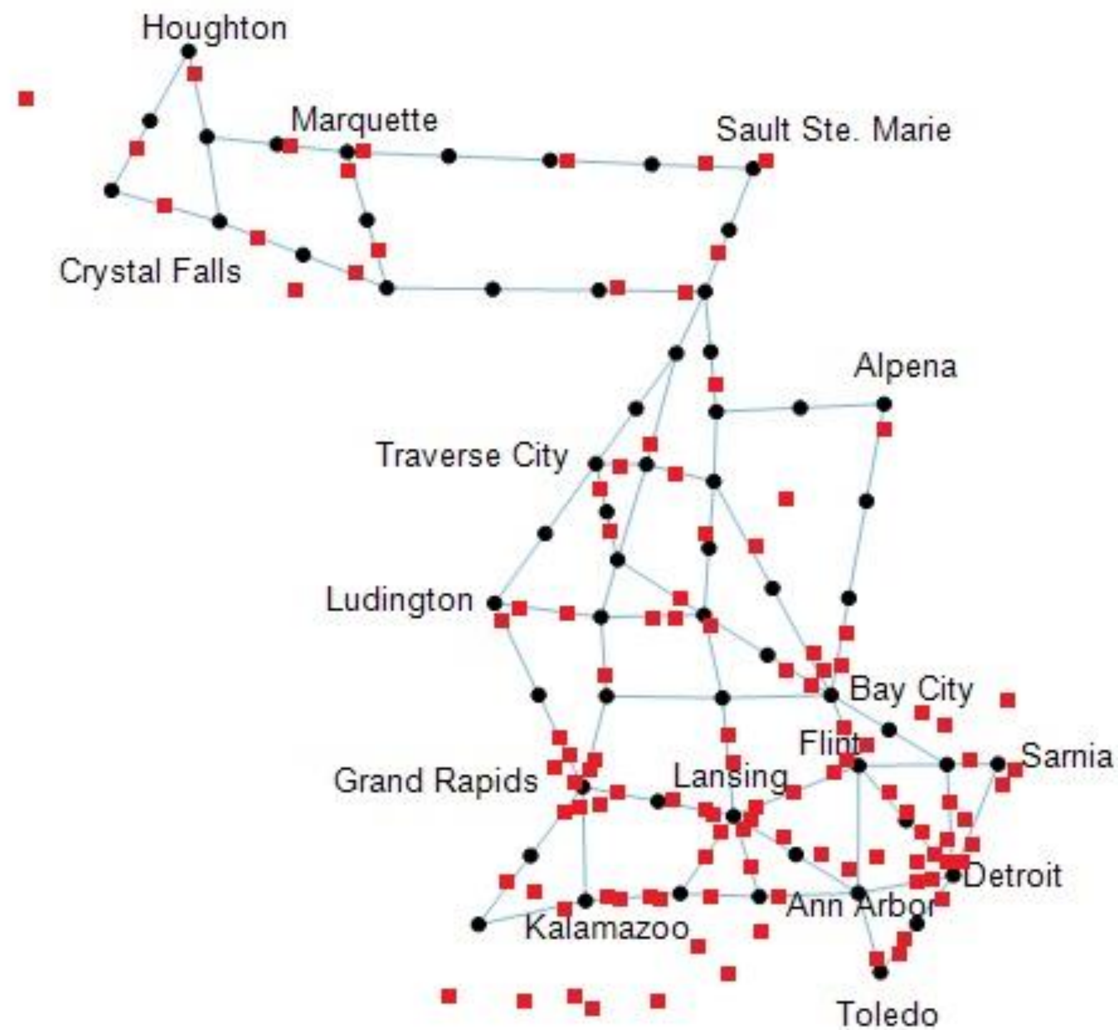
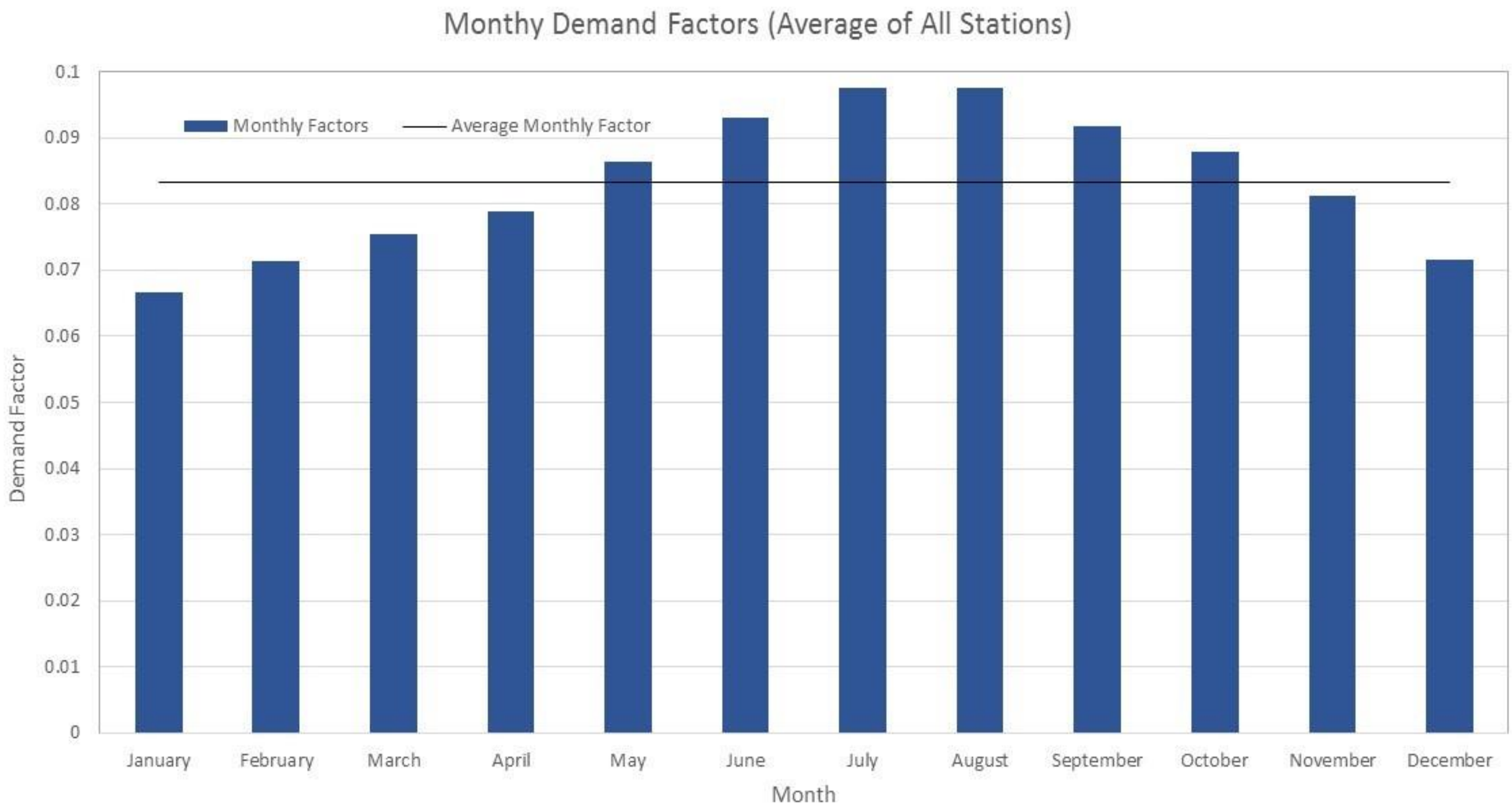
Statewide continuous counting stations

