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Charger Placement Project

City of Detroit

10-15-2019

Outline

- Selected Cities
- Modeling Framework
- Data Collection
  - Candidate points
- Preliminary Results

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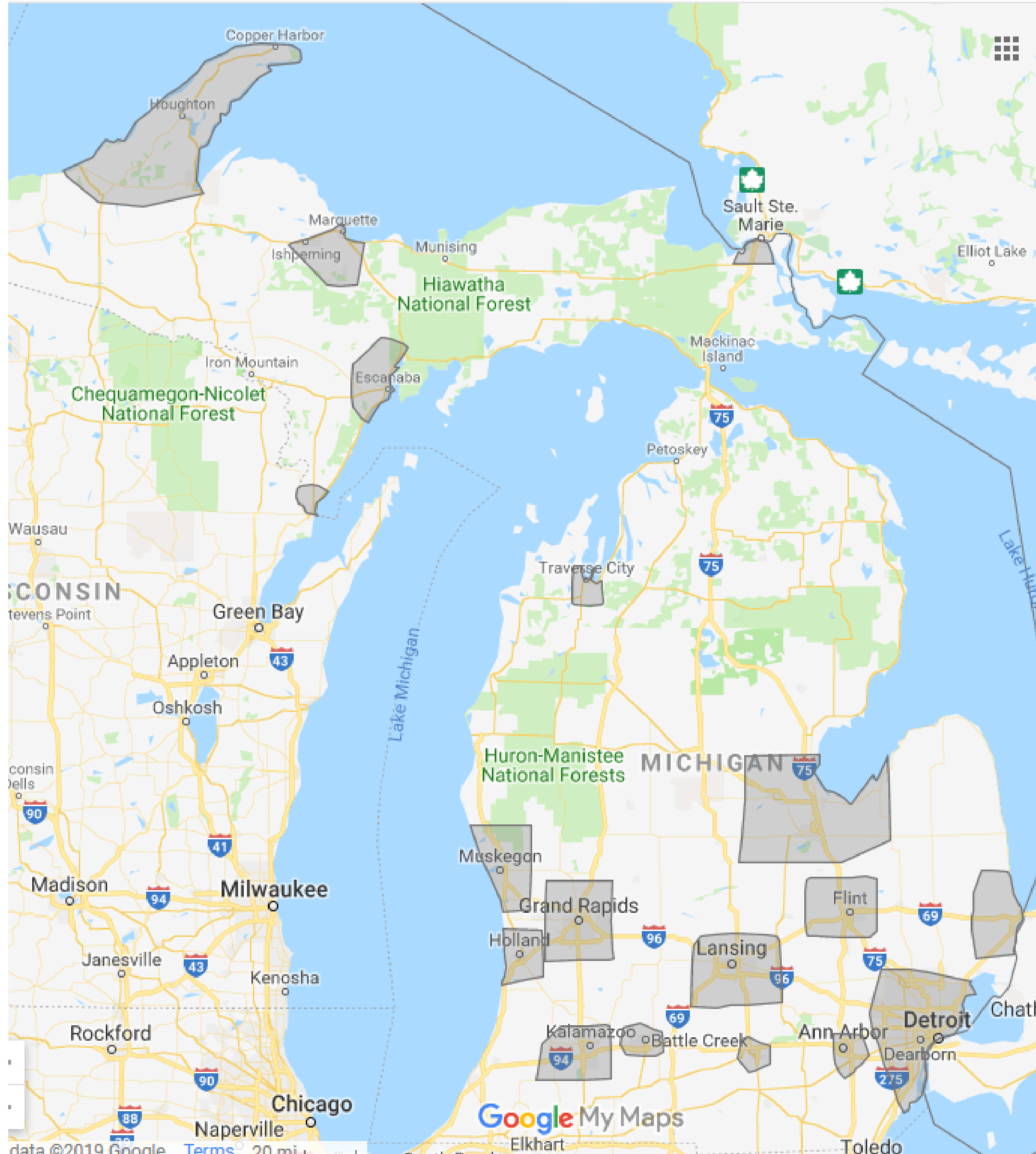
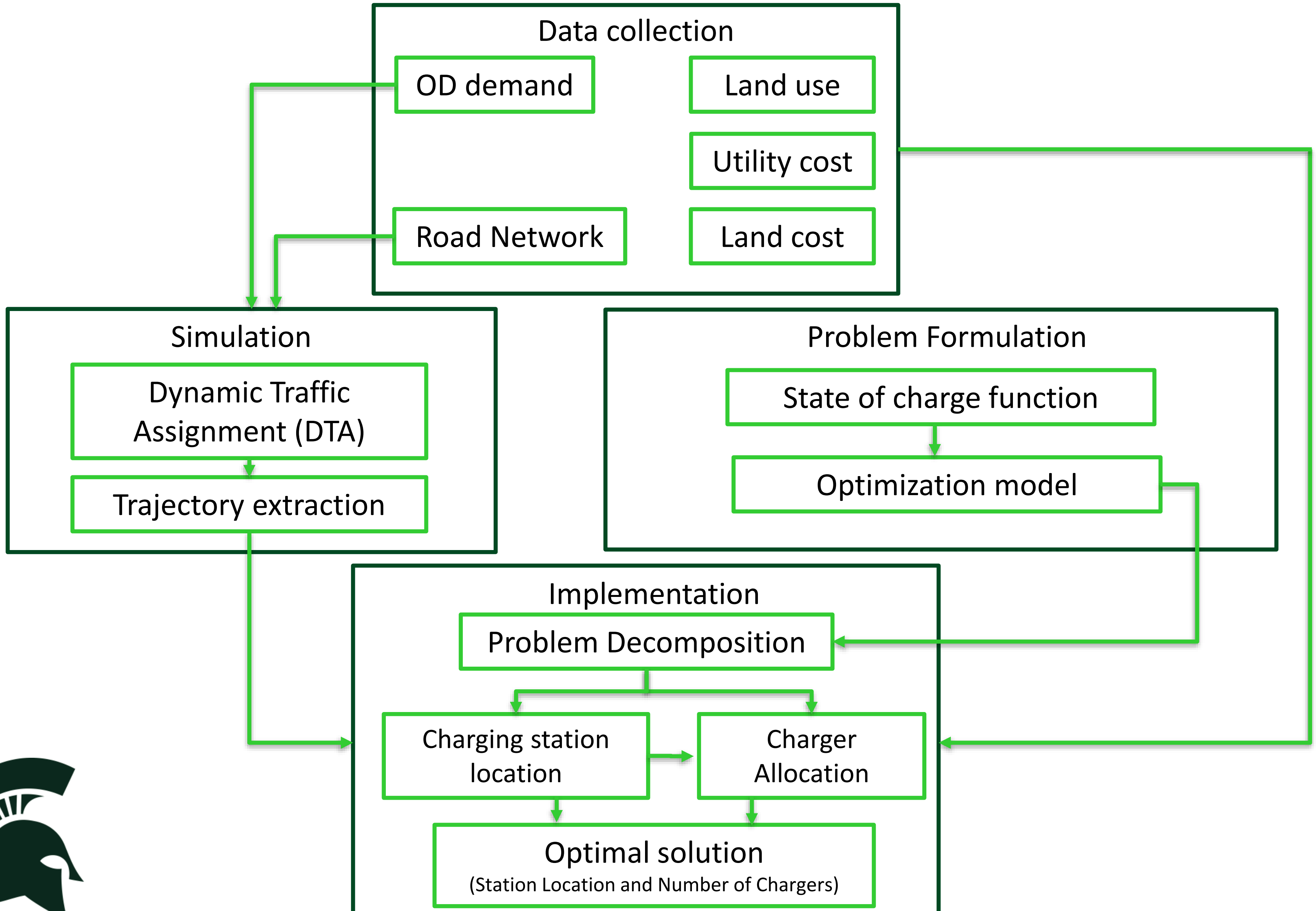
Selected Cities

