Freewheeling: What Six Locations, 61,000 Trips, and 242,000 Miles in Colorado Reveal About How E-Bikes Improve Mobility Options

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1 Introduction

E-bikes have been quickly growing in popularity in recent years. Access to e-bikes poses an opportunity to improve mobility options as a comparatively inexpensive yet similarly convenient alternative to car ownership. This study focuses on the outcomes of the CanBikeCO program developed by the Colorado Energy Office (CEO), which provided e-bikes to low-income users in sites across Colorado. This is the first large-scale, longitudinal evaluation of how privately owned e-bikes are used, revealing energy, emissions, and behavior implications. The following brief is a prelude to a comprehensive paper to be released later in 2023.

2 Energy Implications

A primary motivation for the CanBikeCO program was to improve mobility options without increasing net energy use. To analyze energy impacts, the National Renewable Energy Laboratory (NREL) Open Platform for Agile Trip Heuristics (OpenPATH) was used to collect data for each participant trip. E-bikes were found to replace cars (34% of e-bike trips) and personal micromobility (22%) most often. However, e-bikes are so efficient that the overall energy outcome was strongly positive, with close to 40 MWh in savings across the program (Figure 1).

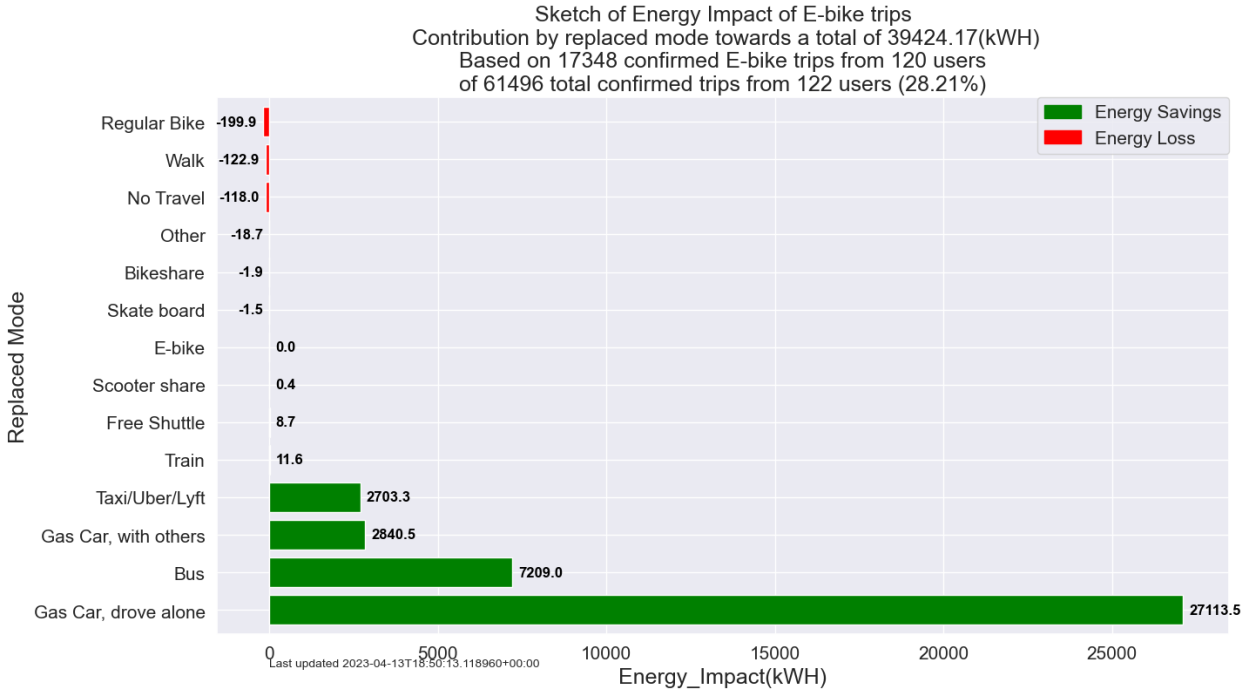


Figure 1. Energy impacts of the modes found to be replaced by e-bikes

3 Support Access to Jobs

Commute trips among participants had nearly 17% higher shares of e-bikes than all trips combined (Fig. 2, top), and the majority of e-bike trips were for commuting (Fig. 2, bottom). Evaluation of trips by purpose suggests that the e-bikes were used for a spectrum of trips, mirroring the range of utilitarian needs, and were not just for recreation, as some speculation anticipated. Participants used the e-bikes to access employment opportunities, and even among the trips that were induced, employment was a primary purpose.

