# NEVI Plan
# Charger Placement Project

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**June 13, 2022**

# Outline

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- Approach
- Input data
- Existing DCFC infrastructure
- NEVI DCFC infrastructure
- Charger placement results (Barebone, current and NEVI)
- Cost breakdown
- Future steps

# Approach

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Step 1- (Basic Feasibility Map)

- Map the **current** location of DCFC
- Find the optimum location of >150kW chargers to ensure **feasibility** of intercity trips
- Overlay the current DCFC locations and optimum location of >150kW DCFC to capture the **upgrades** required


Macroscopic Traffic Simulation

Optimization Model
*(Aggregate O/D Demand)*

Step 2- (NEVI Plan)

- Locate the DCFC based on **NEVI** plan requirements
- Map the **current** location of DCFC
- Find the optimum location of 4-150kW chargers or more to ensure **feasibility** of intercity trips
- Overlay the current DCFC locations and optimum location of 4-150kW DCFC to capture the **upgrades** required

Step 3- (Future Upgrades)

- Possibility of future upgrades to >350 kW chargers

# Data Inputs

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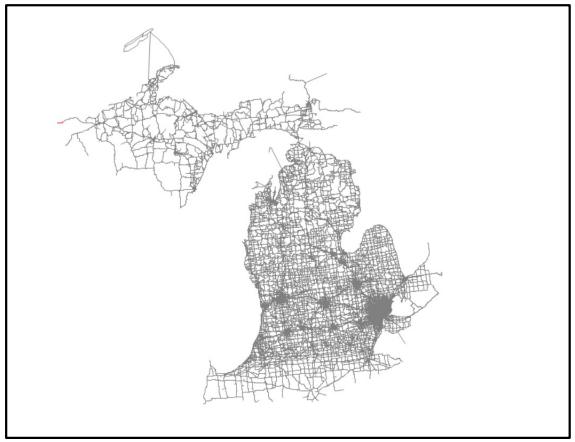
- Current location of DCFC (EGLE and AFDC)
- Road network (Michigan Department of Transportation)
- Traffic Analysis zones (Michigan Department of Transportation)
- Travel demand matrix (Michigan Department of Transportation)
- Electricity Provision Costs (Utilities)
- Charging station and charger costs (Charging Station Companies)
- Vehicle specifications (Car Companies)



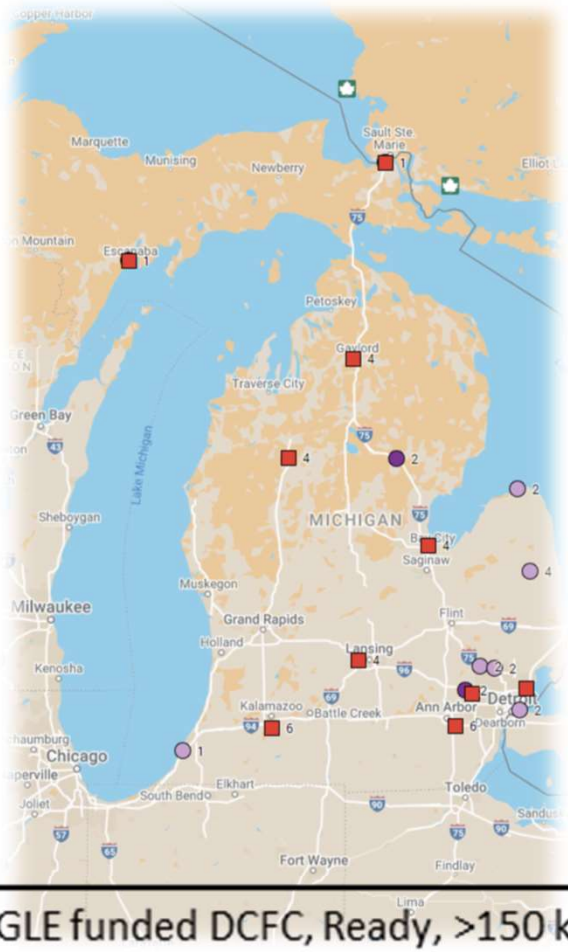
Extended road network of Michigan

- 83821 links
- 62996 nodes

EGLE funded DCFC >150 kw


AFDC DCFC >150 kw


EGLE funded and AFDC DCFC >150 kw




EGLE funded DCFC, Ready, >150 kw

EGLE funded DCFC, Pending, >150 kw

AFDC DCFC, ready, >150 kw

# Michigan Alternative Fuel Corridors

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# Current fast charging stations (>150 kW chargers)

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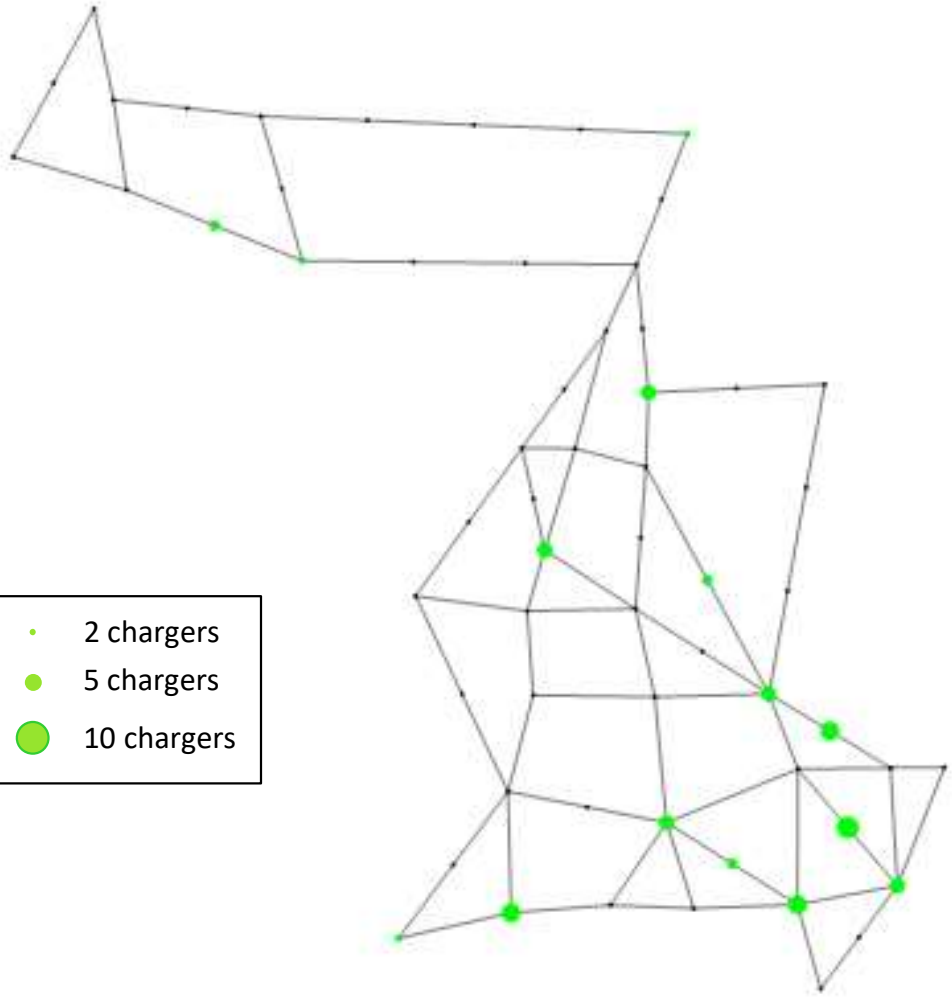
Total Number of Stations = 15
Total Number of Chargers = 55