- 122 counting stations statewide
- Counting two-way traffic
- Fluctuations of demand in different months of year and different days of week



Monthly demand at counting stations



Day of week demand at counting stations

(January/February)

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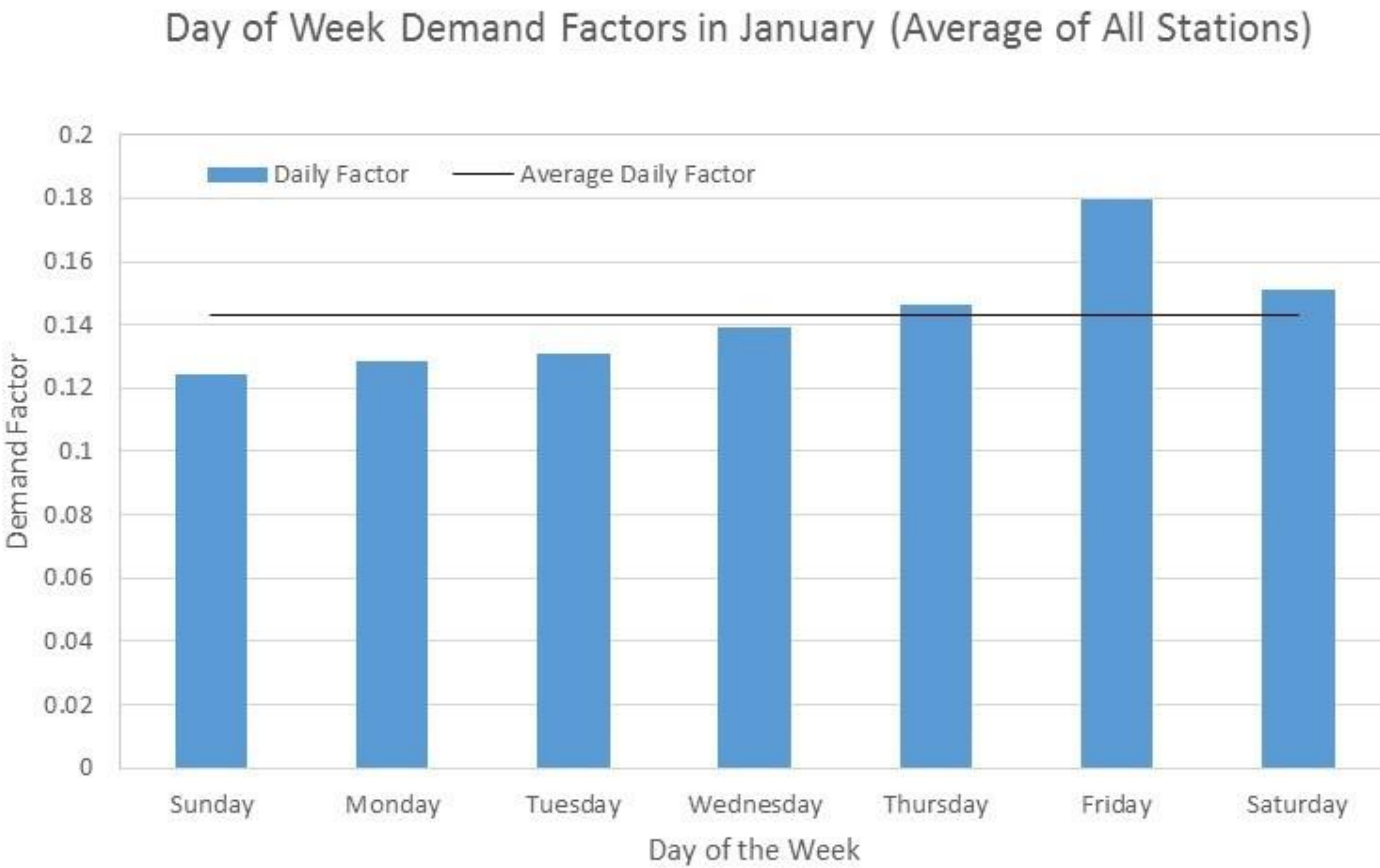

Day of week demand at counting stations

(July)

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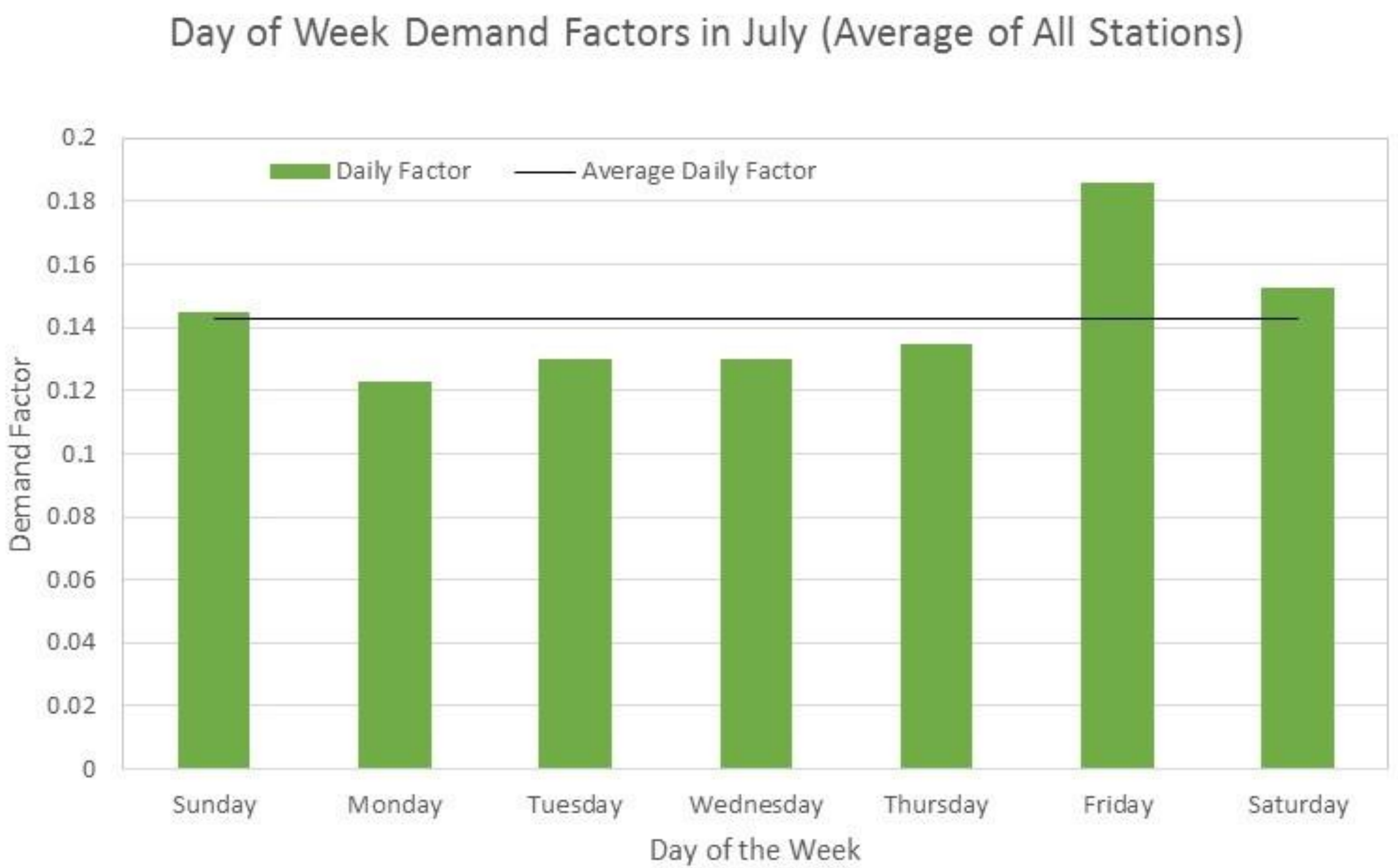

