THE UNIVERSITY OF MEMPHIS

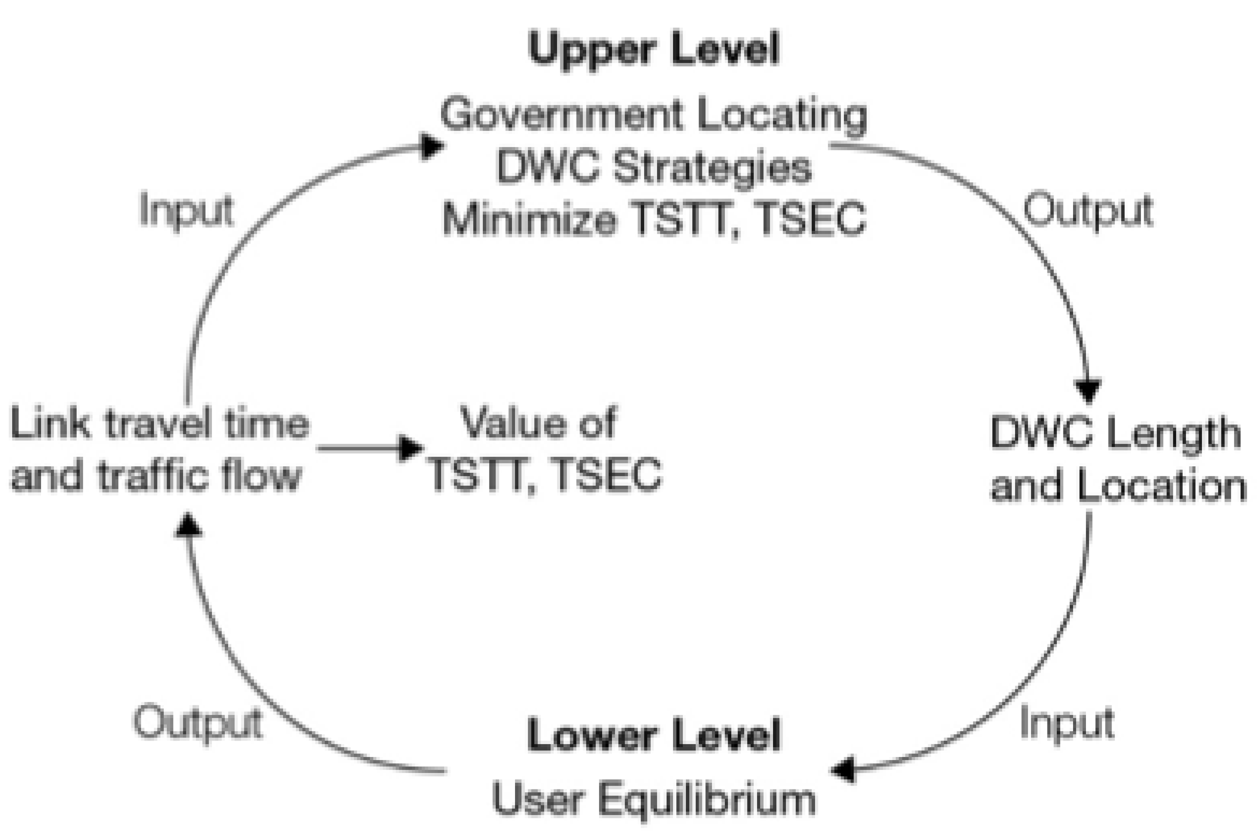
DYNAMIC WIRELESS CHARGING INFRASTRUCTURE PLANNING FOR ELECTRIC VEHICLE

Sabya Mishra: smishra3@memphis.edu, Huan Ngo: hhngo@memphis.edu, Amit Kumar: amit.kumar@utsa.edu
The University of Memphis