# Current >150 kW+ NEVI charging stations

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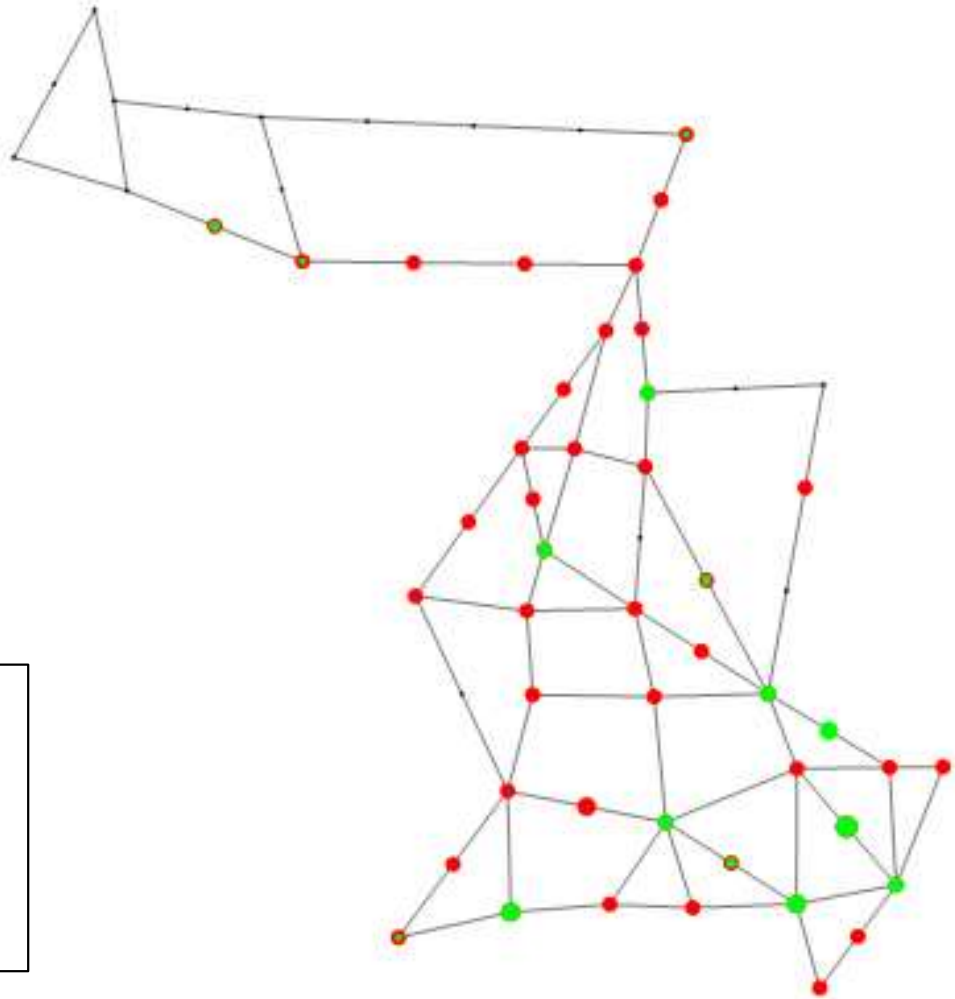
- At least four Combined Charging System (CCS) ports
- Station power capability should be no less than 600 kW
- At least 150 kW per port



# Barebone Without Current

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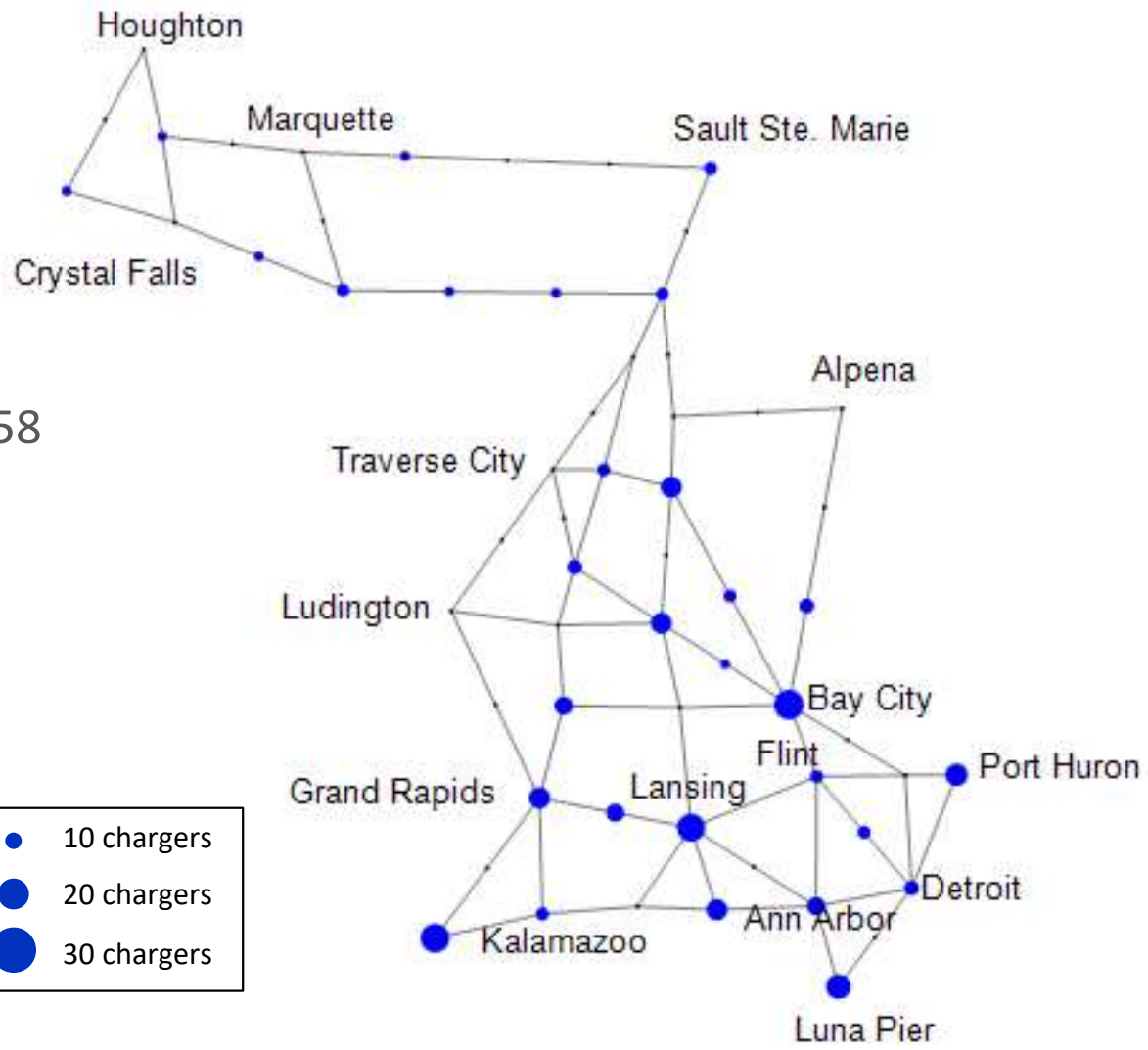
Market Share: 6%
Battery: 70 kWh
Charger: 150 kW
Month: February

Total Number of Stations = 30
Total Number of Chargers = 165
Station Investment Cost (million $) = 5.64
Land Investment Cost (million $) = 0.31
Charger Investment Cost (million $) = 12.58
Total Cost (million $)= 18.53
Total Refueling Time (h)= 1073.22
Total Queuing Time (h)= 0.08
Average Delay (min)= 12.9
Total Energy Demand (MWh) = 128.99



