Informing Electric Micromobility Policy through Demonstrations and Planning

Final Report | Report Number 24-10 | December 2023

NEW YORK STATE | NYSERDA

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Our Vision:

New York is a global climate leader building a healthier future with thriving communities; homes and businesses powered by clean energy; and economic opportunities accessible to all New Yorkers.

Our Mission:

Advance clean energy innovation and investments to combat climate change, improving the health, resiliency, and prosperity of New Yorkers and delivering benefits equitably to all.

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Informing Electric Micromobility Policy through Demonstrations and Planning

Final Report

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Abstract

As new mobility options and technology emerge that can help make our transportation systems more efficient and environmentally friendly, we must identify pathways and strategies to maximize their benefits and minimize barriers to adoption. Part of this mobility revolution centers around the development of electric micromobility (EMM). EMM devices are modes of personal transportation that use electric power to propel or assist the user during their travel. Two primary examples of EMM devices are e-bikes and e-scooters, both of which New York State legalized for public use at the start of this project.

Led by Shared Mobility Inc. (SMI), "Informing Electric Micromobility Policy through Demonstrations and Planning" began in April 2020. The project's goal is to inform local and regional policy decisions through information garnered from public demonstrations and research. Focused on Upstate New York, a region historically less connected to technological and transportation innovations compared to major metropolitan areas, the project sought to identify strategies for cultivating community-centered approaches for shared EMM systems and tangible pathways to increase its overall adoption through policy and outreach efforts.

Keywords

electric micromobility, EMM, e-bike, e-bikes, bikeshare, bikesharing, e-bikeshare, e-bike library, e-bike libraries, e-scooter, e-scooters, scootershare, shared mobility, shared-use mobility

Acknowledgments

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Additionally, we would like to thank our partners at the city of Buffalo, city of Niagara Falls, East Side Bike Club, Create a Healthier Niagara Falls Collaborative, Buffalo Niagara Medical Campus, Greater Buffalo Niagara Regional Transportation Council, city of Rochester, Genesee Transportation Council, city of Syracuse, Capital District Transportation Authority, Capital District Transportation Committee, Rural Health Network of South Central New York, Bike Walk Tompkins, Volunteer Transportation Center, and all the other partner organizations that supported our work and connected us with their target populations throughout the project period.

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Acronyms and Abbreviations

BIPOC	Black, Indigenous, and People of Color
BNMC	Buffalo Niagara Medical Campus
CDTA	Capital District Transportation Authority
CDTC	Capital District Transportation Committee
CHNFC	Create a Healthier Niagara Falls Collaborative
CMAQ	Congestion Mitigation and Air Quality
DOT	NYS Department of Transportation
EMM	electric micromobility
ESBC	East Side Bike Club
GHG	greenhouse gas
LISC WNY	Local Initiative Support Corporation, Western New York office
MOVES	motor vehicle emission simulator
mph	miles per hour
NYSERDA	New York State Energy Research and Development Authority
RFP	request for proposal
RGRTA	Rochester Genesee Regional Transportation Authority
RTS	Regional Transit Service
SMI	Shared Mobility Inc.
UBRI	University at Buffalo Regional Institute
VTC	Volunteer Transportation Center

Executive Summary

As new mobility options and technology emerge that can help make our transportation systems more efficient and environmentally friendly, we must identify pathways and strategies to maximize their benefits and minimize barriers to adoption. Part of this mobility revolution centers around the development of electric micromobility (EMM). EMM devices are modes of personal transportation that use electric power to propel or assist the user during their travel. Two primary examples of EMM include e-bikes and e-scooters, both of which New York State recently were legalized for public use.

Founded in 2009, Shared Mobility Inc. (SMI) is a not-for-profit organization dedicated to advancing emerging transportation technologies and programs in communities not traditionally served by the private sector. With support from the New York State Energy Research and Development Authority (NYSERDA), SMI sought to leverage the innovative, environmentally-friendly potential of EMM to catalyze change within the Upstate New York transportation landscape.