- Muskegon
- Ann Arbor
- Kalamazoo
- Flint
- Saginaw
- Lansing
- Grand Rapids
- Detroit
- Marquette (UP)



Summary of Information

Cities/Parameter	No. of Nodes	No. of Zones	Generated Demand	Generated Demand (without Intra-Zone)	Lane Length (mi)	Miles Traveled
Marquette	62	21	178,741	142,042	336	931,957
Muskegon	387	52	535,443	410,954	916	3,161,057
Ann Arbor	413	36	624,618	503,611	789	3,894,950
Kalamazoo	369	55	712,796	534,587	1128	4,085,052
Flint	694	84	985,411	787,699	1557	6,760,436
Saginaw	783	116	1,054,842	808,925	2726	7,122,931
Lansing	896	91	1,086,242	890,079	2030	7,183,037
Grand Rapids	1031	82	1,726,732	1,353,026	2045	10,447,668
Detroit	5461	301	8,185,778	6,568,349	8776	52,293,864


Data collection
OD demand
Land use
Utility cost
Road Network
Land cost
Simulation
Dynamic Traffic Assignment (DTA)
Trajectory extraction
Problem Formulation
State of charge function
Optimization model
Implementation
Problem Decomposition
Charging station location
Charger Allocation
Optimal solution
(Station Location and Number of Chargers)