# Barebone and Current

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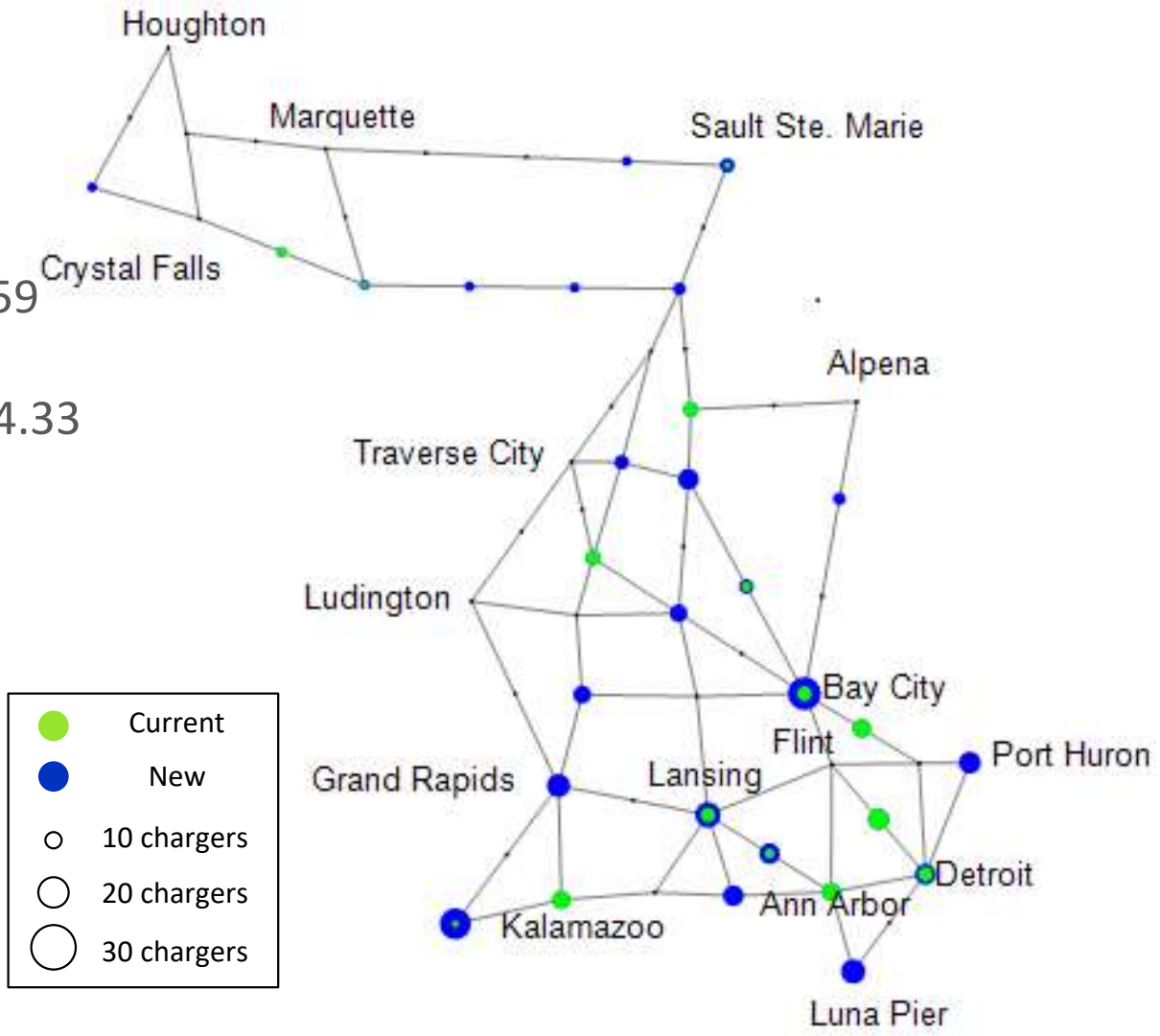
Market Share: 6%
Battery: 70 kWh
Charger: 150 kW
Month: February

Total Number of Stations = 29
Total Number of Chargers = 188
Station Investment Cost (million $) = 5.59
Land Investment Cost (million $) = 0.36
Charger Investment Cost (million $) = 14.33
Total Cost (million $) = 20.29
Total Refueling Time (h) = 1068.57
Total Queuing Time (h) = 0.00
Average Delay (min) = 12.19
Total Energy Demand (MWh) = 126



# Barebone, Current and NEVI

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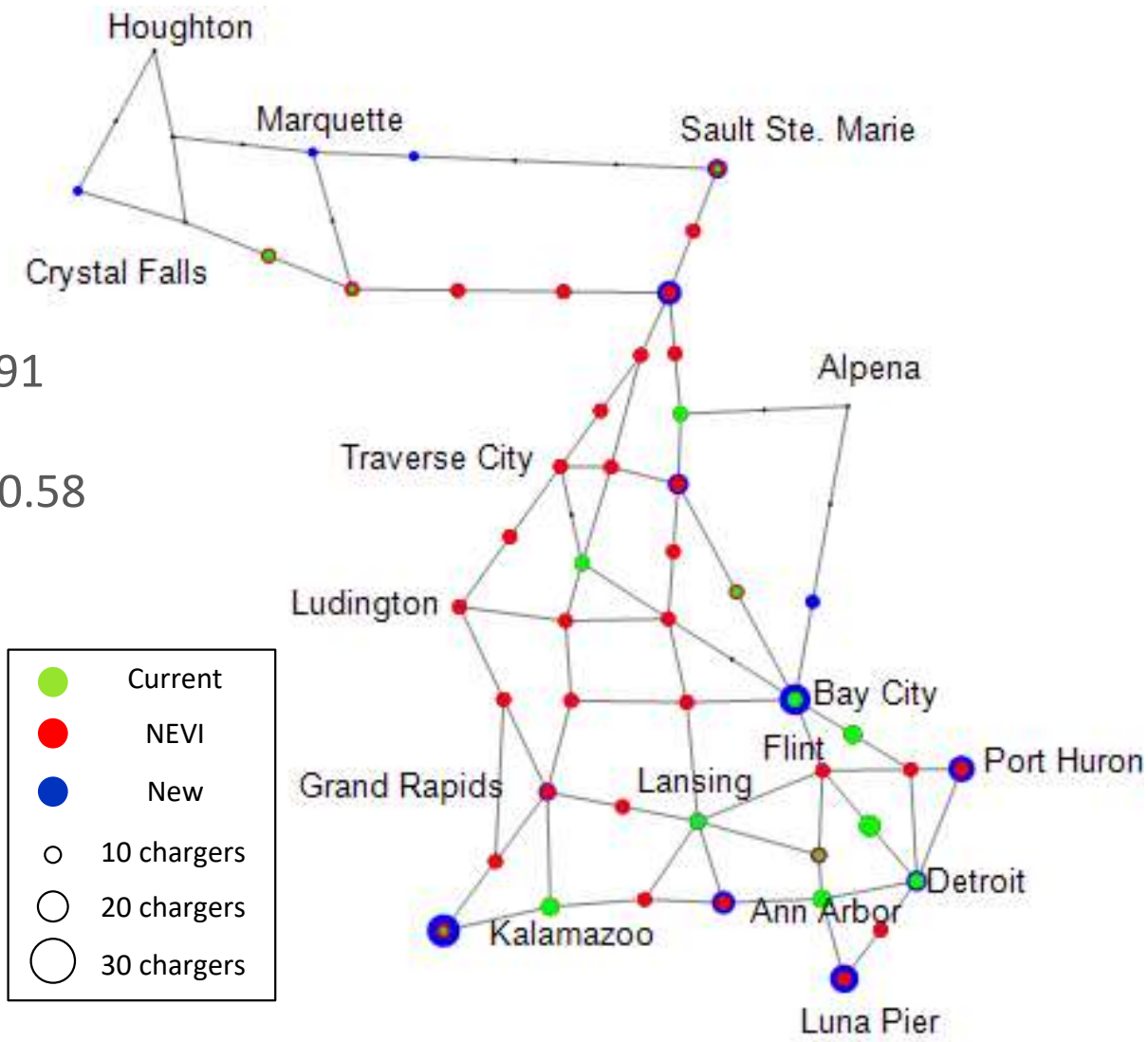
Scenario 1