Day of week demand at counting stations

(October)

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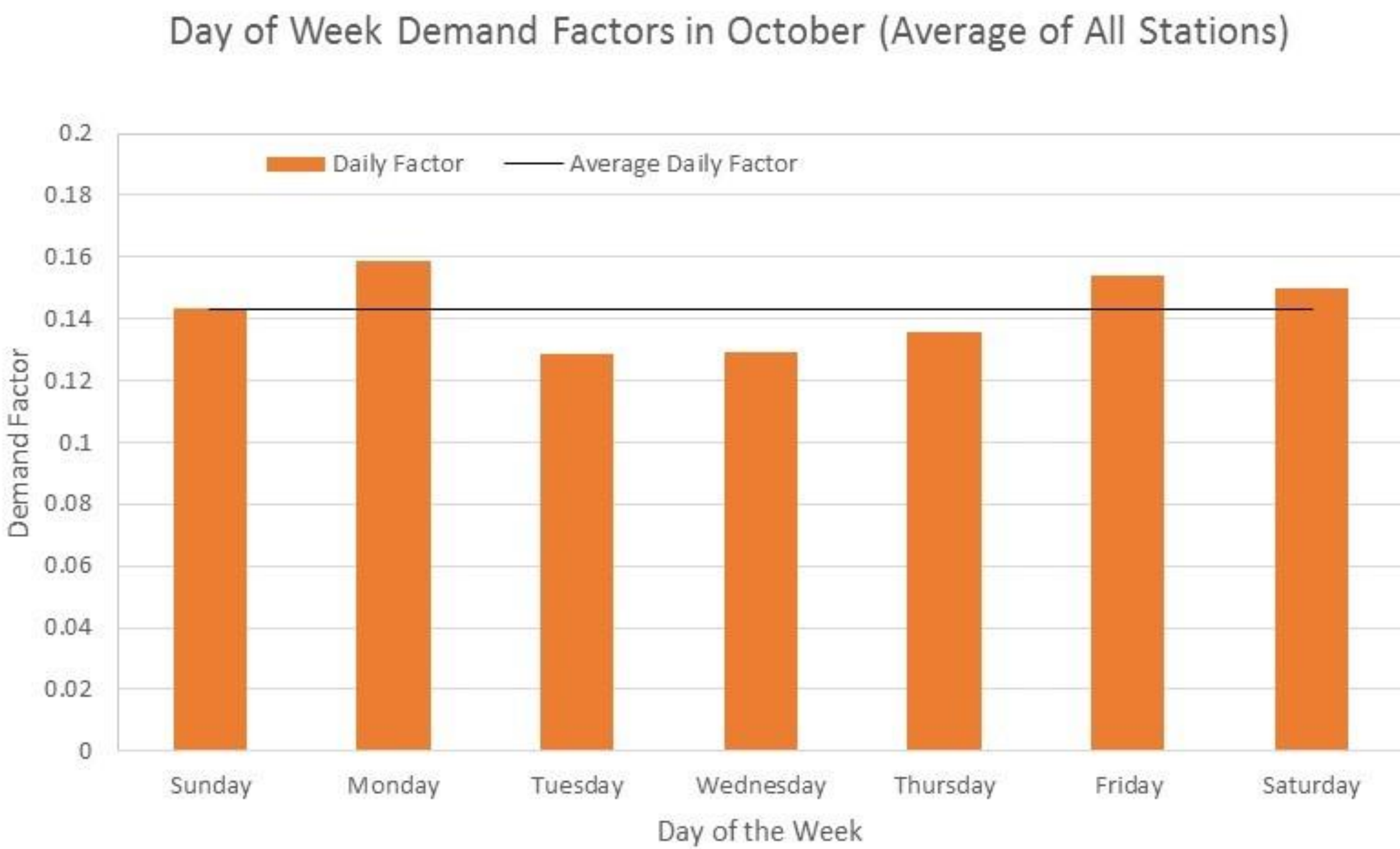

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Thank you!