The project "Informing Electric Micromobility Policy through Demonstrations and Planning" began in April 2020 to inform local and regional policy decisions through public demonstrations and research. Focused on Upstate New York, a region that has not always benefited from technological and transportation innovations compared to major metropolitan areas, the project sought to develop strategies for fostering community-centered approaches for shared EMM systems and to identify tangible pathways to increase its overall adoption through policy and outreach.

First, SMI analyzed policy to determine what has already been implemented, what has and has not worked, and how policy can be adapted to the three focus regions. Second, SMI used this information to assist municipal partners in understanding current EMM policy, guide policy development based on each region, and facilitate partnerships with suitable EMM operators based on municipal preferences. Third, the project assessed the feasibility of implementation along with the anticipated impacts it would have on reducing greenhouse gas (GHG) emissions. SMI worked directly with municipal and community partners across Upstate New York to directly and indirectly support the development of community-controlled EMM programming to sustain positive impacts beyond the project term.

This research and engagement approach yielded several key findings, including:

- Encourage informed and engaged municipal policies to increase EMM usage while making streets safer and the environment cleaner
- Highlight Upstate New York's small and midsize communities demonstrable need for innovative mobility programs while acknowledging vulnerability to EMM industry downturns
- Demonstrate widespread public interest in EMM technologies through interactive demonstrations that, when given the opportunity to try out EMM in a controlled environment, individuals are more likely to use EMM for their daily mobility needs
- Catalyze a sizable reduction in GHG emissions by encouraging personal adoption of EMM devices and shifting away from single-occupancy automobiles
- Explore opportunities for further EMM development in Upstate New York through community-centric mobility program development

The following report details the work SMI and its partners undertook to help understand, engage with, and promote EMM throughout Upstate New York.

1 Project Timeline

1.1 Background

This project was proposed in August 2019 and formally launched in April 2020. Statewide EMM policy had changed within that time period, legalizing the use of electric micromobility (EMM) devices in New York State. The policy change, included in the state budget passed in April, permitted public and private use of personal EMM devices, thereby enabling implementation of this project. During the first year of the project, Uber Technologies donated more than 3,100 JUMP e-bikes to SMI. These e-bikes were used not only to conduct our demonstrations and to introduce e-bikes to the public, but also to pilot the e-bike library concept. Since that time, e-bike libraries have gained national recognition within the EMM industry, and are now being replicated and adapted for communities nationwide.

Following project kick-off, SMI continued its active outreach and demonstration activities through October 2022, dividing the project into two primary phases. Phase 1, research and demonstrations, focused primarily on developing survey and assessment tools, as well as initial capacity-limited demonstration activities with a public health focus. Phase 2, pilots and engagement, expanded the project's scope to support pilot-level e-bikeshare and e-bike library programs, as well as to engage and assist community partners statewide to develop their own EMM programs. Each phase included milestones that enhanced SMI's knowledge and understanding of EMM feasibility in Upstate New York.

1.1.1 Phase 1: Research and Demonstrations (April 2020-June 2021)

The focus of the research and demonstrations phase was on collecting data to inform guidance and recommendations for Upstate New York communities and its stakeholders. Four white papers were finalized during this phase:

1. "EMM State-of-the-Industry Guide"
2. "EMM Best Practices Policy Guide"
3. "EMM Regional Assistance Report"
4. "Electrifying Change: Understanding the Potential for Personal-Use of Electric Micromobility to Reduce Greenhouse Gas Emissions in Upstate New York"

In addition to gathering the research necessary to write these papers, SMI conducted demonstrations to gather public feedback through surveys on feasibility and willingness to adopt EMM as a regular transportation option. The research and survey data enabled SMI and stakeholders to understand the state of the EMM industry, establish best practices, assess potential impact, and gauge public response to this emerging transportation option. SMI conducted this research to assess the feasibility of EMM in Upstate New York.