Market Share: 6%
Battery: 70 kWh
Charger: 150 kW
Month: February
Initial SOC = 100%

Total Number of Stations = 47
Total Number of Chargers = 270
Station Investment Cost (million $) = 8.91
Land Investment Cost (million $) = 0.51
Charger Investment Cost (million $) = 20.58
Total Cost (million $) = 30.01
Total Refueling Time (h) = 1084.80
Total Queuing Time (h) = 0.00
Average Delay (min) = 12.36
Total Energy Demand (MWh) = 130



# Barebone, Current and NEVI

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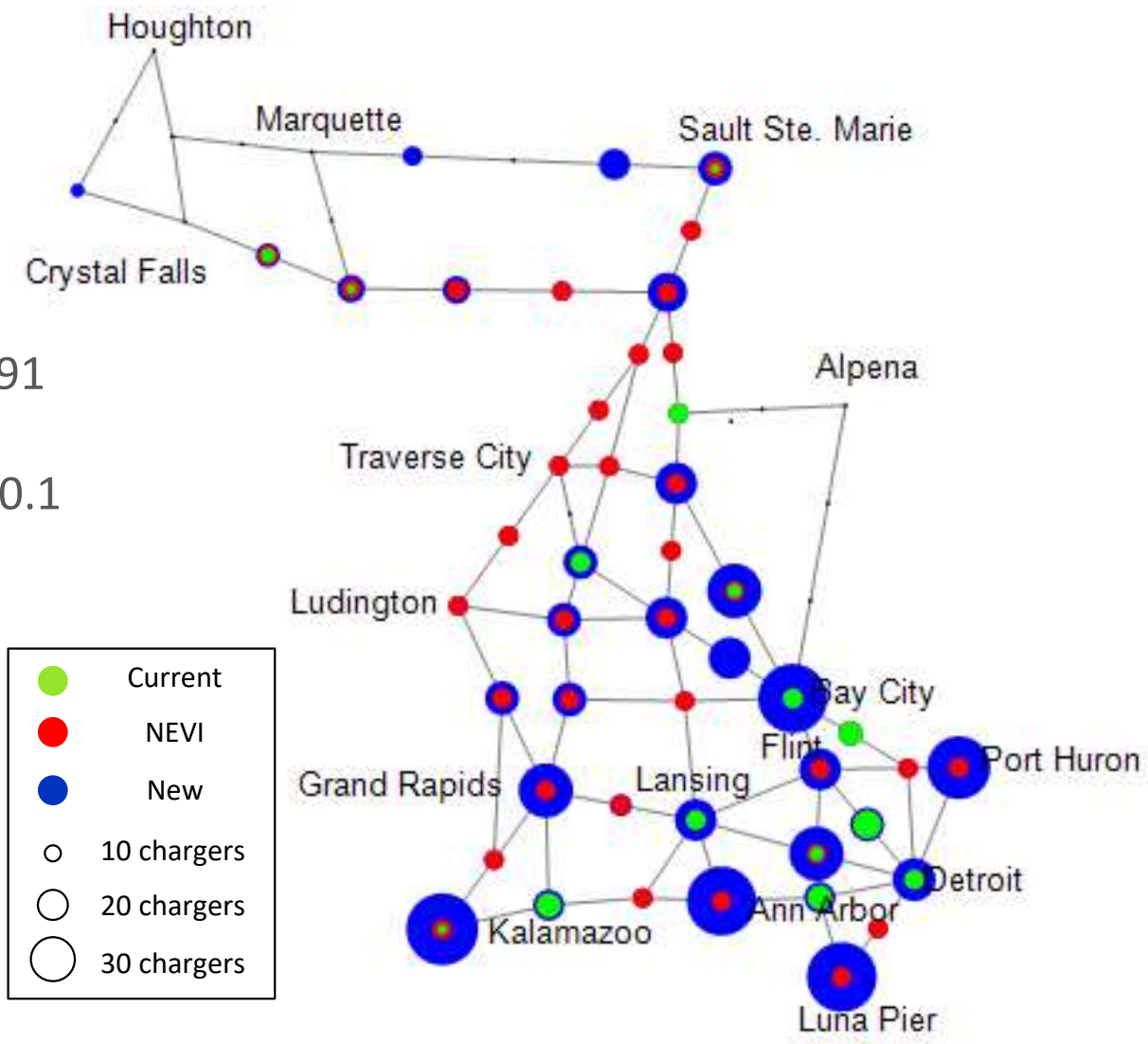
Scenario 2

Market Share: 25%
Battery: 70 kWh
Charger: 150 kW
Month: February
Initial SOC = 100%

Total Number of Stations = 47
Total Number of Chargers = 657
Station Investment Cost (million $) = 8.91
Land Investment Cost (million $) = 1.26
Charger Investment Cost (million $) = 50.1
Total Cost (million $) = 60.27
Total Refueling Time (h) = 3400.36
Total Queuing Time (h) = 1084.57
Average Delay (min) = 16.48
Total Energy Demand (MWh) = 408



# Barebone, Current and NEVI

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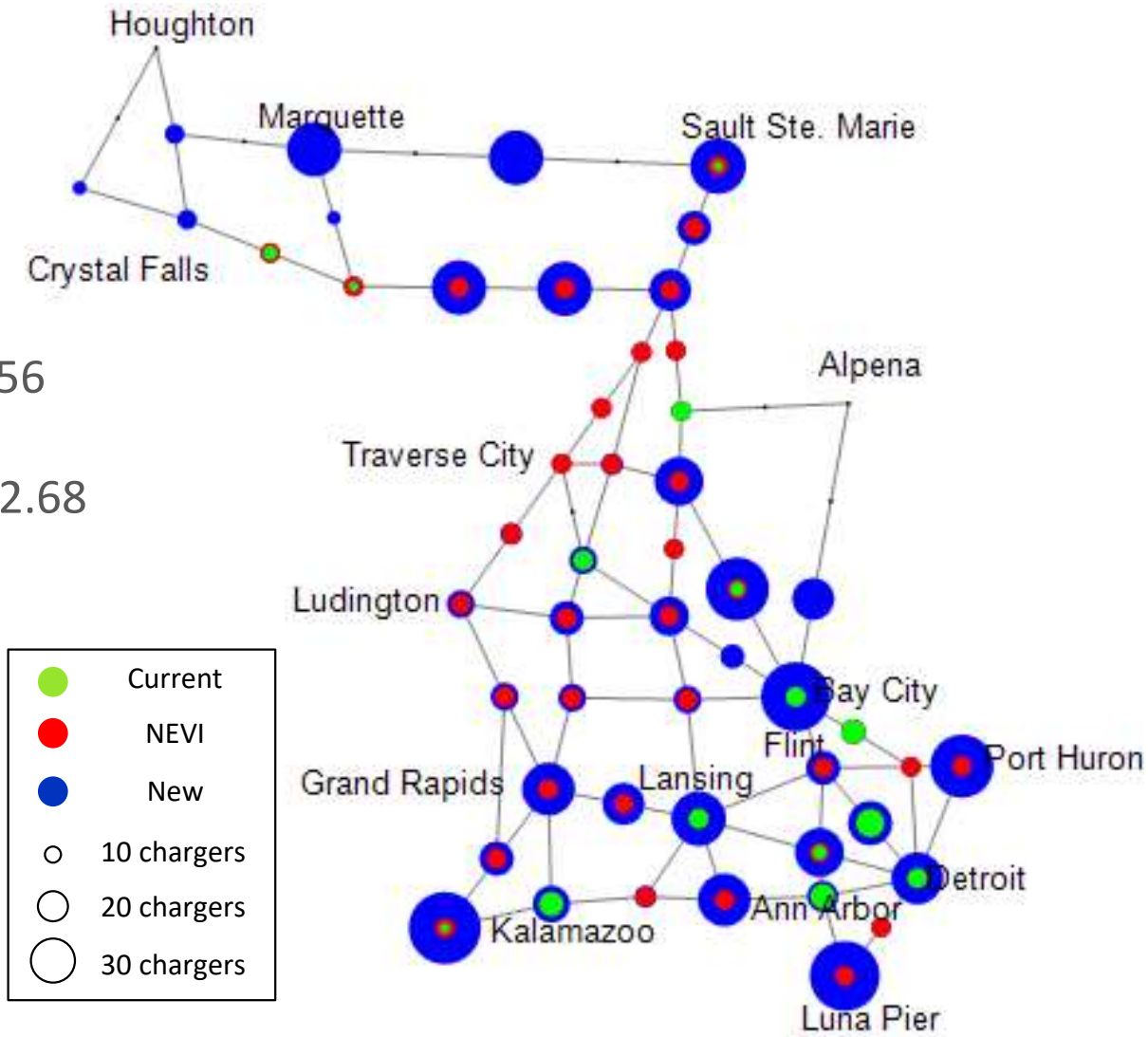
Scenario 3