INTRODUCTION

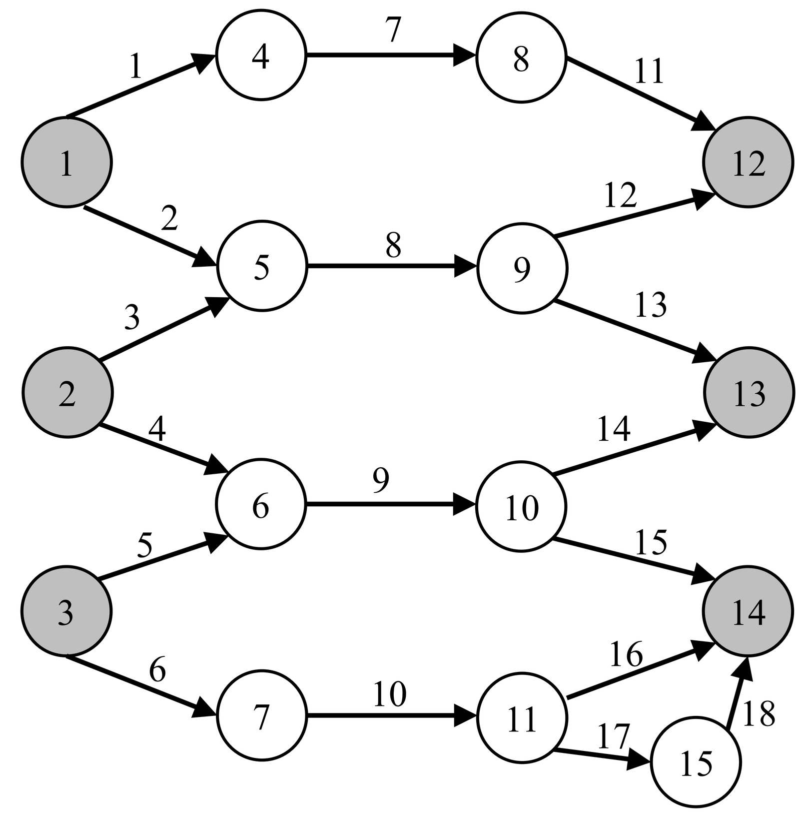
- Battery Electric Vehicles (BEVs) provides a cleaner and more energy efficient transportation option. However, there are two main drawbacks which are limited driving range and extended recharging time.
- Dynamic Wireless Charging (DWC) facilitiy allows BEV to be inductively charge while moving. If implemeneted appropriately, it could overcome the two main drawback of BEVs.
- This research aims to optimally locate DWC infrastructure for battery electric vehicle minimizing the social cost as measured by total system travel time (TSTT) or total system energy consumption (TSEC) with an explicit consideration of user traffic flow behavior via network equilibrium.

METHODOLOGY



- DWC Facility Location Problem is modeled as a bi-level programming, of which consists of an upper level and a lower level
- In the upper level, government comes up with a DWC Locating Plan considering budget and BEV range constraint while minimizing the total social cost as measured by TSTT and TSEC.
- In the lower level, the DWC Plan will affect user route choice behavior where each user will choose their most efficient path as measured by the normalized sum of travel time and energy consumption. The network will ultimately reach equilibrium where one individual cannot improve their travel time by unilaterally prefer one route to another.

DATASET PREVIEW



O-D Demand

O\D	12	13	14
1	10000	4000	0
2	0	10000	3000
3	0	60000	10000

O-D	Path Number	Path as the link sequence
1-12	1 2	1-7-11 2-8-12
1-13	3	2-8-13
2-13	4 5	3-8-13 4-9-14
2-14	6	4-9-15
3-13	7	5-9-14
3-14	8 9 10	5-9-15 6-10-16 6-10-17-18