1.1.1.1 Partner Development

To prepare for the research and demonstrations, SMI focused on building strong partnerships with regional stakeholders. These partnerships were a significant part of phase 1 and enabled its execution. The partnerships created during phase 1, though ongoing throughout the project, formed basis of the white paper “EMM Regional Assistance Report,” one of the primary deliverables. The partnerships enabled SMI to build a connected network of service providers and community beneficiaries, both of which are essential for successful and equitable EMM programming. Collaboration among partners fostered knowledge sharing, thereby allowing SMI to glean from their expertise and vice versa. Partners included municipal officials, departments, local advocacy groups, and service providers. SMI maintained regular communication through monthly newsletters, updating partners on industry developments, best practices, and other important updates.

Following are some of SMI’s project partners:

- City of Buffalo
- Greater Buffalo Niagara Regional Transportation Council
- Niagara Frontier Transportation Authority
- City of Rochester
- RGRTA
- Regional Transit Service (Rochester)
- Bike Walk Tompkins
- Capital District Transportation Authority
- Capital District Transportation Council
- Los Angeles Department of Transportation
- University at Buffalo
- Buffalo Niagara Medical Campus (BNMC)
- Vidwheel (formerly Nickel City Graphics)
- GObike Buffalo
- Niagara River Greenway Commission/NYS Parks
- Drop Mobility
- KUHMUTE
- CLIP
- OneMotor

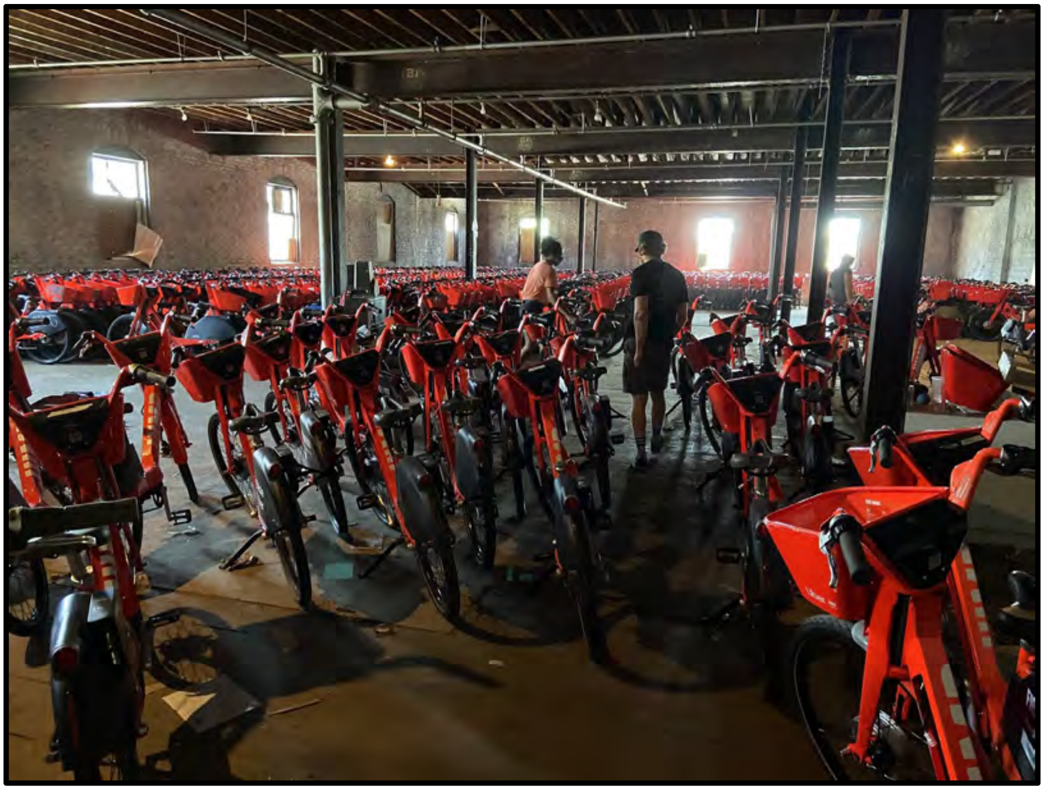
1.1.1.2 JUMP E-bike Donation

In May 2020, Uber announced that it would discontinue its JUMP bikeshare division, leaving the future of tens of thousands of shared e-bikes uncertain. In response, SMI reached out to Uber to request a donation of a portion of the former JUMP fleet. After numerous discussions, SMI received approximately 3,100 pedal-assist JUMP e-bikes over the course of six weeks at our Buffalo warehouse facility.