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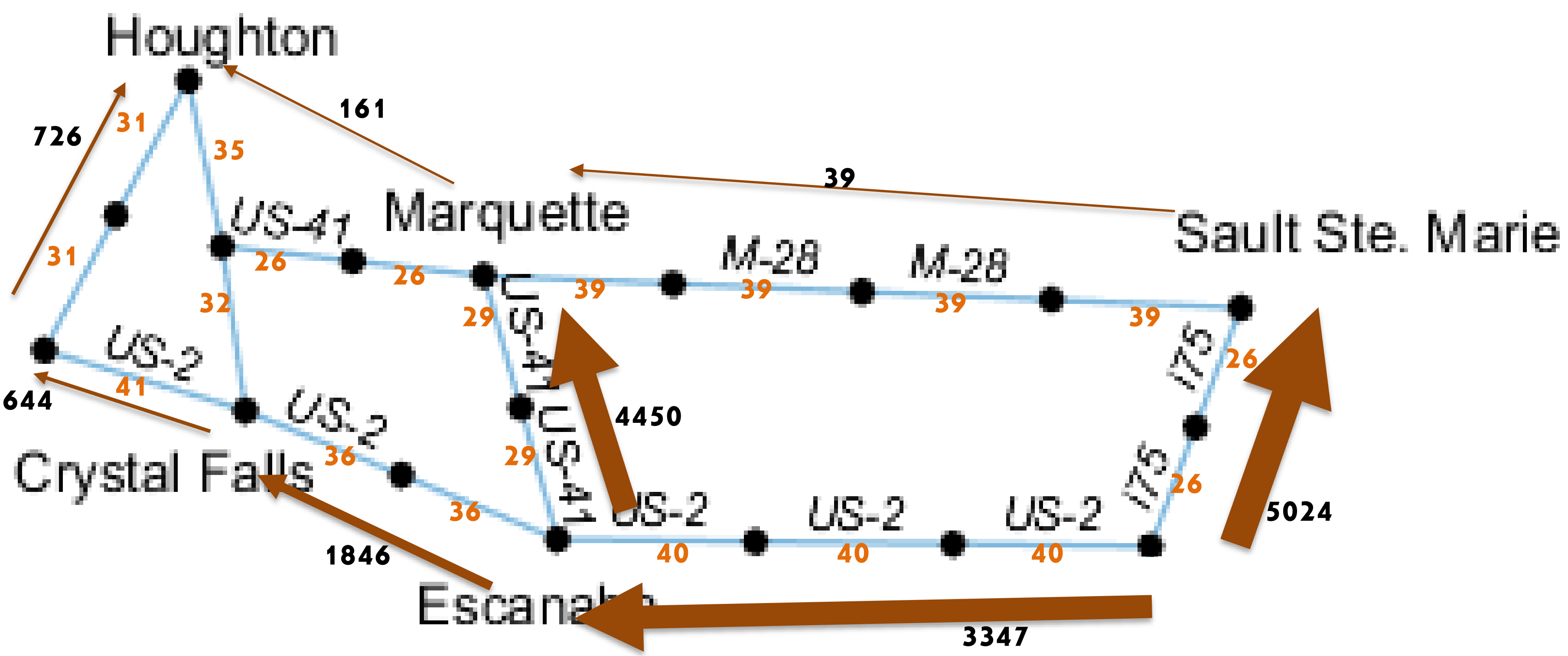
Demand and Distance in UP