Figure 1. Small 18 link Dataset

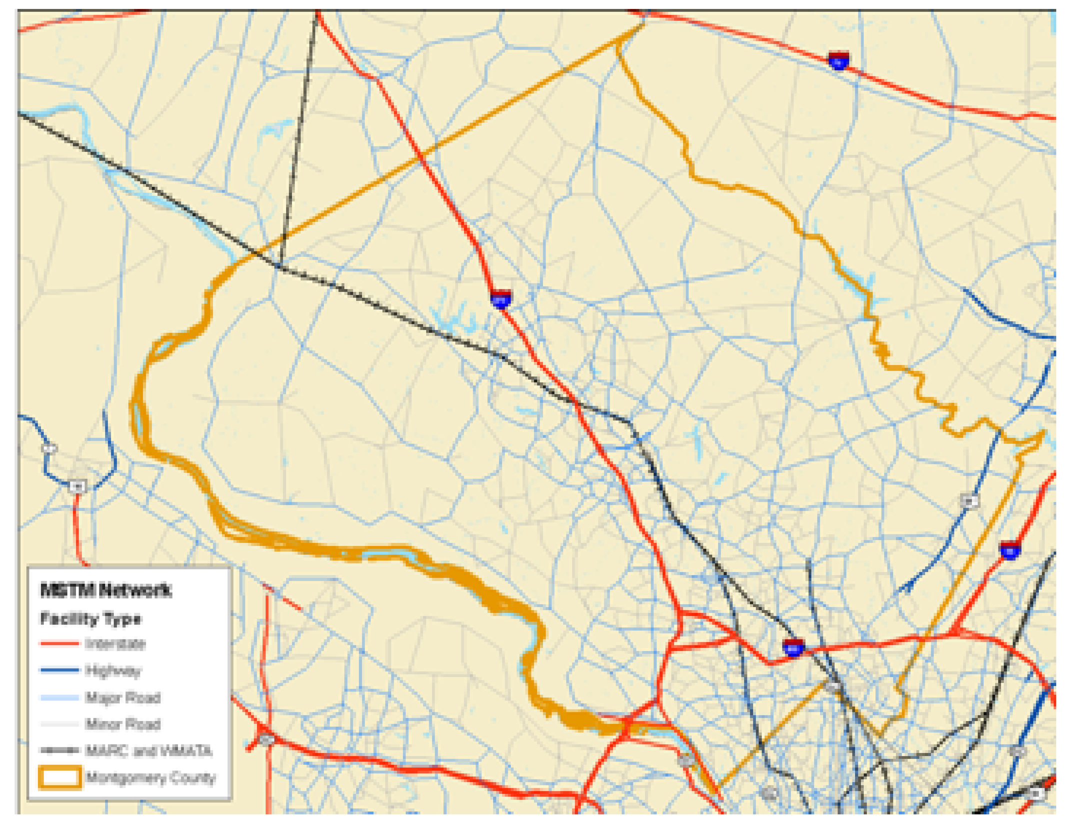


Figure 2. Montgomery County Network

RESULTS

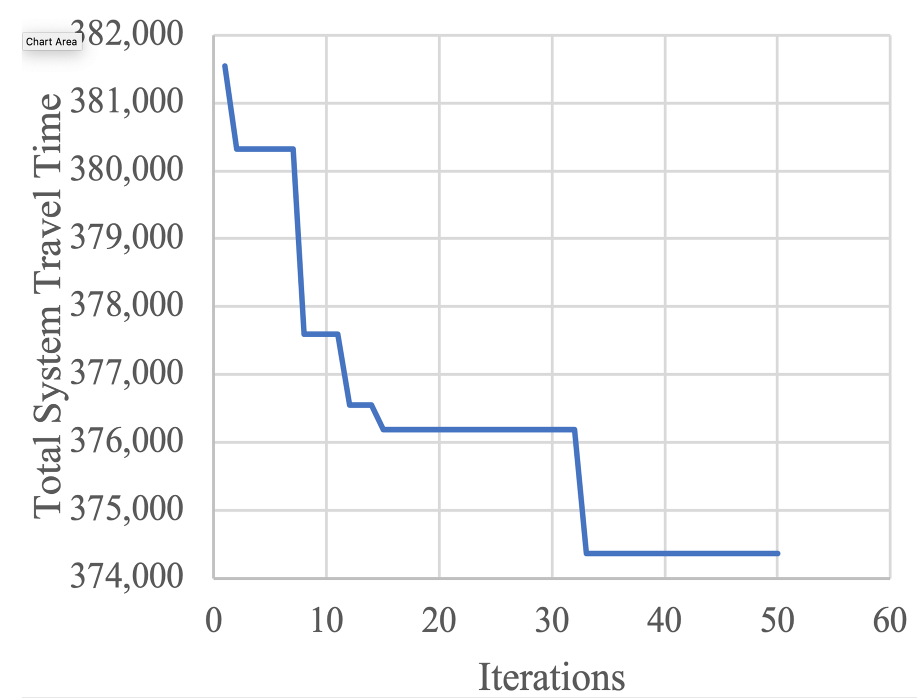


Figure 3.a. TSTT Convergence

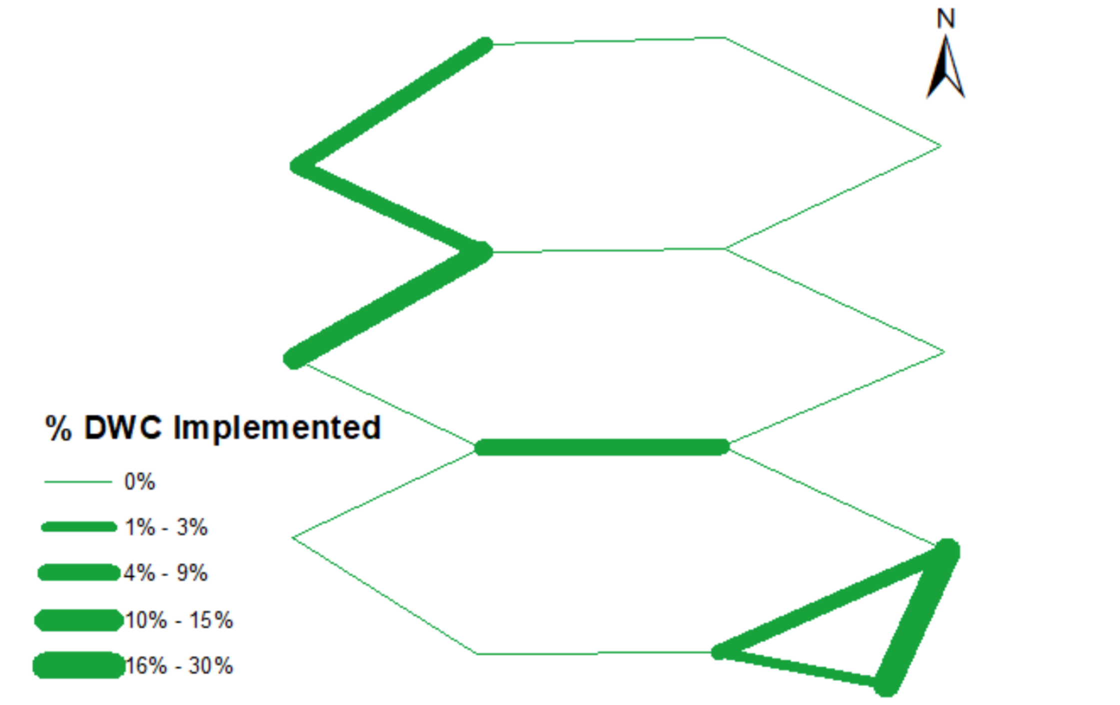


Figure 4.a. DWC plan for minimizing TSEC at $3.2 million Budget