Data Collection

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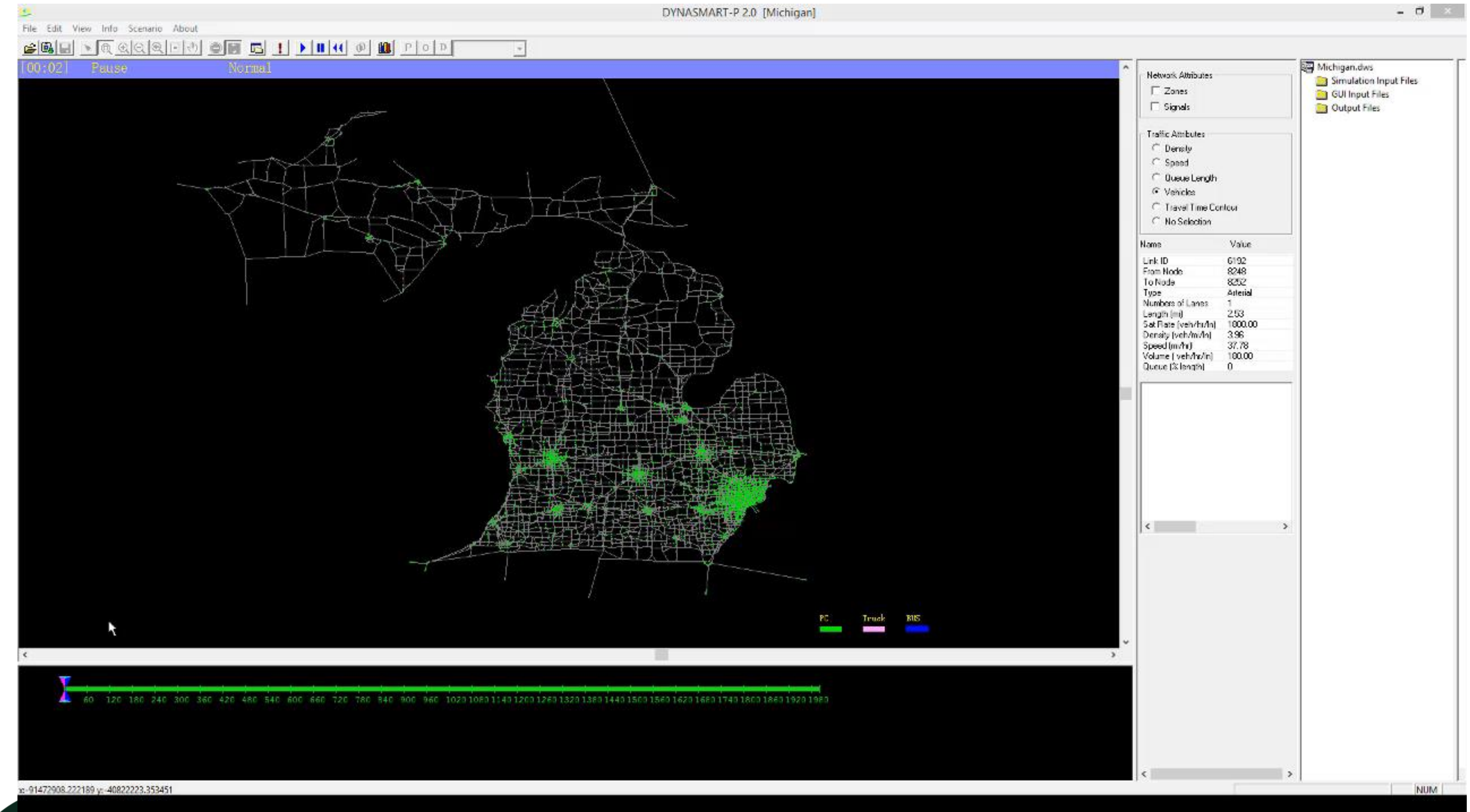
Stakeholder Meetings

The required inputs to the model include:

- Road network (Michigan Department of Transportation)
- Traffic Analysis zones (Michigan Department of Transportation)
- Travel demand matrix (Michigan Department of Transportation)
- Electricity Provision Costs (Utilities)
- Land Use (Michigan Department of Transportation and MPOs)
- Average Land Cost (MPOs)
- Car Companies
- Charging station and charger costs (Charging Station Companies)


DYNASMART-P 2.0 [Michigan]
File Edit View Info Scenario About
[00:02] Pause Normal
Network Attributes
Zones
Signals
Traffic Attributes
Density
Speed
Queue Length
Vehicles
Travel Time Contour
No Selection
Name Value
Link ID 6192
From Node 8248
To Node 8252
Type Arterial
Numbers of Lanes 1
Length (mi) 2.53
Sat Rate (veh/hr/ln) 1000.00
Density (veh/m/ln) 3.96
Speed (m/hr) 37.78
Volume (veh/hr/ln) 100.00
Queue (% length) 0
Michigan.dws
Simulation Input Files
GUI Input Files
Output Files
PC
Truck
BUS
60 120 180 240 300 360 420 480 540 600 660 720 780 840 900 960 1020 1080 1140 1200 1260 1320 1380 1440 1500 1560 1620 1680 1740 1800 1860 1920 1980
x:-91472908.222189 y:-40822223.353451
NUM

Modeling Framework

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The modeling framework considers:

- Origin-Destination travel demand (input)
- Simulated trip trajectories

- Minimizing charging station investment cost
    - Cost of charger
    - Land cost
    - Electricity provision cost
- Minimizing travelers' detour

The required inputs to the model include:

- Road network
- Traffic Analysis zones
- Travel demand matrix
- Electricity Provision Costs
- Land Use
- Average Land Cost