Market Share: 25%
Battery: 70 kWh
Charger: 150 kW
Month: February
Initial SOC = 60%

Total Number of Stations = 51
Total Number of Chargers = 822
Station Investment Cost (million $) = 9.56
Land Investment Cost (million $) = 1.56
Charger Investment Cost (million $) = 62.68
Total Cost (million $) = 73.80
Total Refueling Time (h) = 4310.38
Total Queuing Time (h) = 429.21
Average Delay (min) = 14.86
Total Energy Demand (MWh) = 518



# Future 350 Upgrade

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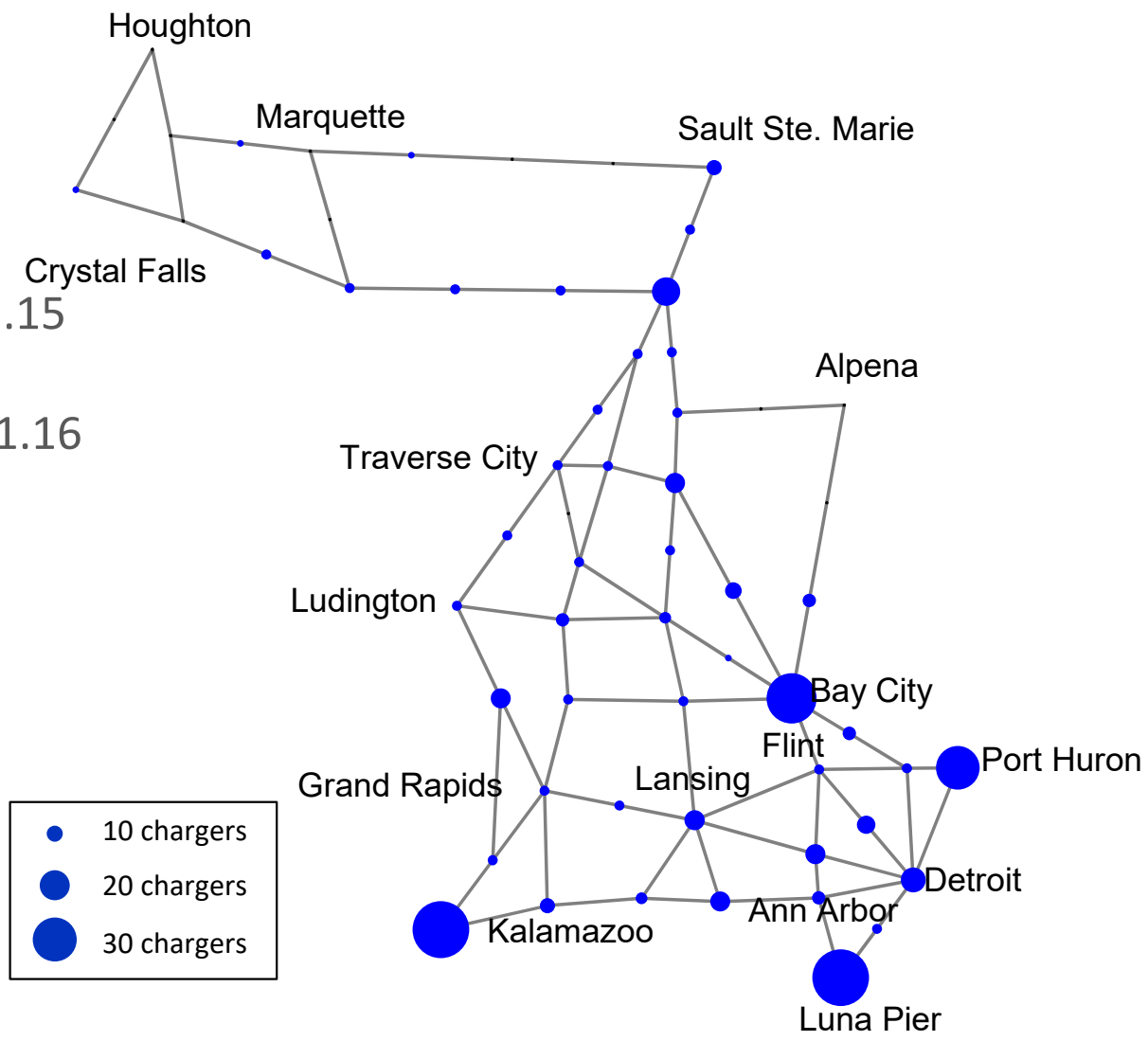
Market Share: 25%
Battery: 70 kWh
Charger: 300 kW
Month: February

Total Number of Stations = 48
Total Number of Chargers = 359
Station Investment Cost (million $) = 11.15
Land Investment Cost (million $) = 0.68
Charger Investment Cost (million $) = 51.16
Total Cost (million $)= 62.99
Total Refueling Time (h)= 1563.69
Total Queuing Time (h)= 40.76
Average Delay (min)= 4.6
Total Energy Demand (MWh) = 360.85



# Cost breakdown of Barebone Network

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| Item | Current/ Pending | New | Total |
|---|---|---|---|
| Number of Stations | 15 | 14 | 29 |
| Number of Chargers | 55 | 133 | 188 |
| Station Investment Cost (million $) | 2.93 | 2.67 | 5.59 |
| Land Investment Cost (million $) | 0.10 | 0.25 | 0.36 |
| Charger Investment Cost (million $) | 4.19 | 10.14 | 14.34 |
| Total Cost ($ million) | 7.23 | 13.06 | 20.29 |

# Cost breakdown of NEVI and Barebone Network

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## Scenario 1- 6% Market Share and 100% i-SOC

| Item | Current/ Pending | NEVI | New | Total |
|---|---|---|---|---|
| Number of Stations | 15 | 28 | 4 | 47 |
| Number of Chargers | 55 | 127 | 88 | 270 |
| Station Investment Cost (million $) | 2.97 | 5.29 | 0.65 | 8.91 |
| Land Investment Cost (million $) | 0.10 | 0.24 | 0.17 | 0.51 |
| Charger Investment Cost (million $) | 4.19 | 9.68 | 6.71 | 20.59 |
| Total Cost ($ million) | 7.27 | 15.21 | 7.53 | 30.01 |