Selected continuous counting stations

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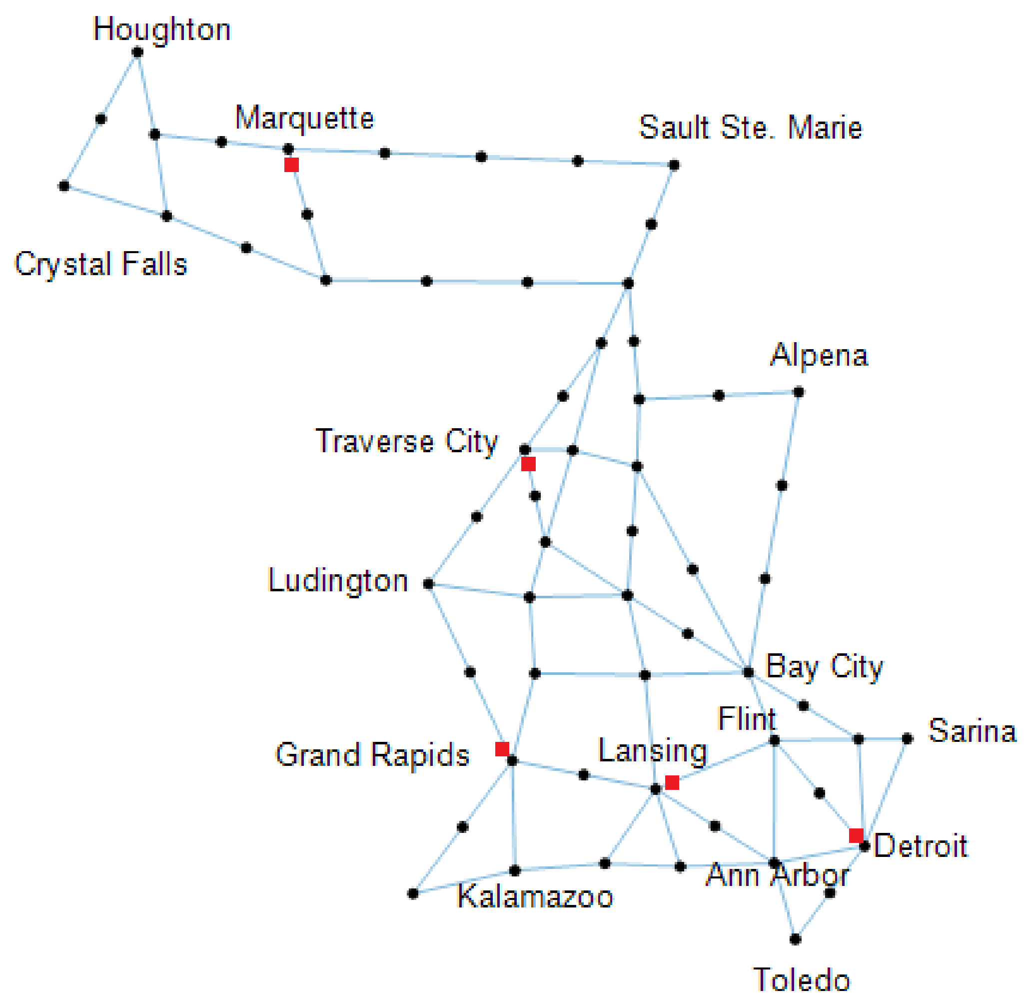
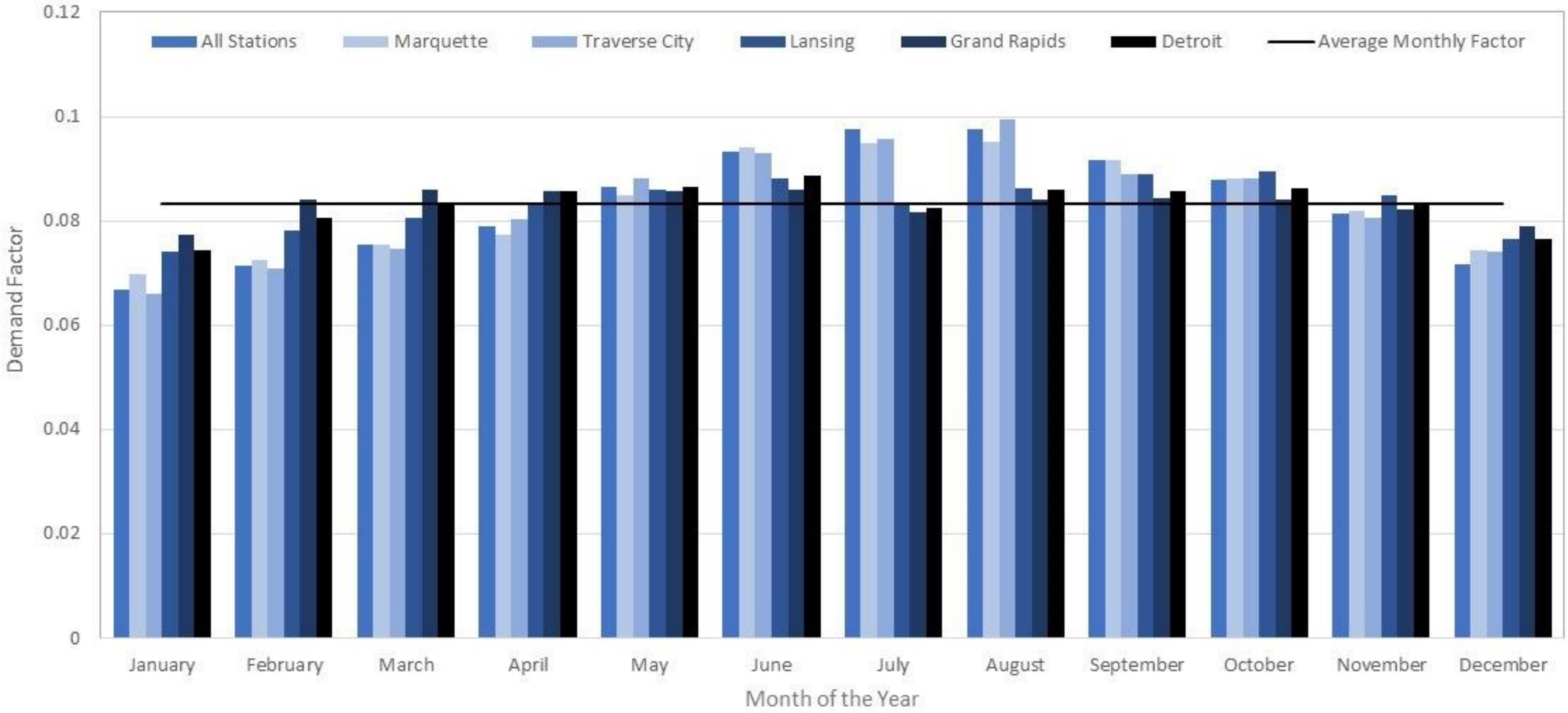
- 5 out of 122 counting stations statewide
- For demonstration and scenario selection purposes
- Distributed among major cities of the state