This phase focuses on investing in DC fast chargers for urban trips of EV users

Land use and trip purpose

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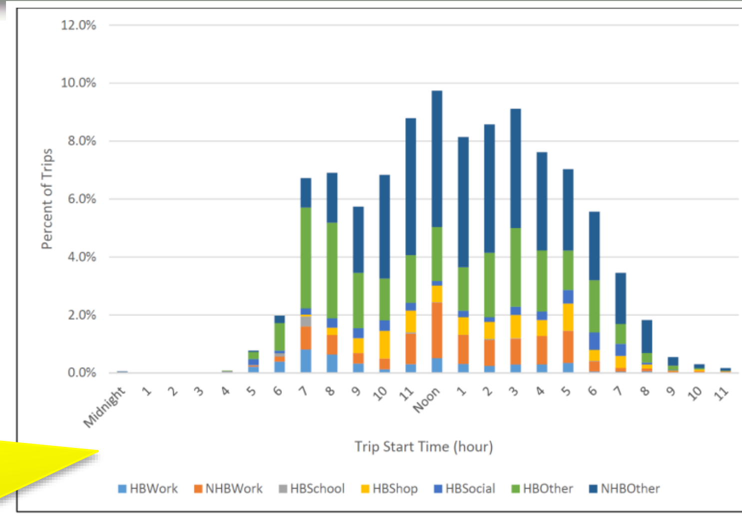
Trips start point are classified as:

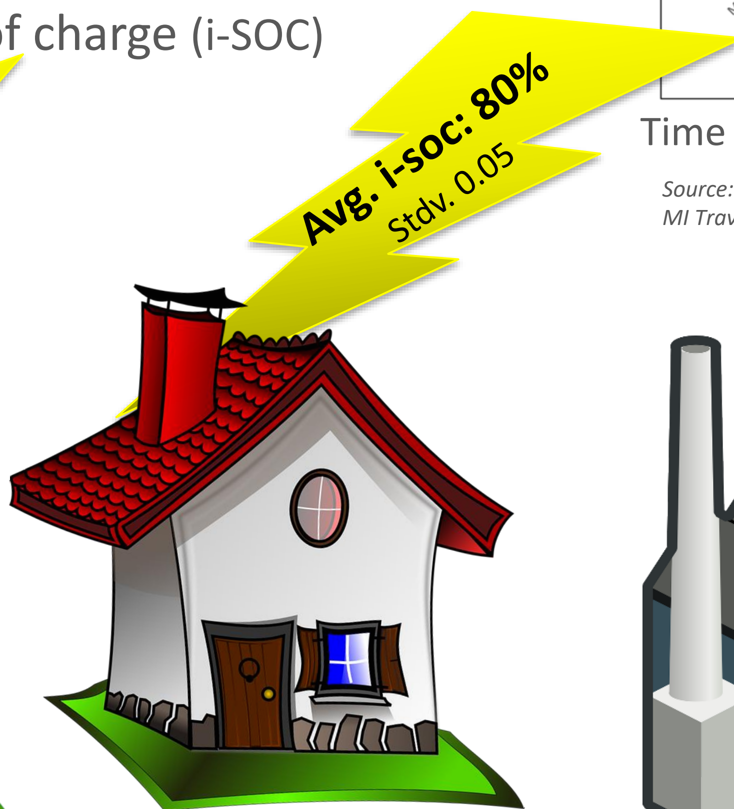
- Single family homes
- Multi-family residential
- Work places
- Other (i.e. commercial)

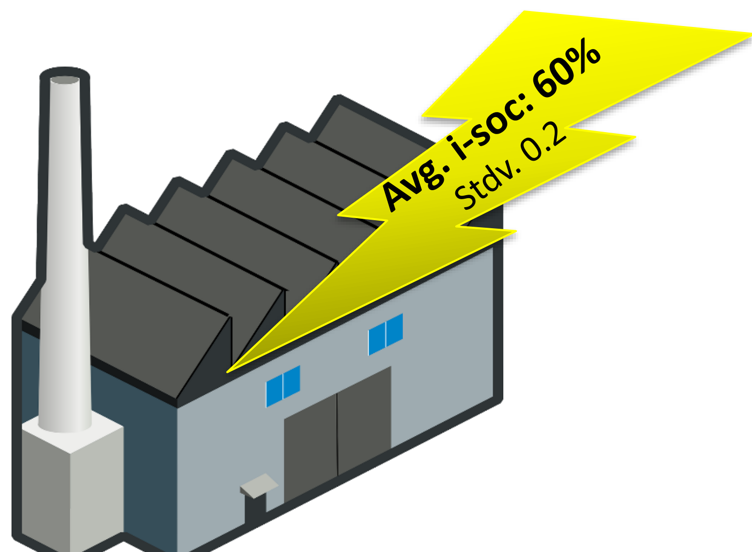
Affects initial state of charge (i-SOC)



Time dependent trip purpose in Michigan

Source: Nancy McGuckin, Jesse Casas, Martha Wilaby, (September 2016), MI Travel Counts III Travel Characteristics Technical Report