# Cost breakdown of NEVI and Barebone Network

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## Scenario 2- 25% Market Share and 100% i-SOC

| Item | Current/ Pending | NEVI | New | Total |
|---|---|---|---|---|
| Number of Stations | 15 | 28 | 4 | 47 |
| Number of Chargers | 55 | 127 | 475 | 657 |
| Station Investment Cost (million $) | 2.97 | 5.29 | 0.65 | 8.91 |
| Land Investment Cost (million $) | 0.10 | 0.24 | 0.92 | 1.26 |
| Charger Investment Cost (million $) | 4.19 | 9.68 | 36.22 | 50.10 |
| Total Cost ($ million) | 7.27 | 15.21 | 37.79 | 60.27 |

# Cost breakdown of NEVI and Barebone Network

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## Scenario 3- 25% Market Share and 60% i-SOC

| Item | Current/ Pending | NEVI | New | Total |
|---|---|---|---|---|
| Number of Stations | 15 | 28 | 8 | 51 |
| Number of Chargers | 55 | 127 | 640 | 822 |
| Station Investment Cost (million $) | 2.97 | 5.29 | 1.30 | 9.56 |
| Land Investment Cost (million $) | 0.10 | 0.24 | 1.22 | 1.56 |
| Charger Investment Cost (million $) | 4.19 | 9.68 | 48.80 | 62.68 |
| Total Cost ($ million) | 7.27 | 15.21 | 51.32 | 73.80 |

# Spatiotemporal Analysis

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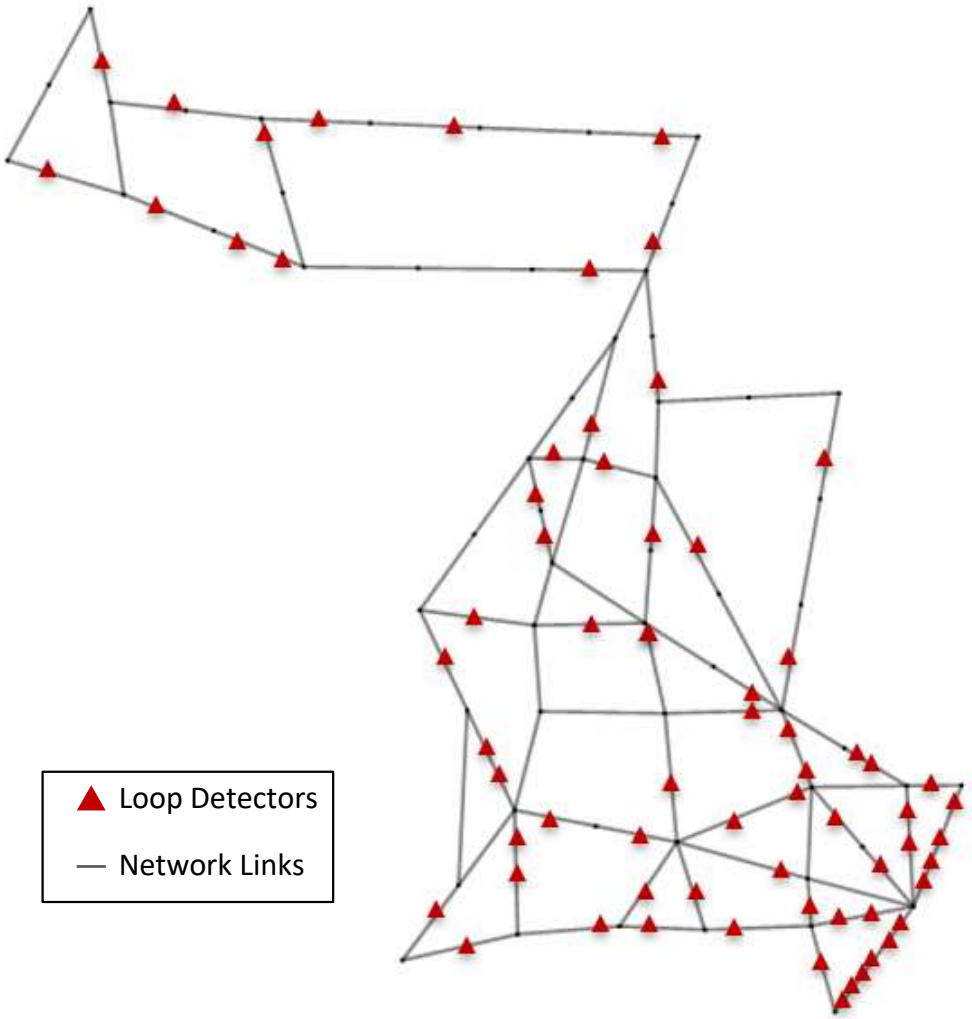
Total Number of Counters = 122
# Counters Matched to Existing Links = 69



# Total Demand

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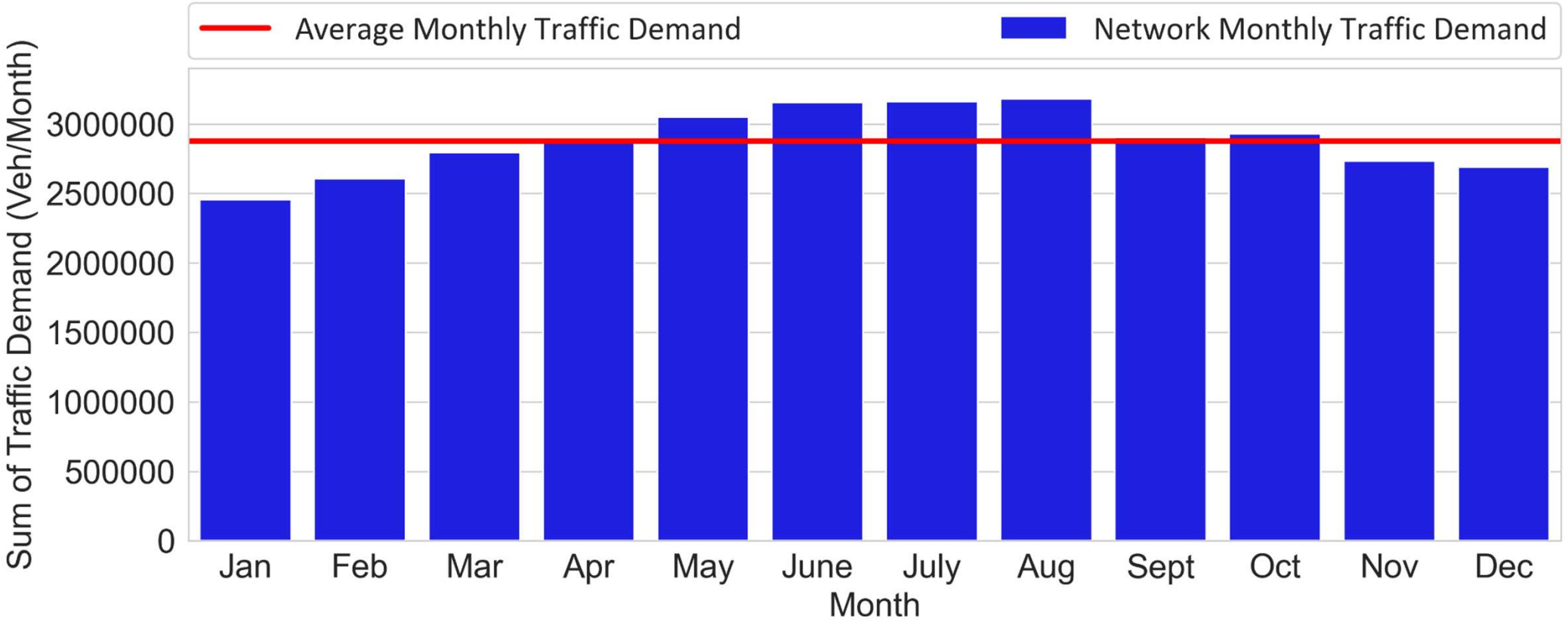
Total monthly demand of the Michigan network for different months
AVG = 2.88 millions



