Energy Science
Technology & Policy
Carnegie Mellon University
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Shared Electric Micro-Mobility Solutions Could Offset 50% of Transportation Energy Demand for Pittsburgh

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BACKGROUND & MOTIVATION

- **The transportation sector** is the most polluting, least efficient and the **2nd most** energy intensive end-use sector in the U.S.

Comparison of End-Use Sectors: U.S.

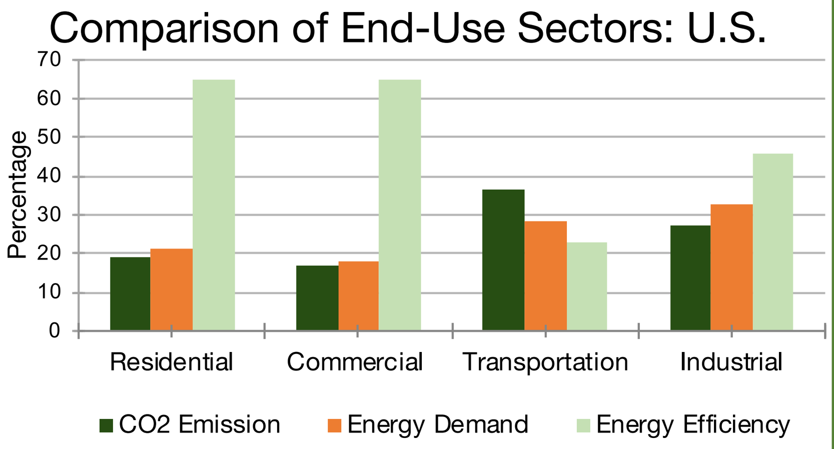

Figure 1

- Cars dominate the current vehicle fleet for personal commute and have a very poor passenger-vehicle weight ratio.

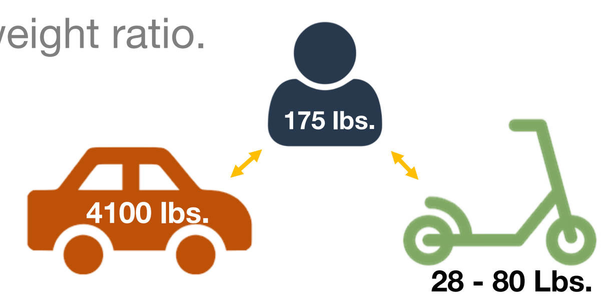

Figure 2

- 37% of all trips are under 5 miles distance while 20% of the trips are under 3 miles based on survey data.

Cumulative Distribution Function

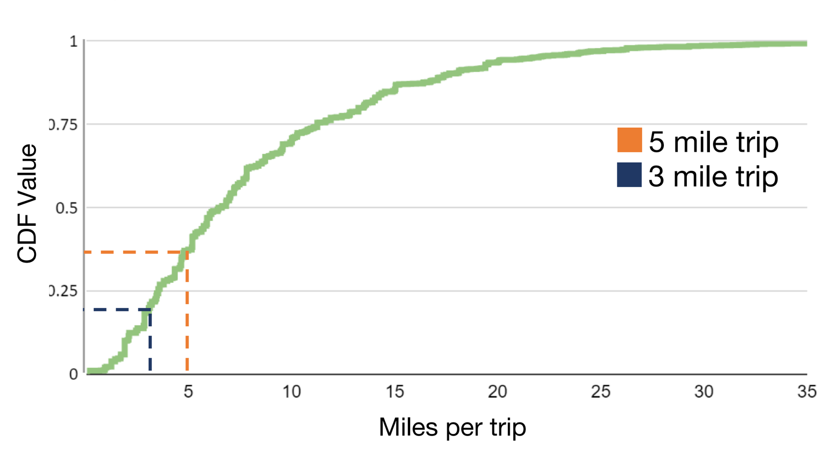

Figure 3

- Shared electric micro-mobility has the potential to expand access to public transportation, reduce energy use and life cycle environmental footprint, and save costs.

Table 1

	E-bike	E-scooter	Car	Bus
kWh/mile	0.11	0.20	1.44	0.61
gCO_2/mile	190	141	414	82
miles	20	10	400	175
kWh	0.7	0.3	-	-
years	2	2	10	10

OBJECTIVES

- Perform a quantitative analysis of replacing current mode of transportation with shared micro-mobility electric vehicles for short distances.
- Reduce the energy consumption of the transportation sector by 50%
- Estimate related reduction in CO_2 emissions.
- Investigate economic feasibility of this transition.