Figure 1. Delivery of Donated JUMP E-bikes

To understand the operational capabilities of the donated fleet, SMI’s operations team reached out to multiple former JUMP employees in New Orleans, Sacramento, San Francisco, Seattle, and elsewhere. These conversations, coupled with an assessment of the fleet, led SMI to determine that the majority of the JUMP fleet could be repurposed with corrective maintenance and basic upgrades to the on-bike battery management system.

Figure 2. Unloading Donated JUMP E-bikes



By September 2020, SMI began using the JUMP fleet in its demonstration events, which was continued throughout the project. Additionally, during late phase 1, SMI began engaging with local partners to explore programming options to establish e-bike libraries as community-controlled pilots. These programs offered free access to e-bikes for residents in local marginalized communities. Details on the pilot activities can be found later in this report.

Figure 3. Storage of Donated JUMP E-bikes

1.1.1.3 Survey Design and Initial Demonstrations

To effectively gauge public interest in using EMM devices, SMI organized 12 large public events. These events, which demonstrated EMM devices, including e-bikes and e-scooters, allowed individuals to ride the devices in a controlled setting and provide feedback via surveys. Unfortunately, due to the COVID-19 pandemic, large-scale events were not permitted in New York State during the majority of the project term. In an effort to maintain this original approach as much as possible, SMI organized demonstration meetings with local partner organizations, limiting attendance and ensuring socially distancing. These initial meetings allowed SMI to refine the concept for public demonstration events, relaunching in summer 2020. For the remainder of the project, SMI focused on smaller-scale events to comply with public health guidelines and create a safe and interactive experience for demonstration participants.

Figure 4. Grand Island Public Electric Micromobility Demonstration Event

Based on survey results, SMI was able to determined several components, including estimating the length and percentage of trips users would replace with EMM, assessing individuals' willingness to use e-bikes or e-scooters for daily trips, identifying locations users would feel comfortable riding EMM devices, and evaluating how EMM would fit into their existing travel patterns in each respective metropolitan area. The survey also included questions about an individual's demographics, socioeconomic status, and travel patterns. Analysis of these results can be found in section 4.

Figure 5. Niagara River Greenway Stakeholder Electric Micromobility Demonstration

1.1.1.4 University at Buffalo Graduate Studio

SMI partnered with the University at Buffalo and Dr. Emmanuel Frimpong-Boamah, who led a graduate-student studio to research the equity component of EMM deployment in Buffalo. Dr. Frimpong-Boamah is a leading research professor specializing in global planning and institutional structures that affect marginalized communities. The studio researched how EMM can be programmed to prioritize equity and inclusion, and how to best serve low-income communities.

Figure 6. University at Buffalo Graduate Students on JUMP E-bikes

SMI established the studio as a collaborative approach to give students the most exposure to SMI as an organization and introduce them to the EMM landscape. SMI facilitated sessions with six key partners from across the country that shared their expertise with the students via Zoom and hosted an in-persondemonstration event for the students. The students used SMI's market and industry research as the basis for their work, and then conducted in-depth policy analysis along with geographic suitability analysis using local street conditions, walkability, income, and commute time data.

Figure 7. University at Buffalo Graduate Student with E-scooter

The policy analysis resulted in nine principles gleaned from successful programs across the country, including connectivity, diversity, and safety. One example is from Baltimore, Maryland, where the Department of Transportation implemented a Resident Mobility Advisors program, empowering community members with leading roles. The students' proposed solutions were innovative and community-centered, requiring collaboration among multiple stakeholders such as the City of Buffalo and the Niagara Frontier Transportation Authority. The students found that EMM deployment and programming would be the most successful and equitable with support from municipal officials, local transit authorities, and engaged citizens.