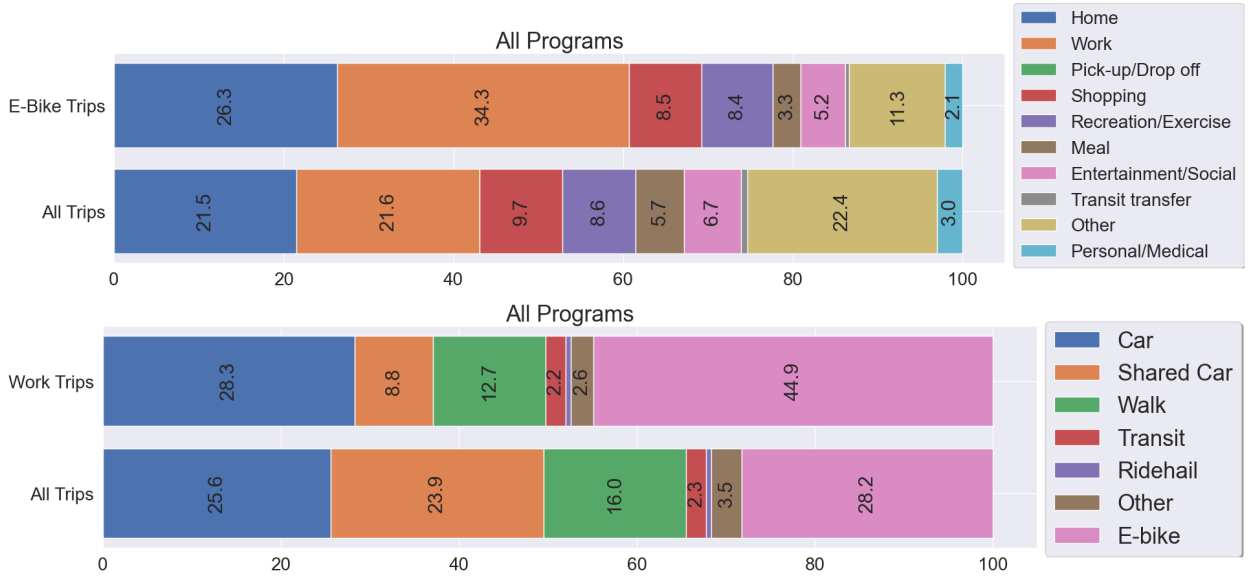
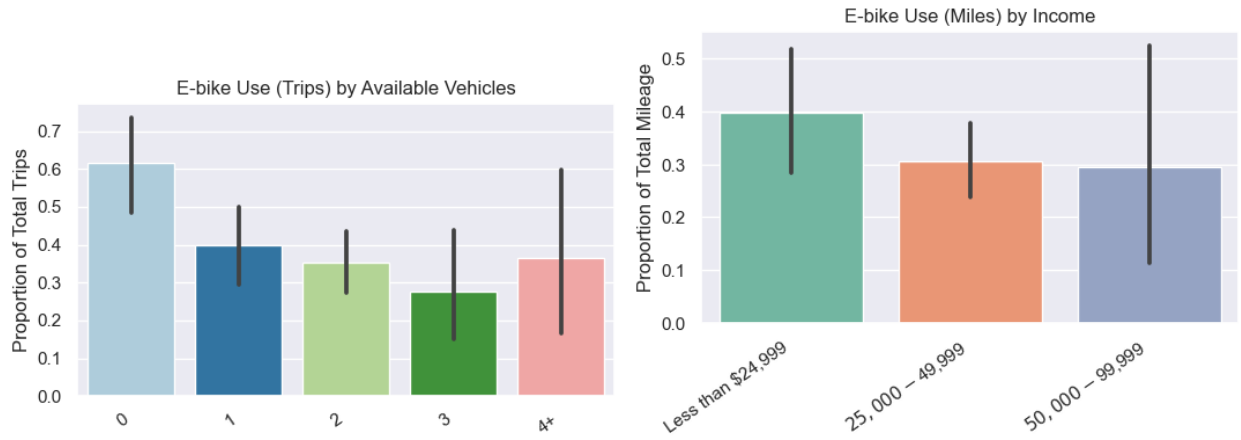


Figure 2. Composition of combined trip modes and purposes across all programs

4 Equitable Mobility for All

E-bikes were used across a broad range of age groups and income levels. However, the greatest proportion of trips was by people who did not have access to a car (60% of trips) and were in the lowest income category (approximately 45% of miles for the $< \$25,000$ group) (Figure 3). The age distribution of users across e-bike trips tended to be older than for personal micromobility (e.g., manual bikes) and considerably older than for shared micromobility trips (Figure 4). This may indicate that e-bikes provide an access point to micromobility for individuals older than 40.