Monthly demand at counting locations



Demand at counting locations- Winter 2016

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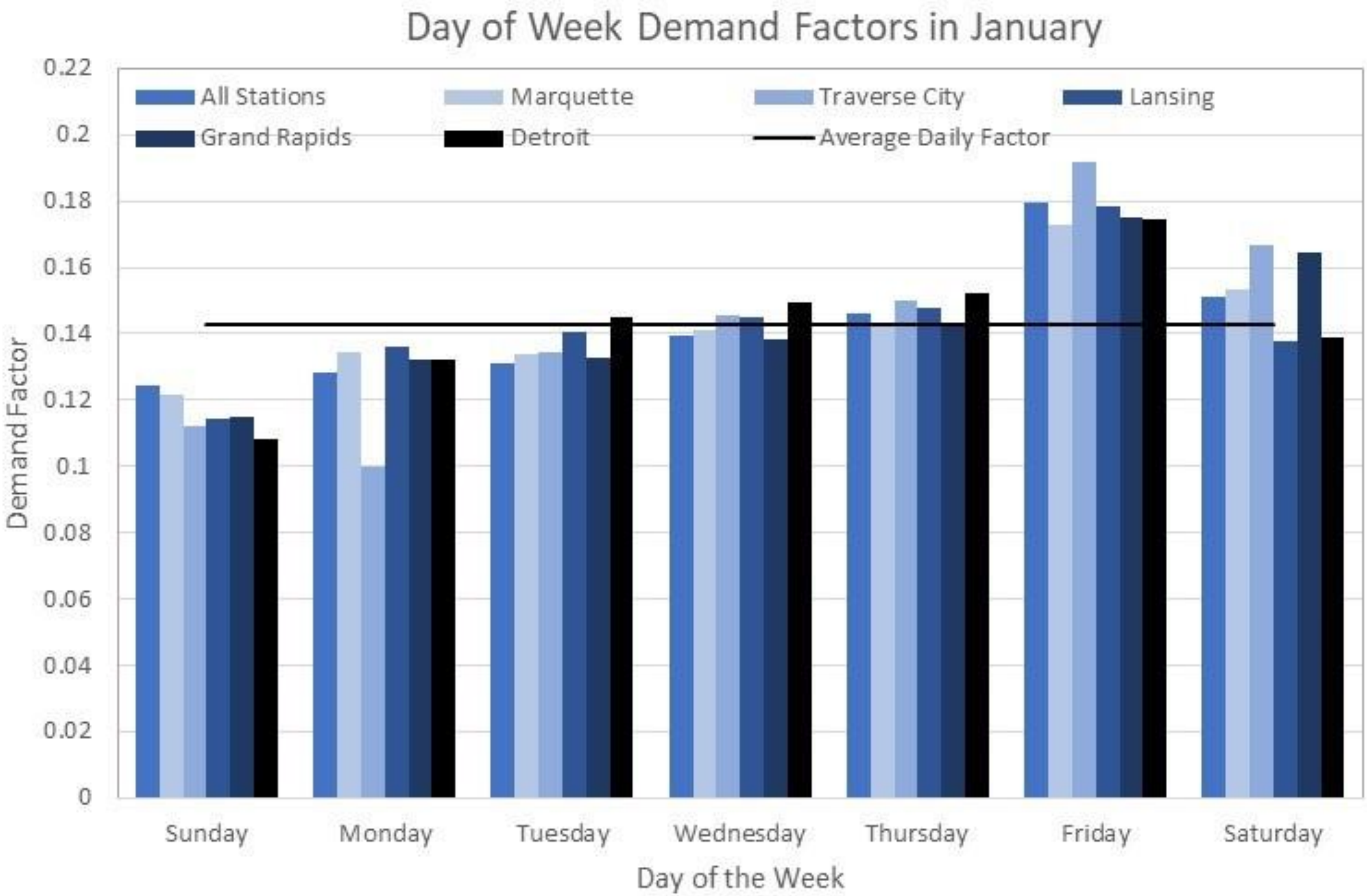