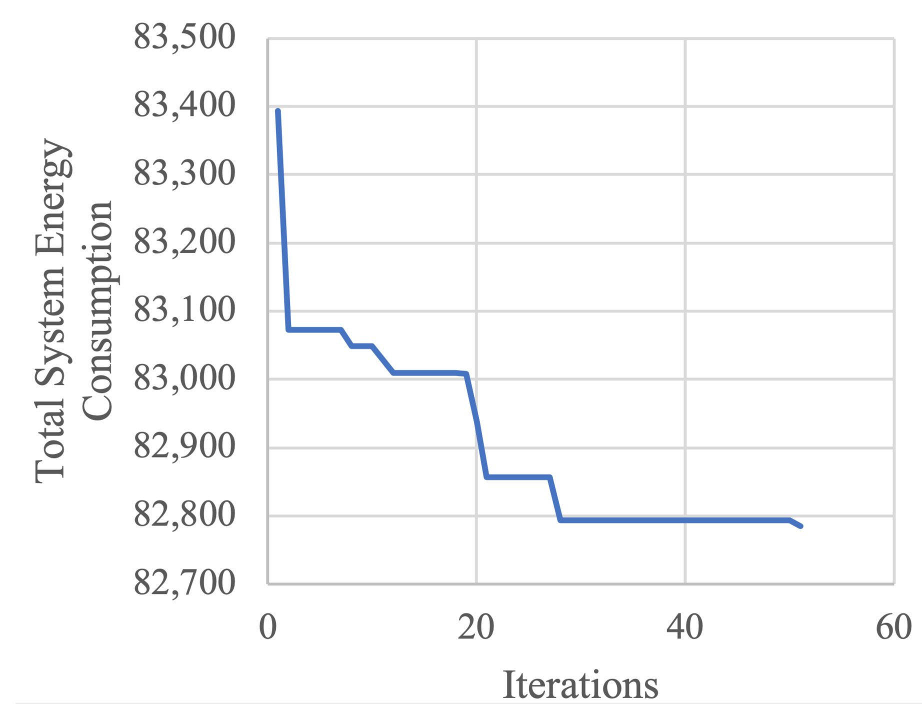


Figure 3.b. TSEC Convergence

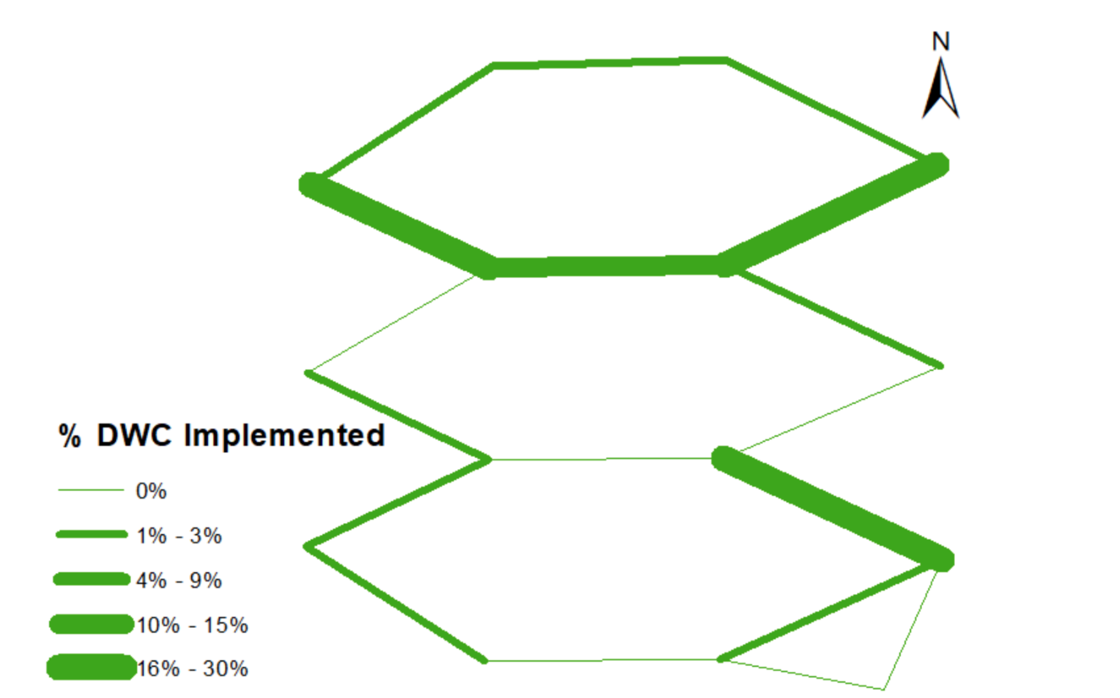


Figure 4.b. DWC plan minimizingTSEC at $3.2 million Budget

Objective Function	Budget	Budget Scenario	TSTT	TSEC
TSTT	$3.2 million	Base	374,347.091*	83,313.720
TSEC	$3.2 million	Base	376,563.410	82,785.450*
TSTT	$2.4 million	0.75×Base	374,361.600*	83,329.670
TSEC	$2.4 million	0.75×Base	376,542.710	82,790.430*
TSTT	$4 million	1.25×Base	374,247.054*	83,304.715
TSEC	$4 million	1.25×Base	376,537.147	82,789.452*

Table 1. Budget Sensitivity Analysis

RESULTS (CONT.)