(a) Variation by available household vehicles **(b) Variation by household income**

Figure 3. Variation in the proportion of e-bike usage by number of household vehicles and income

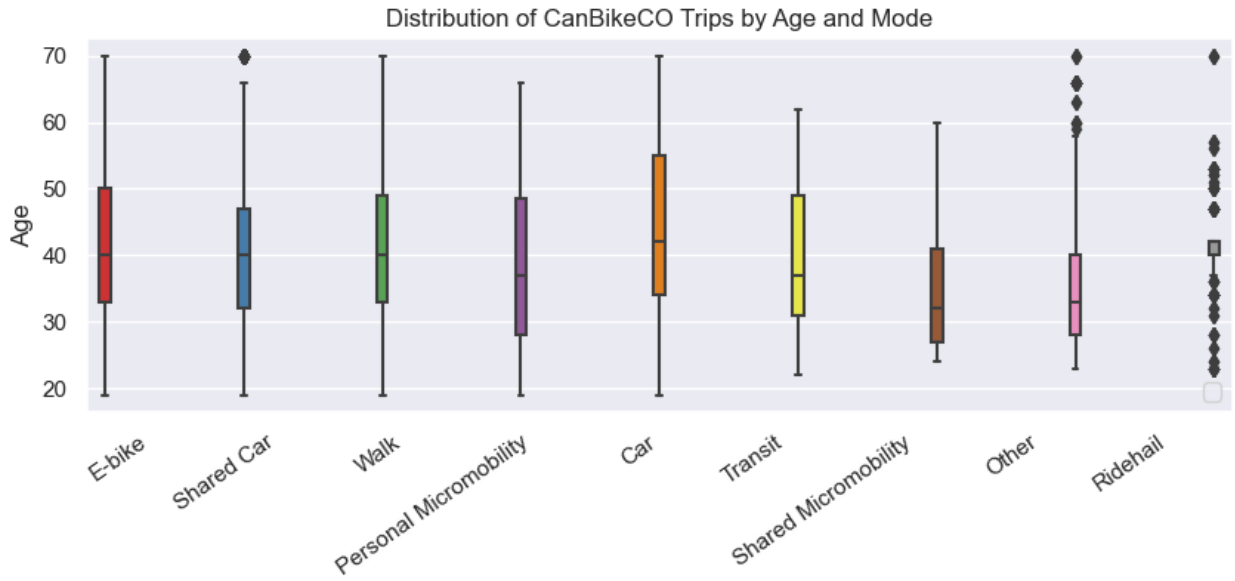


Figure 4. Age distribution for e-bike and non-e-bike trips

5 Viable Mode for the Majority of Trips (<5 miles)

In the United States, a majority of trips are shorter than 5 miles, and about half of trips are shorter than 3 miles. These distances are within easy range of e-bikes, which have maximum legal speeds between 20 and 28 miles per hour. In examining trips logged by participants, the viability of e-bikes for trips between about 1 and 5 miles is evident. Walking dominates short trips (less than 1 mile) but is gradually replaced by car and e-bike trips as distance increases (Figure 5). E-bike, car, and shared car evenly split most trips 4–6 miles in length.