Candidate Points

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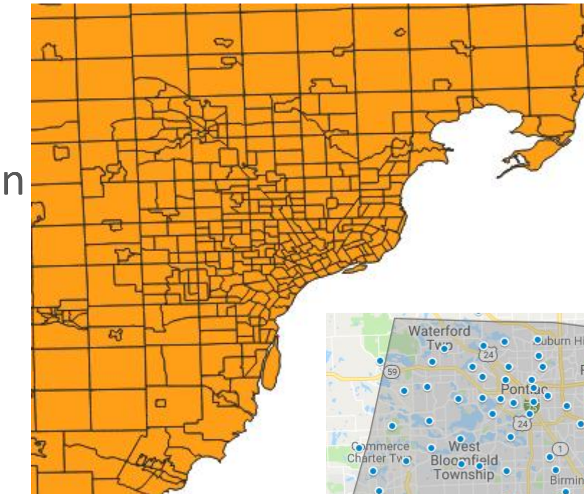
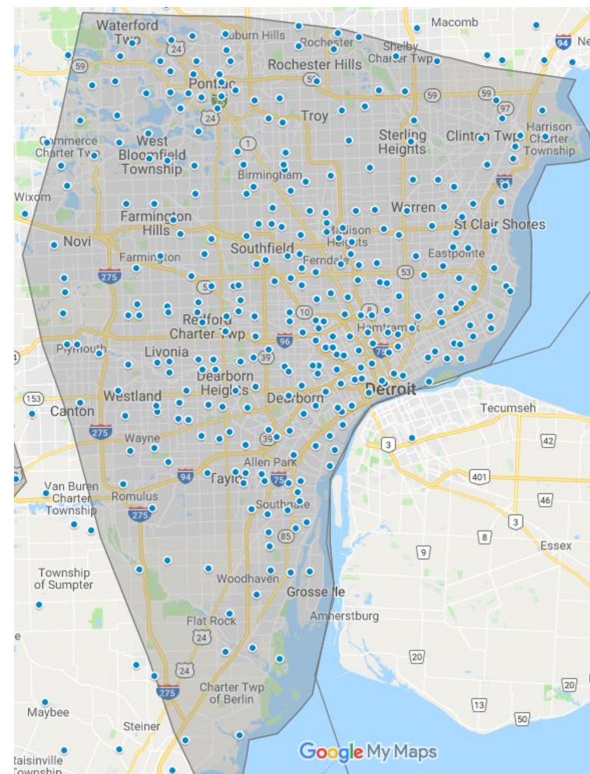
Traffic Analysis Zones (TAZ)



Unit area defined to be used in transportation planning.

Important factors:

- Size of area
- Density
- Land use
- Geographic features



Candidate Points

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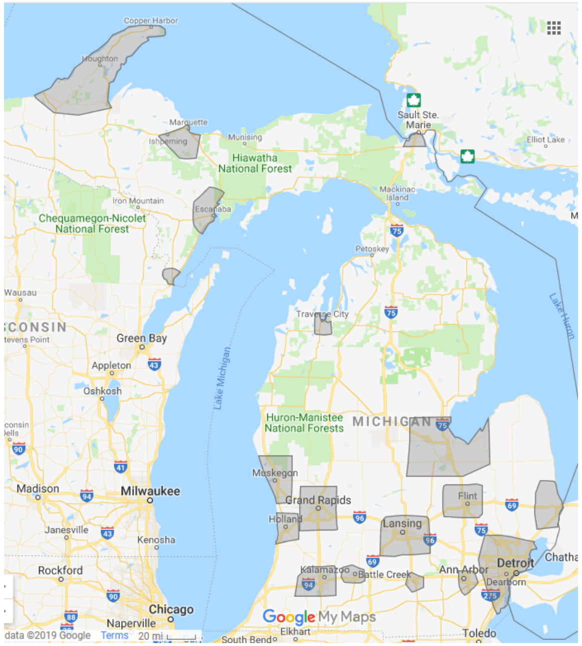