METHODS

- Analysis of travel modes and miles based on the weekly trip data for Pittsburgh by Western Pennsylvania Regional Data Center.
- Energy consumption and emission metrics for E-scooters and E-bikes are obtained from Monte-Carlo analysis in previous research. [1]

Commuter Mode Demographic Split

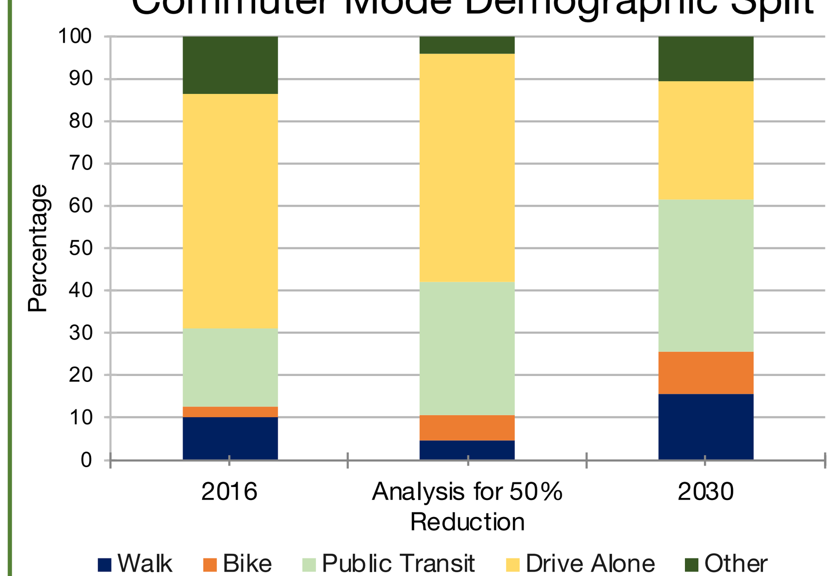

Figure 4

- Flowchart for the replacement of conventional modes of transportation with electric micro-mobility solutions:

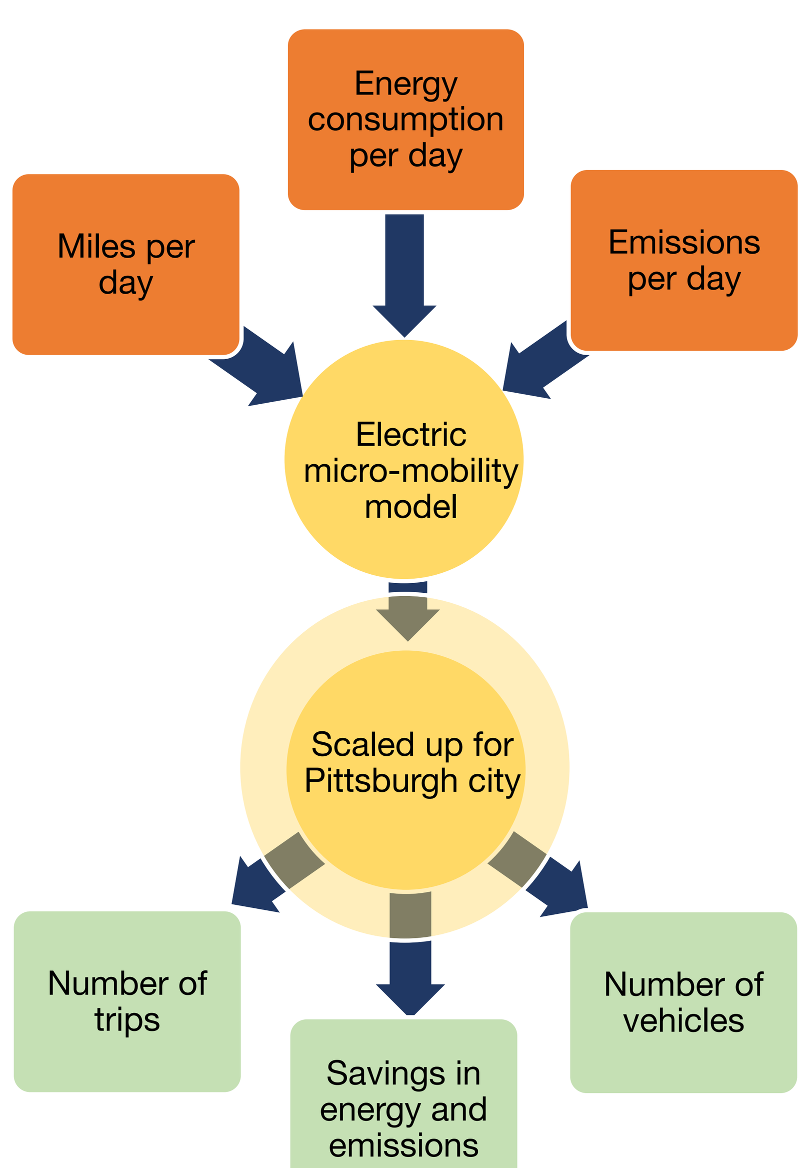

Figure 5

- Cost analysis and comparison of the considered means of transportation is performed based on the number of trips and the cost per trip ($/trip).
- Miles reduced from conventional-powered vehicles are assumed to be replaced by shared micro-mobility for 50% reduction in energy demand:

Table 2

Modes of Transportation	Transition Percentage
Bus	25%
Carpool	0
Drive Alone	75%
Taxi	75%
Park and Ride	75%
Shuttle	0
Vanpool	0

- Fleet distribution between e-scooters and e-bikes is assumed to be 30% : 70% respectively.
- CO_2 emissions for every mode are considered over the entire life cycle.

RESULTS

- A 50% reduction in energy demand can be achieved by replacing conventional-powered vehicles with shared electric scooters and bikes for trips of 3 or 5 miles. Mentioned below are the statistical results of the analysis:

Effect of deploying shared electric micro-mobility

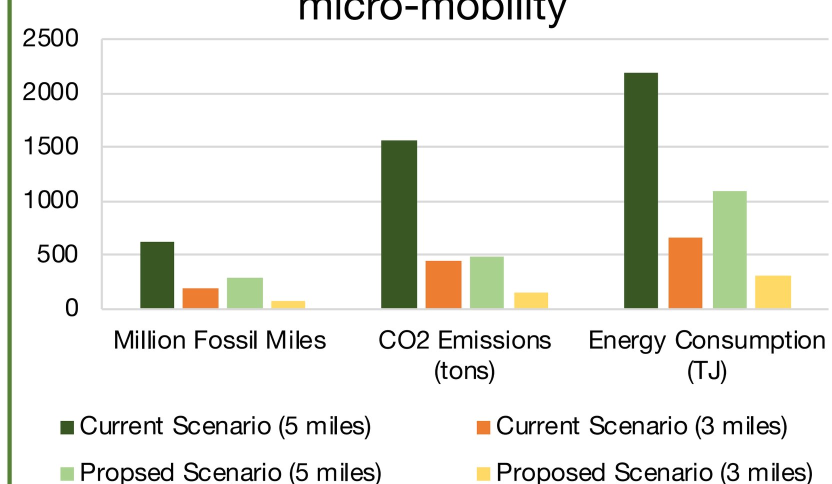

Figure 6

- To achieve the targets, **~7,700** e-mobility trips are required per day for distances under 3 miles, while **~15,500** such trips are required for distances up to 5 miles.

Trends of shared mobility usage in Pittsburgh

Figure 7

- The average dollar per trip cost of commuting by electric scooters and bikes is approximately 6 times lower than driving alone for short trips.