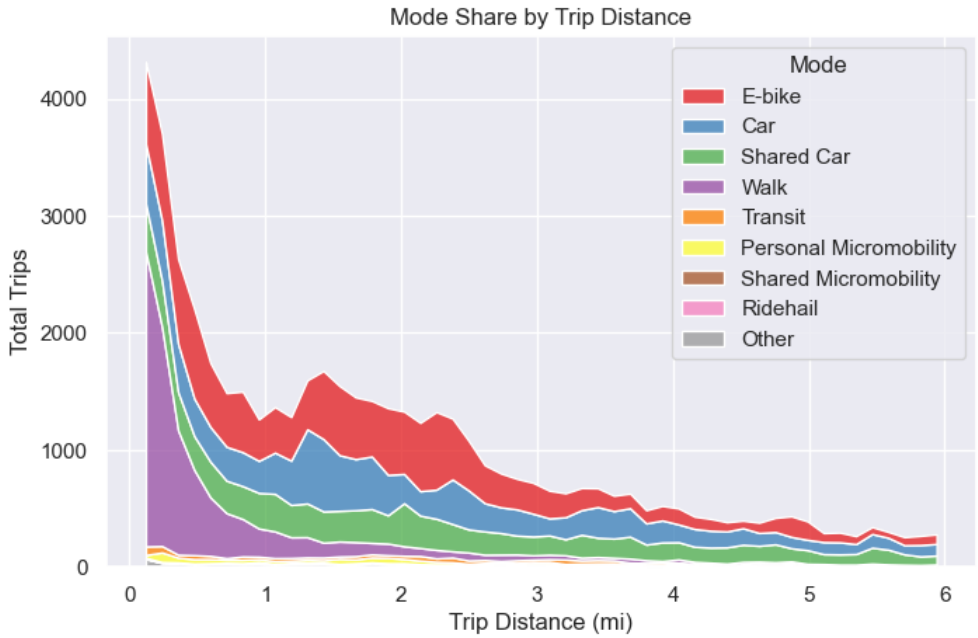
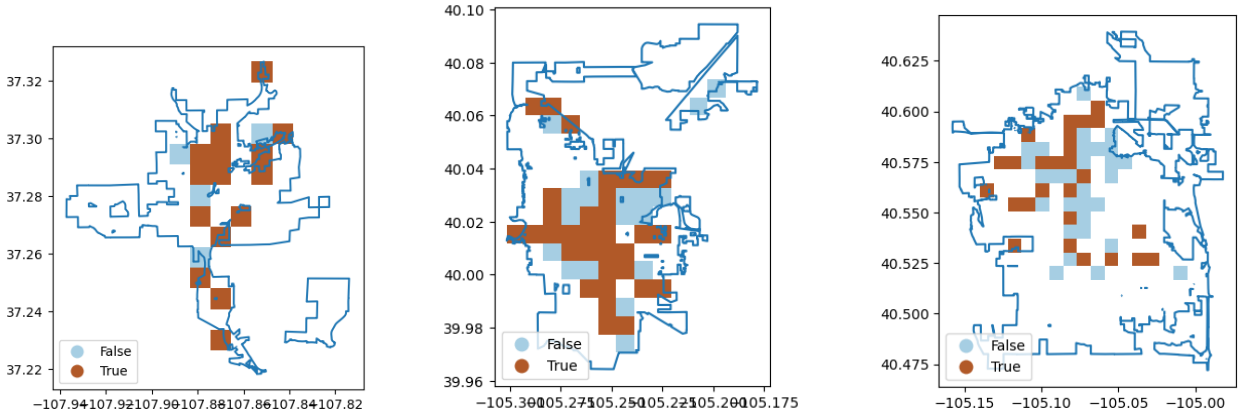


Figure 5. Mode shares across trip distance for trips less than 6 miles

6 Competitive With Cars—In Some Locations

In areas with supporting land use and infrastructure, e-bikes are competitive with cars in the number of destinations that can be reached in a given time, with travel speeds and timing near parity, while being less energy-intensive and

cheaper to use. These areas can include both dense urban cores and portions of small or midsize towns with relatively high density of opportunities/destinations. Dividing the program locations into a 1 x 1-km grid and counting the number of trips that started and ended in each grid pixel, we see that there are many locations where e-bikes were used more than cars by program participants. This effect is particularly pronounced in Durango (approximately 80%), Boulder (65%), and Fort Collins (approximately 50%) (Figure 6).



(a) Four Corners (Durango) **(b) Community Cycles (Boulder)** **(c) Fort Collins**

Figure 6. Pixels from a 1 x 1-km grid showing where e-bikes were used more than cars (brown: e-bikes used more than cars; blue: cars more than e-bikes; white: no trips)

7 Conclusion

Analysis of the CanBikeCO pilot program revealed that e-bikes have substantial energy and emissions advantages in replacing larger motorized modes for short trips. Even when e-bikes replace trips that would otherwise be made by energy-advantaged modes, such as personal micromobility or shared cars, overall net energy outcomes are minimally affected, savings remain strongly positive, and the mobility improvements result in reduced travel time, contributing to higher quality of life. E-bikes are used by a broader population as compared to other micromobility modes and tend to be used by people who might otherwise not be as interested in micromobility. In some geographic settings, e-bikes are competitive in time and convenience with cars, especially considering that a majority of U.S. trips are less than 5 miles. This program precedes a larger program to be implemented in Colorado and is informing design of similar programs across the nation. More in-depth evaluation of the CanBikeCO pilot is forthcoming, and is among the first such study to concentrate on the energy, emissions, and behavioral outcomes of private-ownership e-bikes.