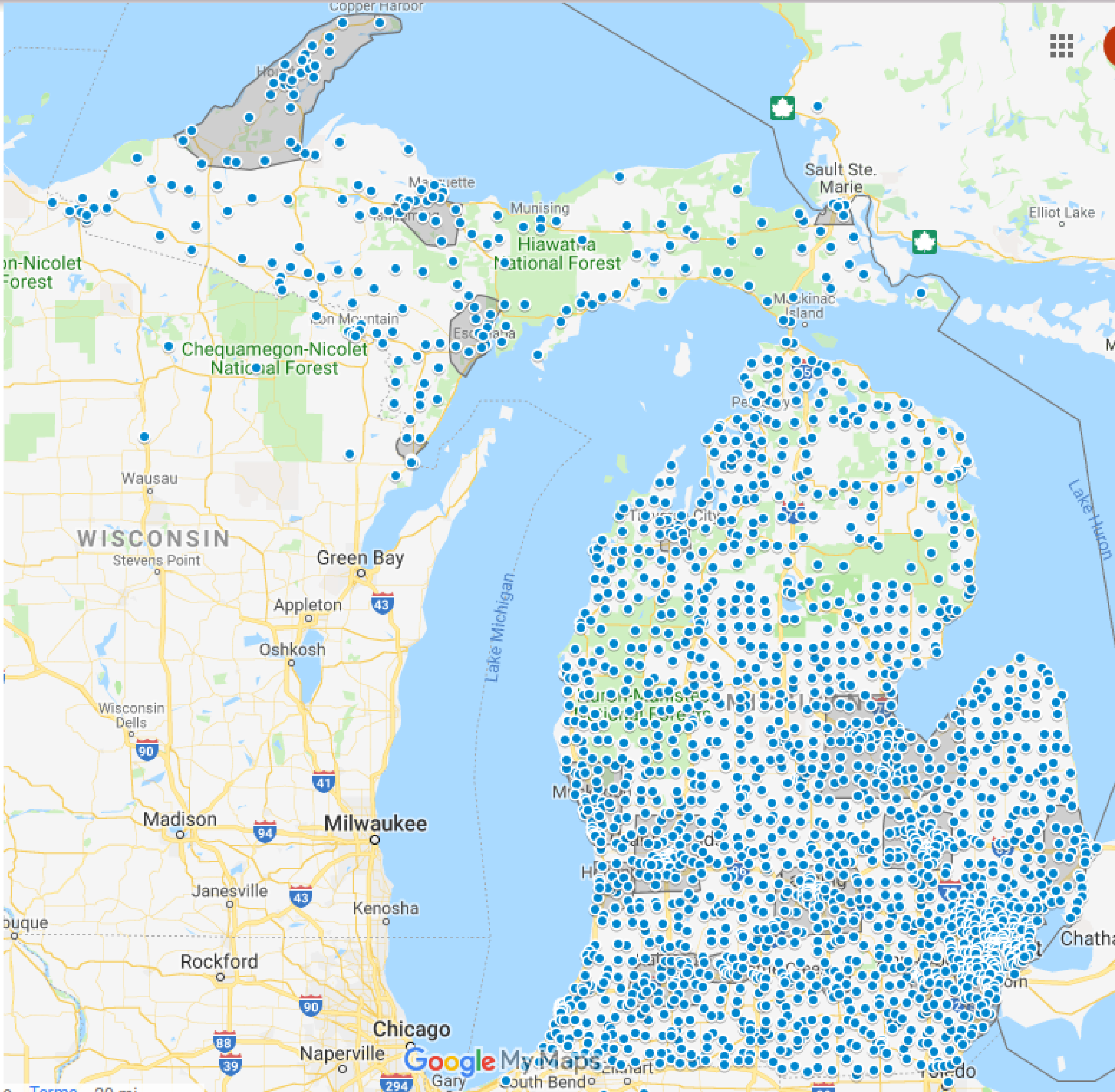

Source:
https://www.google.com/maps/d/viewer?mid=1tOVyNqg6TWeYNq1hyFLWaPq3bMXDDU_3&ll=44.614258938290696%2C-86.93730349321822&z=7

Results

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Scenario	Small battery and low tech charger	Large battery and low tech charger	small battery and high tech charger	large battery and high tech charger	Small battery and low tech charger-External demand
Battery size (kWh) =	70	100	70	100	**70**
Charging station (kW)	50	50	150	150	**50**
Number of zones =	301	301	301	301	**301**
Electric trajectories =	224045	224045	224045	224045	**250478**
Number of stations =	68	61	57	44	**66**
Number of chargers=	530	510	195	185	**804**
Average charging and queuing delay (min)	165,928	158,274	55,699	53,443	**268,781**
Total station cost (m$) =	16.86	15.12	15.94	12.30	**16.36**
Total charger cost (m$) =	19.20	18.48	15.35	14.57	**29.13**
Total infrastructure cost (m$) =	36.06	33.60	31.29	26.87	**45.49**