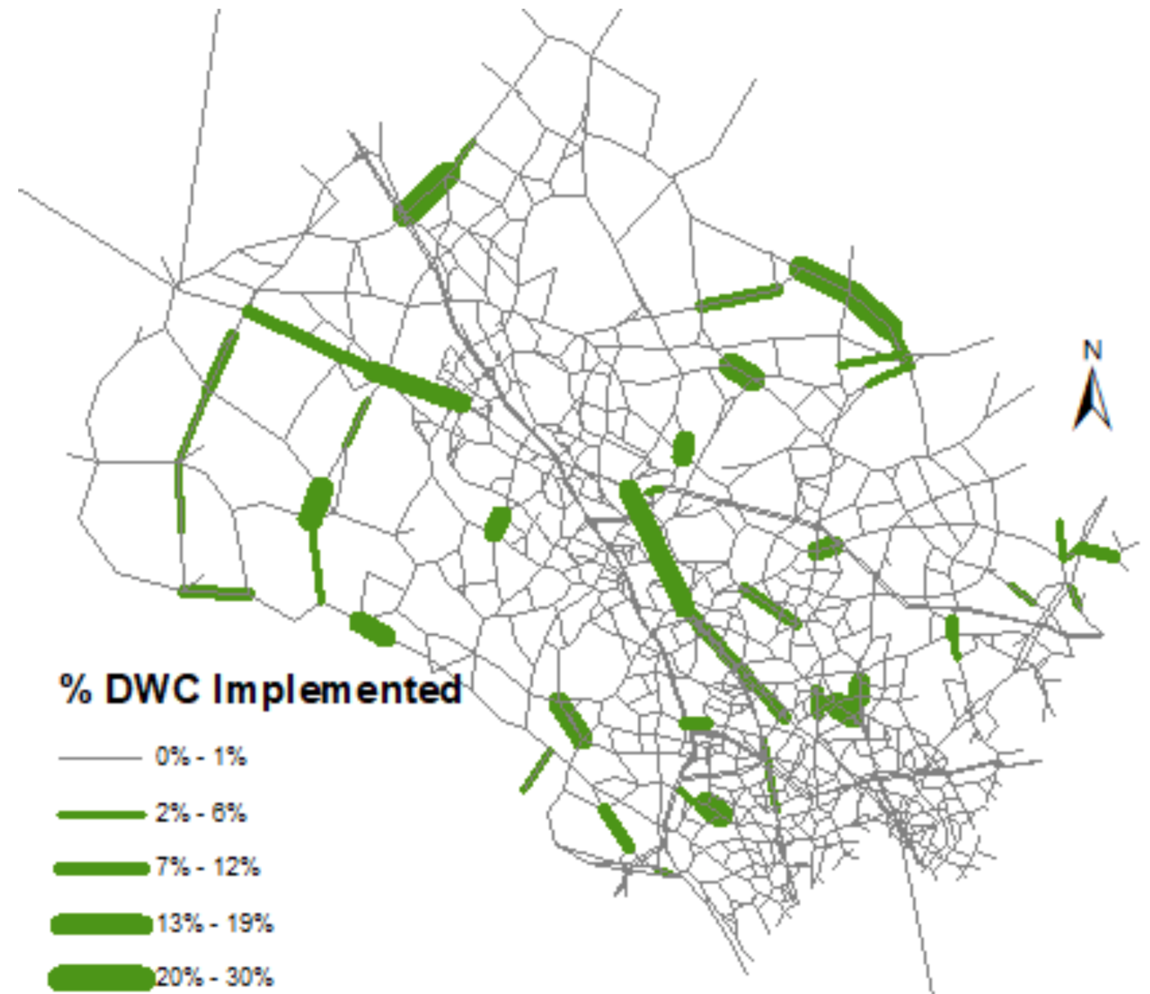


Figure 5.a Montgomery County DWC plan minimizing

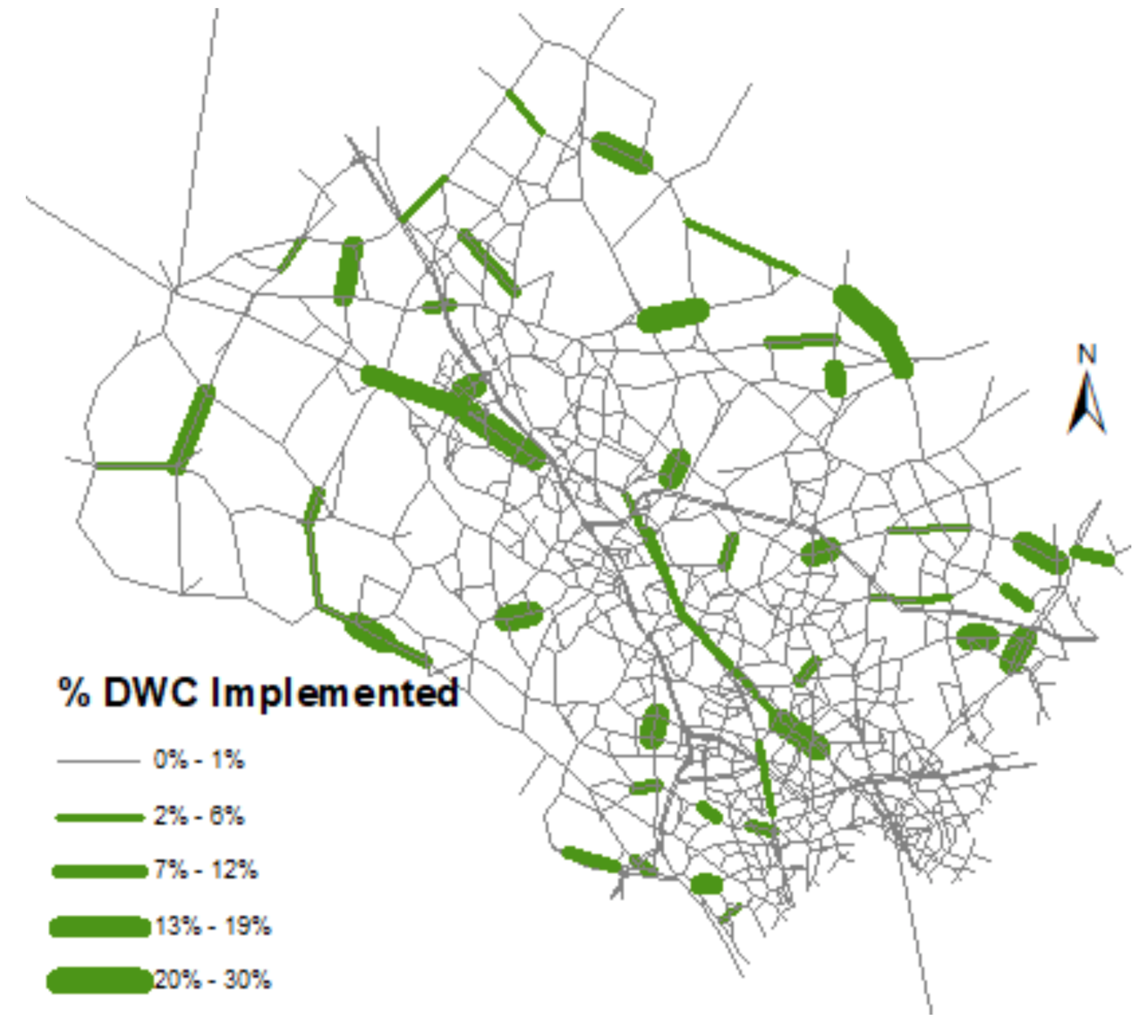


Figure 5.b. Montgomery County DWC plan minimizing TSEC

DISCUSSION

- The analysis results showed that DWC implementation in a region with one million population is expected to reduce the overall energy consumption by more than 10% with an estimated cost savings of $30 billion, assuming an average gasoline price of $2 and electricity cost of 25 cents per unit.
- Future avenues of research include analysis of DWC network in a mixed environment of conventional vehicles and BEVs; consideration of power availability from neighborhood electric grids; and induced demand because of DWC implementation.