Hi all, we are researchers in the Center for Integrated Mobility Sciences at the National Renewable Energy Laboratory. We are here to share our experience and results on *ownership* micromobility.
We obtained these results by partnering with the Colorado Energy Office (CEO) e-bike program. In Fall 2020, the program provided e-bikes to low-income, essential workers under an ownership model. The workers already had limited mobility options, which were constrained even further during the COVID-19 pandemic, as concerns about shared mobility led to significant cuts in transit service. Concerned that this may result in a mass shift to driving alone, the Colorado Energy Office experimented with providing access to affordable and energy efficient single occupancy vehicles – e-bikes.

The results are based on 3 months of data from 12 participants in the Denver area. While the sample size is small, the detailed data, the non-traditional deployment model, and, more importantly, the longitudinal data collection provide novel insights. However, the narrow demographic profile of study participants and their limited mobility alternatives indicate caution in broader interpretation.

User picture from: https://rapp-arts.org/user-group-default-user-group/
3 month picture from: https://letslearnenglish.com/product/access-3-months/
- We collected the data for the evaluation using a custom version of the OpenPATH (formerly e-mission) platform. The core of OpenPATH is an end-to-end system that ingests sensed and surveyed data through a smartphone app, and runs an analysis pipeline to convert the raw data into a “travel diary” – a linked timeline of traveler trips between places with full trajectories, segmented for multiple modes. Each trip or section can have both auto-generated and human annotated labels. The diary can then be displayed to the traveler using the smartphone app for information and/or correction. The travel diary also functions as an individual mobilityscope, or transportation meter, whose data can be gamified to influence traveler behavior. The polar bear gamification was originally developed as part of the TripAware project, presented by John Leyden at BECC 2018.

The results indicated that e-bikes were the dominant mode of transportation for program participants as a whole, followed closely by driving alone and carpooling. This is significantly higher than the census bicycle mode share for Denver County, which was under 5% in the 2019 ACS. It even exceeds the ambitious future goals which aims to have 30% of commuters walking, biking or taking transit by 2030. Counting carpools as “transit”, the mini-pilot participants had commuted 60% of the time using those three modes.

Prior work on shared micro mobility systems has indicated that they are primarily used to bridge the first mile and last mile to transit. These results indicate that, under the ownership model, e-bikes are used in end-to-end trips for a wide variety of purposes. This difference may be due to difficulty of loading heavy e-bikes on transit, and reluctance to leave a $3,000 bike locked up at a transit station.
Since the mini-pilot ran for three months, we were able to measure the change in e-bike usage over time. As the weather cooled, e-bikes were no longer the dominant mode. However, the new dominant mode was carpooling instead of driving alone. The program thus met its original goal of preventing a mass shift to driving alone, even during the winter months in a cold climate.
OpenPATH captures detailed trip history, annotated with user-specified labels that include the mode and the replaced mode. We can use this to assess the trip level impact of e-bike trips by calculating the difference in emissions intensity caused by the e-bike replacement and multiplying it with the trip length. We can sum up all the trip-level impacts to obtain the program-level impact. We found that e-bike trips typically replaced car, walk and bike trips. The car trip replacement resulted in emission savings, while the walk and bike replacement actually resulted in a small amount of increased emissions. However, the e-bikes are so efficient that the overall impact was positive. Note that the walk and bike replacement increased participant *productivity* (similar to the Mobility Energy Productivity Metric, ), so the program actually balanced equity and sustainability goals.
The use of OpenPATH was critical for this evaluation. Without OpenPATH, the CEO would have most likely used web surveys such as SurveyMonkey or Google Forms to evaluate their program. In fact, the mini-pilot actually included a weekly survey for participants. The survey included open-ended, qualitative questions, but it also asked questions about e-bike usage and mode replacement in the past week.

Unfortunately, while it is somewhat feasible for participants to estimate the count of their trips in the past week, it is extremely difficult to estimate distance. So in our energy or emissions impact calculation, which involves multiplying the difference in energy or emission intensity by the trip length, we would not have the trip length. In contrast, OpenPATH maintains an auto-generated record of all trips, which allows us to get trip-by-trip lengths.

This side-by-side comparison also revealed that many users did not complete the survey, and among those that did, there was significant overreporting of e-bike trips. Such under and overreporting biases are well-documented in the travel survey literature.

The results of the mini pilot were so positive that the Colorado Energy Office decided to go ahead with a full pilot in 5 locations across Colorado. The participants will be asked to contribute data for 2 years. Four of the programs in the full pilot have already launched, you can see the real-time results at the public dashboard (https://dashboard.canbikeco.org/).

Over the summer, we had several interns work on a machine learning system that would automatically identify common trips and re-use their labels. This reduces the labeling burden on participants, specially as we settle in for the long haul of multiple months of data collection. We deployed the auto-labeling system at the end of August, after extensive beta testing by program administrations and are looking forward to seeing how it works in the real world.

We are also working on providing easy-to-use access to the OpenPATH platform to other groups for conducting similar behavioral studies. Our primary request is that the resulting data be archived in the Transportation Secure Data Center (TSDC), a DOE-and-DOT funded travel survey archive, for long-term research access. Please contact any of us if you are interested!