# Demand of LP vs UP

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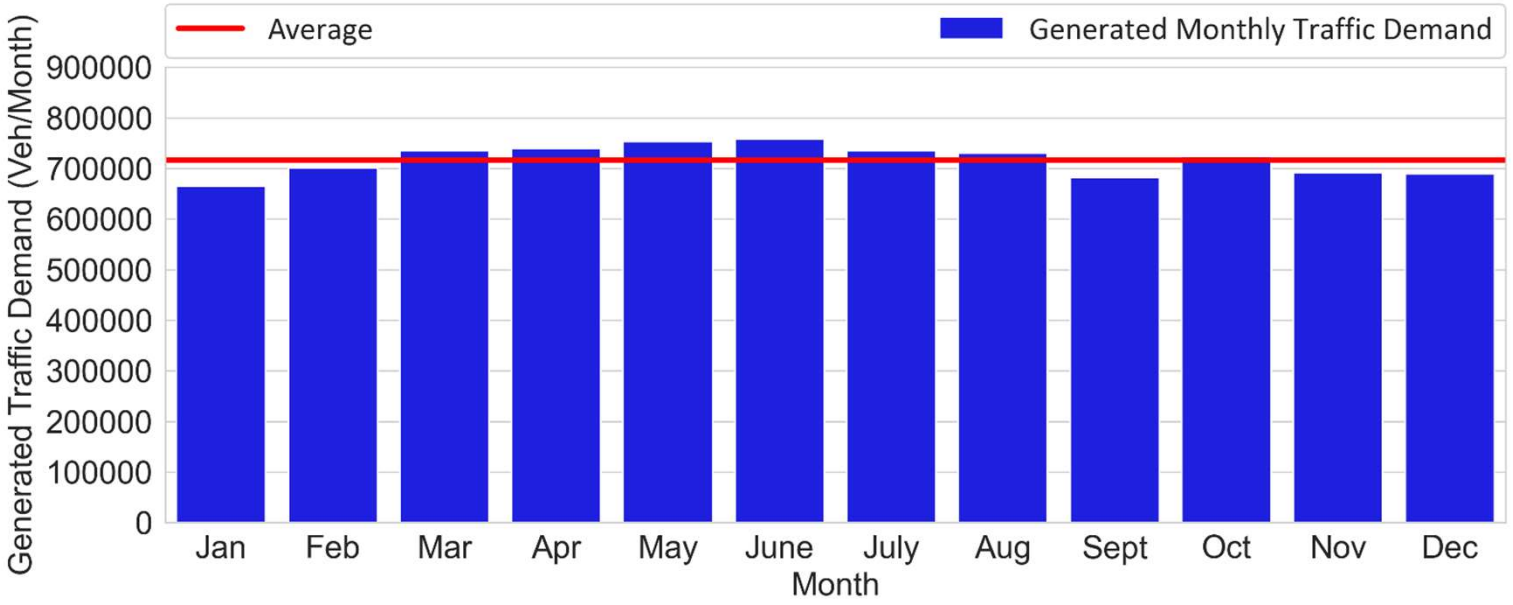
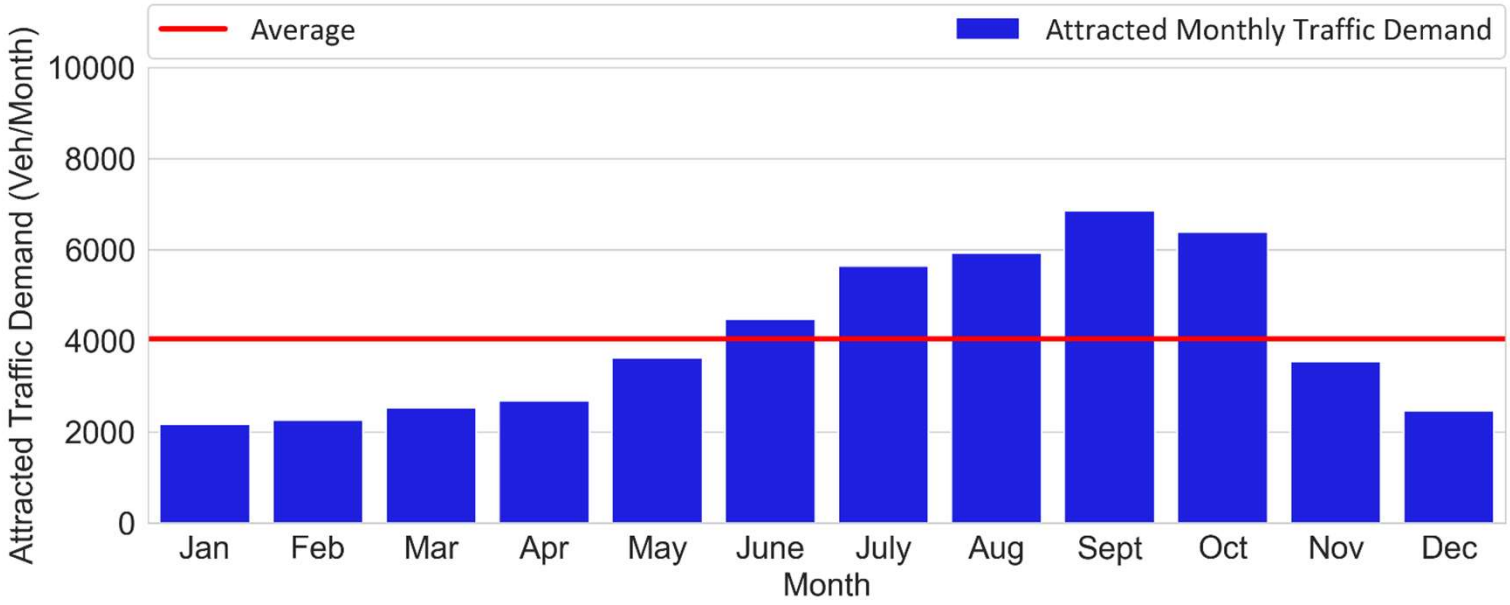
Generated Trips in **Detroit**