Scenario 1- 70kwh battery, 50 kw charger

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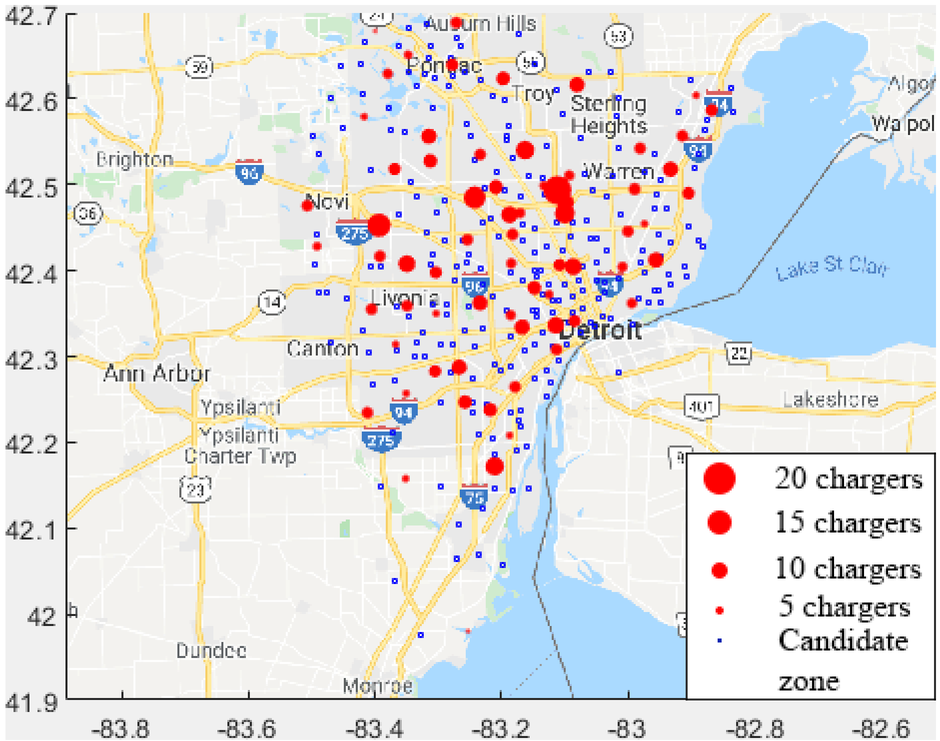
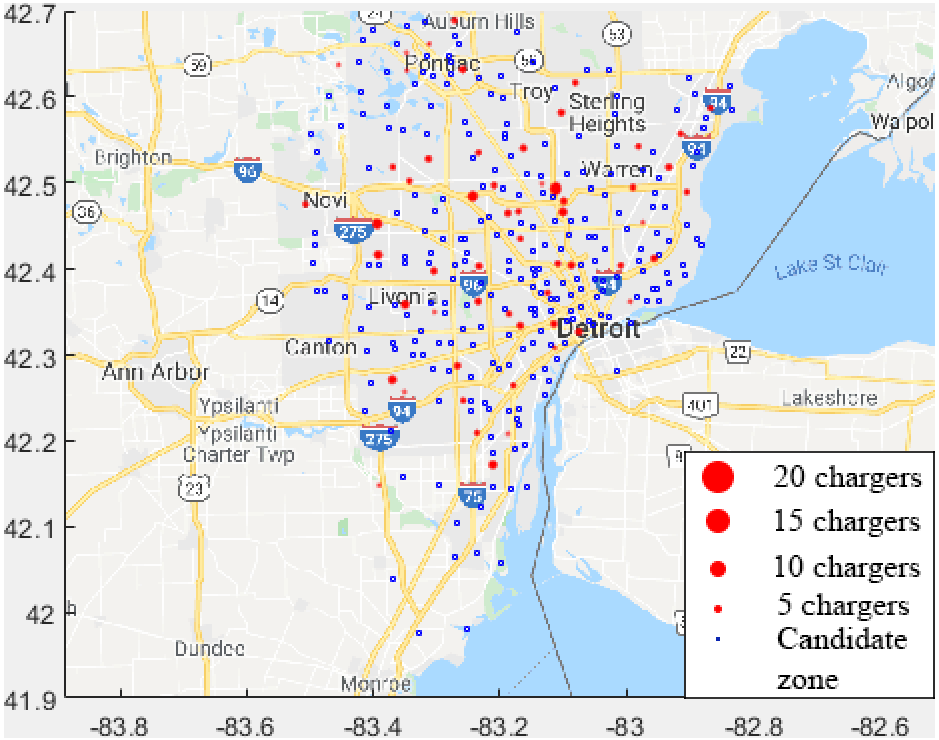