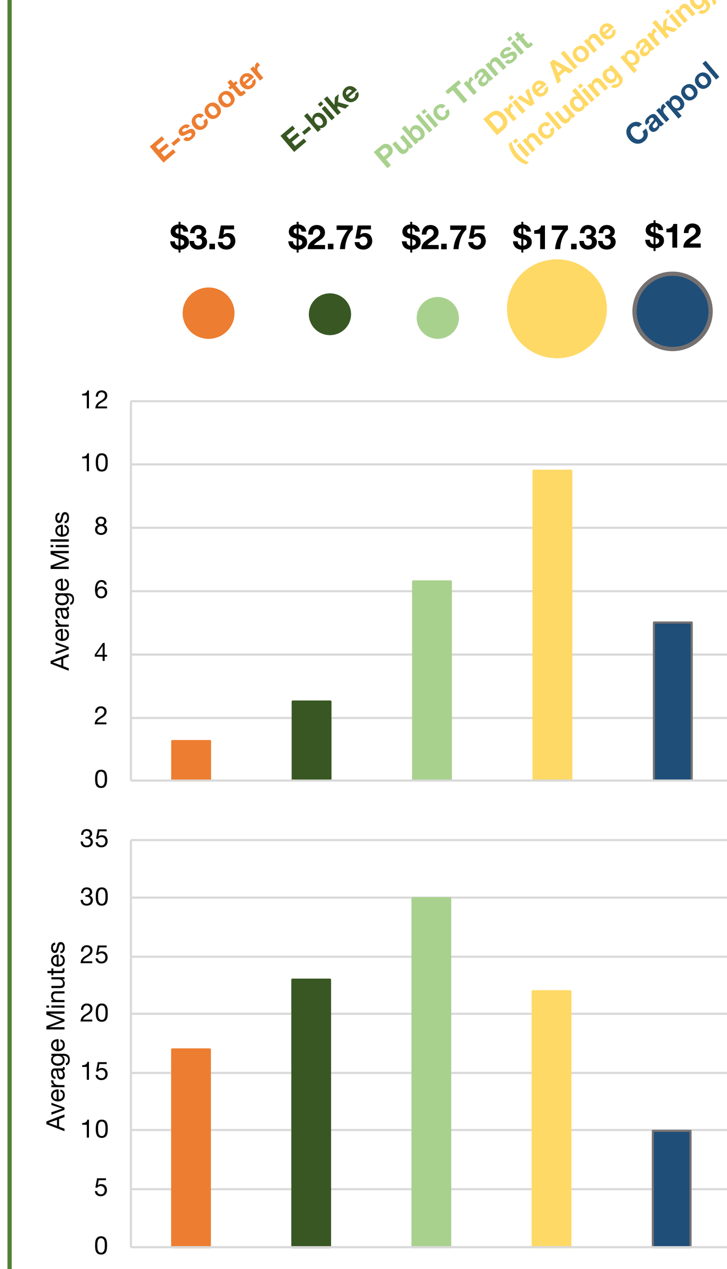

Figure 8

- The combined fleet size of E-bikes and E-scooters used to replace fossil miles of conventionally powered cars and buses is **210** and **104** for 5 and 3 mile trips respectively.

SENSITIVITY ANALYSIS

Sensitivity for Energy Savings

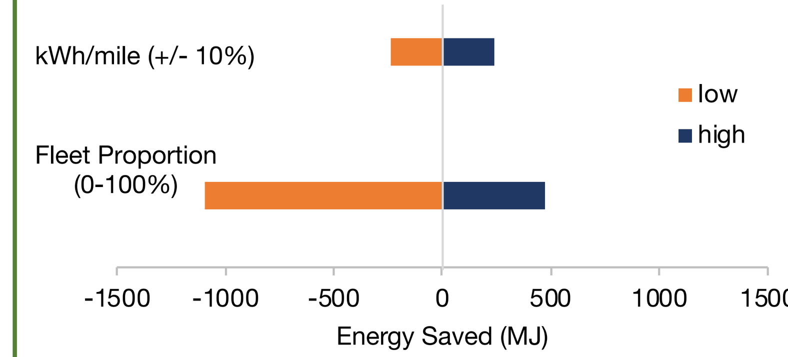

Figure 9

Sensitivity for Emissions Reduction

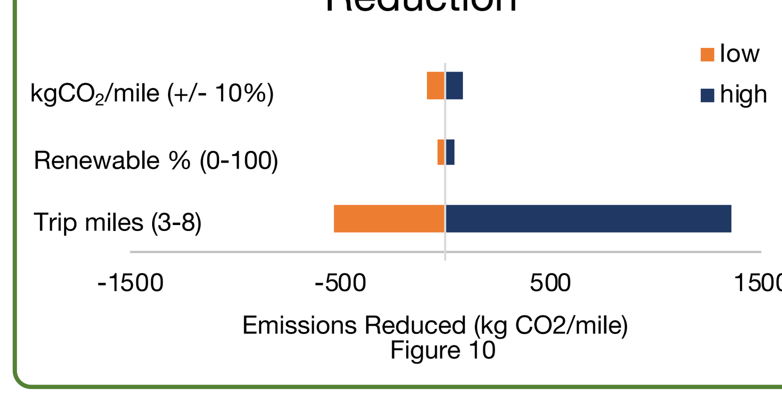

Figure 10

CONCLUSION

- 50% of the energy used (~2200 TJ) in short trips can be reduced by making **5.6%** of all trips in Pittsburgh with e-bikes and e-scooters.
- The results from our analysis are in agreement with Pittsburgh city's transportation demographic goals for 2030.
- In the **5 mile** scenario, **50.5%** of energy is saved and **27.5%** of emissions are cut down.
- In the **3 mile** scenario, **46.3%** of energy is saved and **23.4%** of emissions are cut down.
- An individual makes an annual saving of ~**$2250** per year by switching to electric mobility.

CHALLENGES

- Deploying the charging infrastructure, vehicle collection & transportation in Pittsburgh and operational challenges that come along with it.

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ACKNOWLEDGEMENTS

This poster was supported in part by the Energy, Science, Technology and Policy Program at Carnegie Mellon University. Special thanks to Prof. (Dr.) Constantine Samaras.