Attracted Trips to **Sault Ste. Marie**



# Barebone, Current and NEVI

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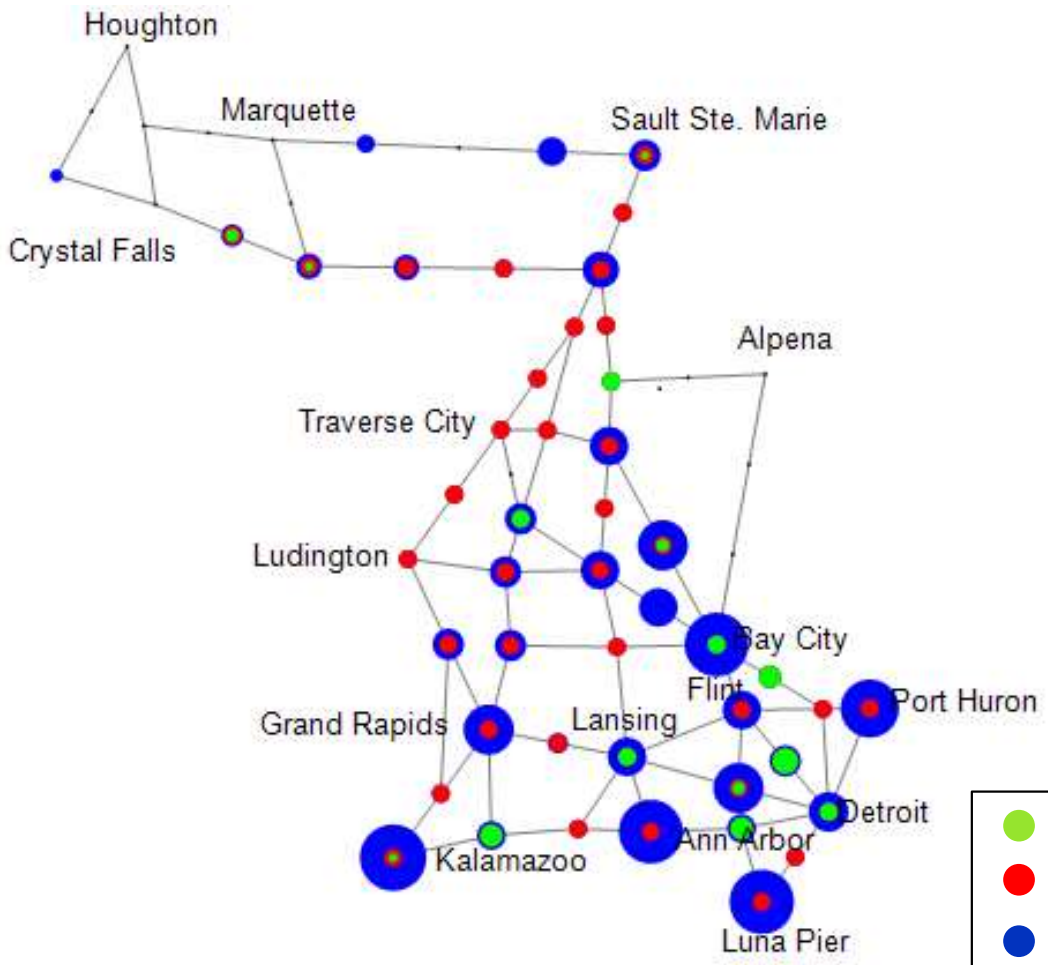
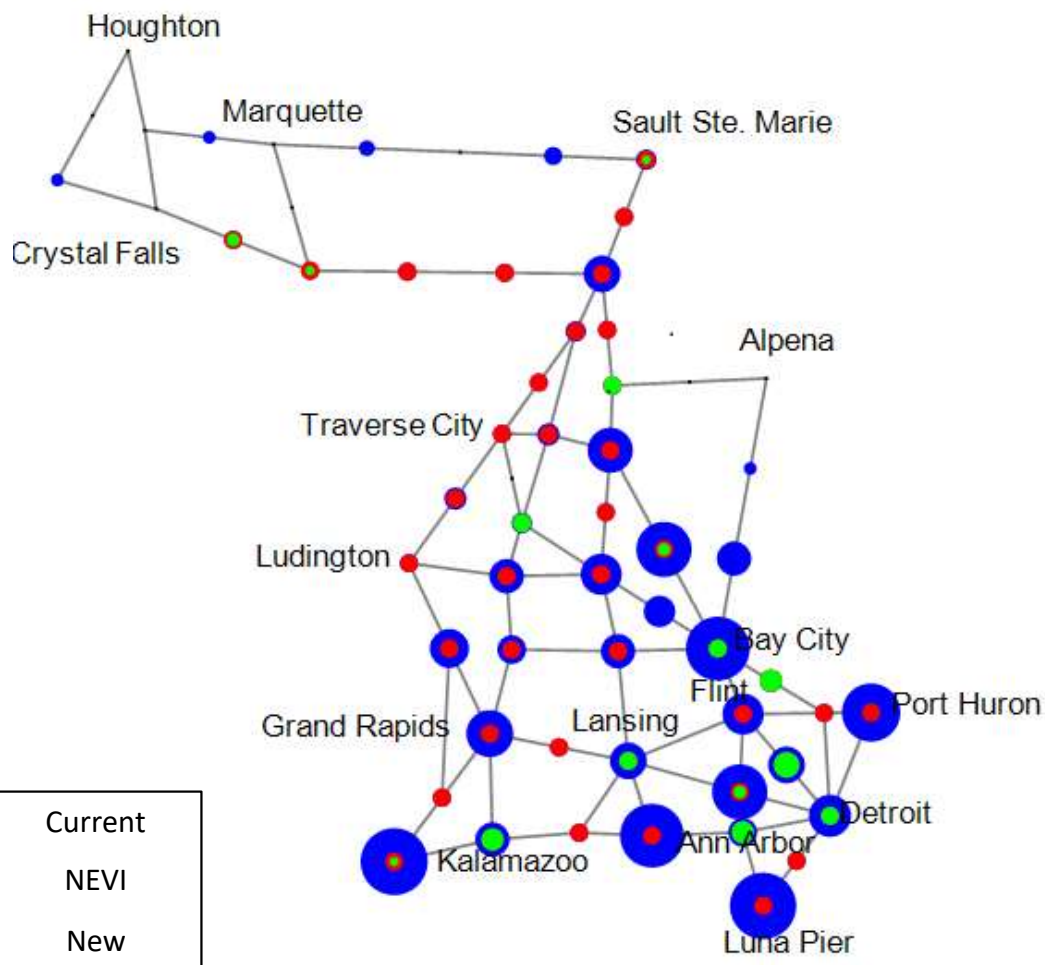
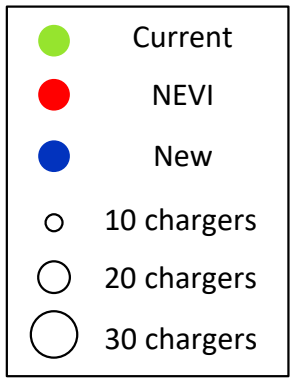
## Previous OD Factors




## New OD Factors



# Barebone, Current and NEVI

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## Previous OD Factors

Scenario 2
Market Share: 25%
Battery: 70 kWh
Month: February
Initial SOC = 100%
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Total Number of Chargers = 657
Station Investment Cost (million $) = 8.91
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Total Cost (million $) = 60.27
Total Refueling Time (h) = 3400.36
Total Queuing Time (h) = 1084.57
Average Delay (min) = 16.48
Total Energy Demand (MWh) = 408

## New OD Factors

Scenario 2
Market Share: 25%
Battery: 70 kWh
Month: February
Initial SOC = 100%
Total Number of Stations = 50
Total Number of Chargers = 688
Station Investment Cost (million $) = 9.35
Land Investment Cost (million $) = 1.31
Charger Investment Cost (million $) = 52.46
Total Cost (million $) = 63.12
Total Refueling Time (h) = 4085.63
Total Queuing Time (h) = 191.00
Average Delay (min) = 14.19
Total Energy Demand (MWh) = 491

# Future Steps

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- ✓ Update the Michigan intercity demand file
- ✓ Modify the modeling framework to consider current/pending charging infrastructure
- ✓ Analyze the Barebone Network considering current/pending DCFC infrastructure
- ✓ Consider the NEVI infrastructure assumption
- ✓ Update the network file
- ✓ Considering 25% market share
- ✓ Potential future upgrades to 350 kW
- ✓ Consider the spatial-temporal changes in demand

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# Thank You

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