Demand at counting locations- Summer 2016

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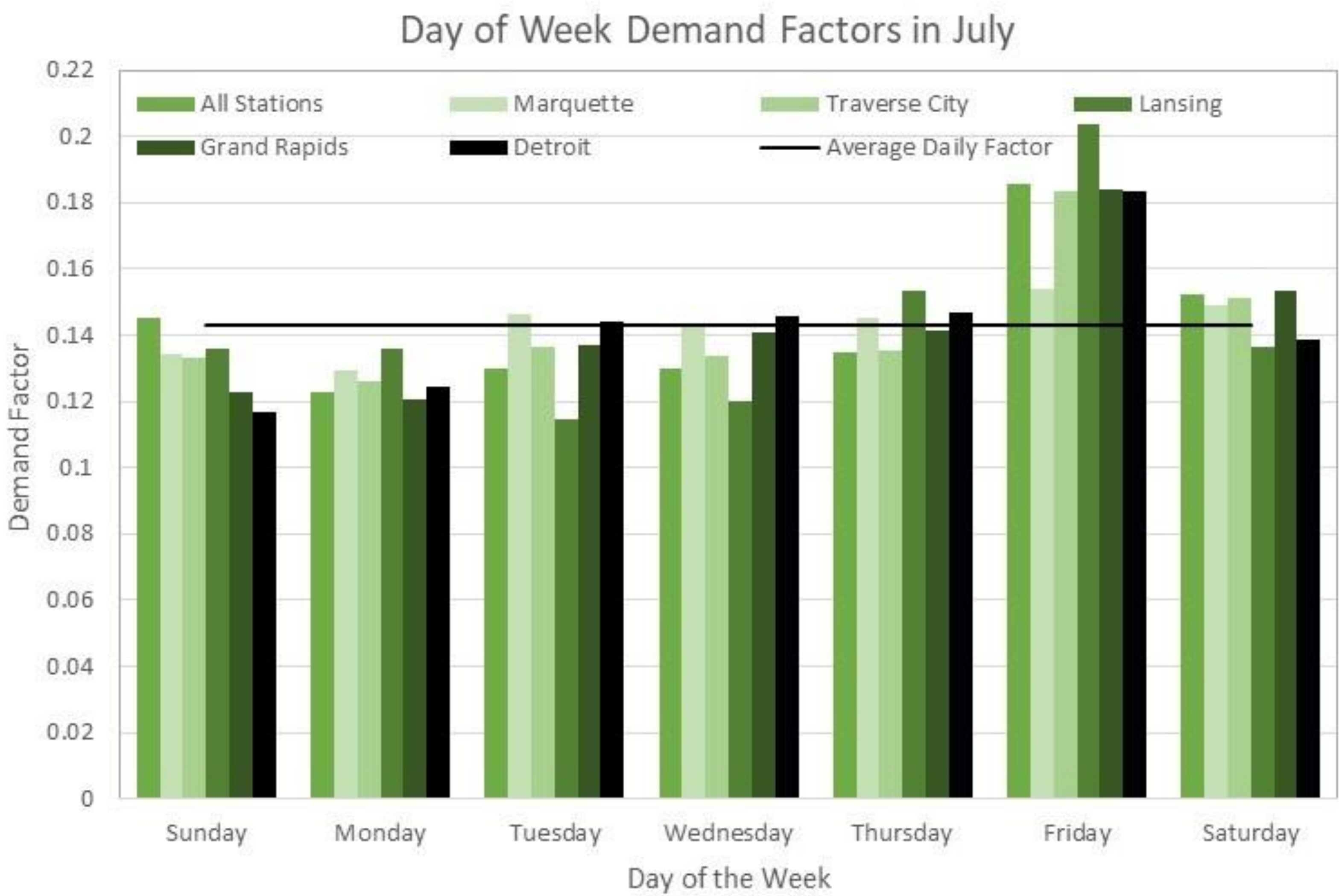

Demand at counting locations-Fall 2016