Scenario 2- 70kwh battery, 150 kw charger



Scenario 3- 100kwh battery, 50 kw charger

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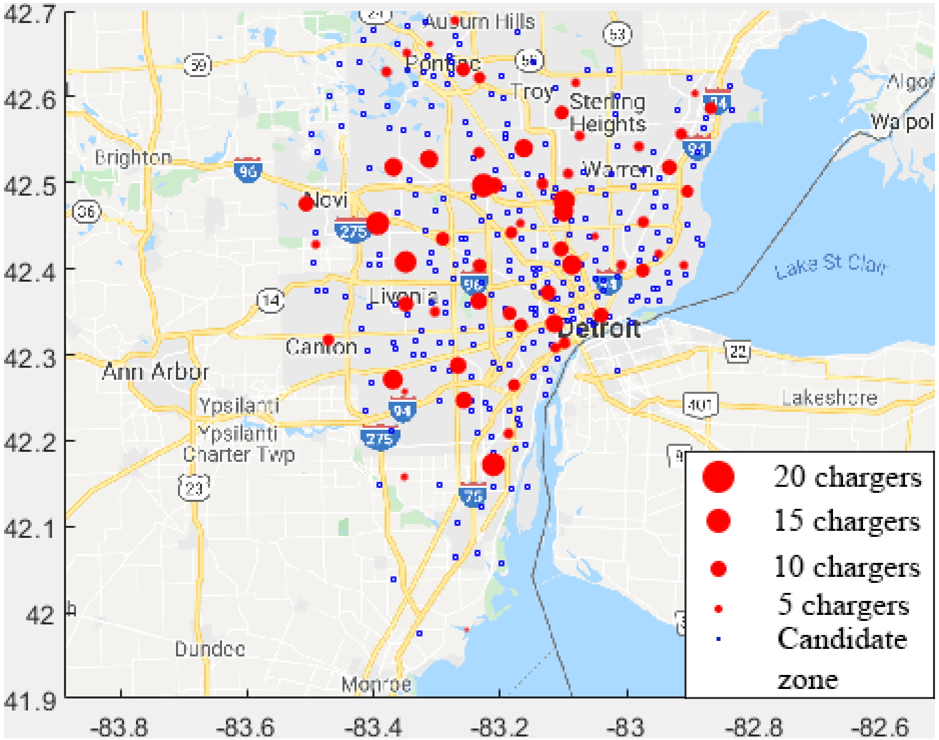
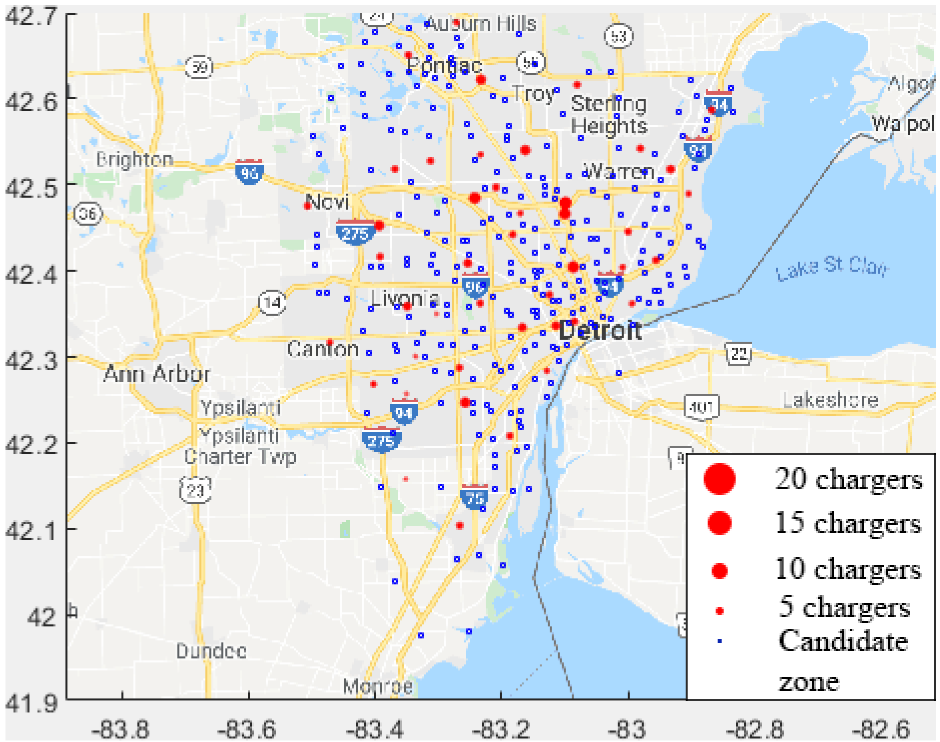
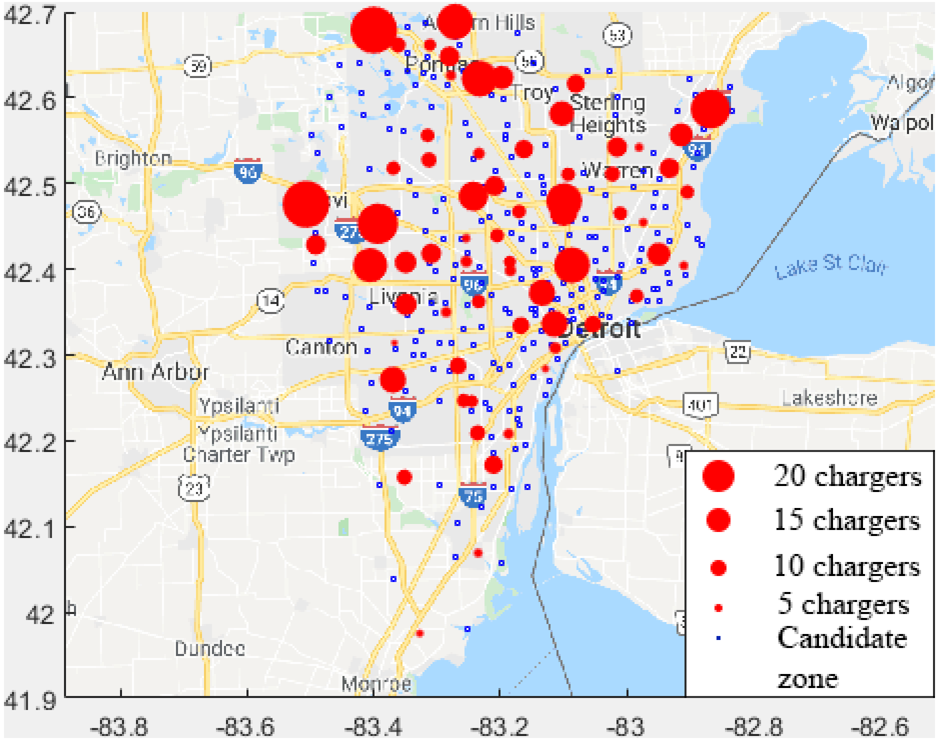


Scenario 4- 100kwh battery, 150 kw charger



External Demand Scenario- 70kwh battery, 50 kw charger



Thank You