1.1.2 Phase 2: Pilots and Engagement (June 2021—October 2022)

1.1.2.1 E-bike Library Program Development

The e-bike library pilot was operated and refined over two summers. These initiatives gave community members no-cost access to e-bikes, similar to borrowing books from a public library. E-bike libraries are dynamic programs that can be tailored to fit the specific needs of the community the program serves. E-bike library members are able to return to the library hub to receive a recharged battery or to have their e-bike serviced throughout the duration of their loan.

The initial library pilot began in summer 2021 and underwent refinements in summer 2022. These pilots were conducted in collaboration with two key community partners, the East Side Bike Club (ESBC) and Create a Healthier Niagara Falls Collaborative (CHNFC). The ESBC is a Buffalo-based, Black, Indigenous, and People of Color (BIPOC)–led community bicycling organization, and CHNFC is a not-for-profit organization dedicated to promoting healthy living for Niagara Falls residents. SMI was intentional in selecting partners that were leaders in their communities to ensure that the program remained community-led and controlled. SMI worked with these organizations to build out the full library model and worked to create a healthier "mobility ecosystem." Without these partnerships, the pilots would not have been possible.

Figure 8. Create a Healthier Niagara Falls Collaborative E-Bike Library Orientation

By leveraging the assets in hand, as well as support for this project from the New York State Energy and Research Development Authority (NYSERDA), SMI and ESBC successfully secured funding from two additional grants: a pilot-focused grant from the National Center for Mobility Management, a program funded by the Federal Transit Administration technical assistance center, and the other grant from the Community Foundation for Greater Buffalo. These grants allowed SMI and ESBC to build a fully functional pilot program that included a community workshop in Buffalo's Kensington-Bailey neighborhood in the heart of the city's East Side, where transportation disparities are the greatest in the region. The workshop served as the hub for the e-bike library program, providing a gathering space for community members to meet with program staff, borrow and return e-bikes, participate in ESBC group rides, and access other services such as bike repairs and training classes for those interested in learning more about active transportation.

Figure 9. East Side Bike Club Community Workshop Grand Opening

The SMI operations team undertook the first step in launching the pilots by preparing the e-bike fleet. The team determined that the bikes would need a new battery-management system to prolong the lifespan of the onboard lithium-ion batteries, thereby increasing the range of the e-bikes and making them more useful in a programmatic setting. The bikes were mechanically sound, requiring only basic tune-ups and repairs to make them fully operational. Participants in the pilot programs had the opportunity to build longer-term relationships with the EMM through this program. The programs also provided an opportunity to demonstrate smartphone and radio frequency identification technologies for bike rental, similar to processes used in shared EMM systems.

During the pilot in summer 2021, community members were able to try e-bikes at community events and borrow the e-bikes for up to 2 weeks. The community partners leading outreach efforts for their communities created the procedures for the way members access the e-bikes and register to participate in the pilot program. The goal of this pilot program was to advance NYSERDA's overall project goals by increasing accessibility to e-bikes for community members to use for a variety of purposes: demonstrations, recreation, errands, and commuting.

Figure 10. Weekly East Side Bike Club Group Ride on Pilot E-bikes

At the beginning of 2022, the SMI team began evaluating the potential impact of using more of the donated JUMP pedal-assist e-bikes to enhance programming and demonstrations. Specifically, SMI sought to expand its work on the e-bike library concept. Throughout the 2022 riding season, SMI continued collaborating with CHNFC, providing the group 10 JUMP e-bikes and 10 bike racks to use as a mini-library demonstration from its office in Niagara Falls. Additionally, SMI worked with CHNFC to secure long-term funding for library programs in Niagara Falls, including the Accelerating Clean Communities with E-bike Systems proposal to NYSERDA's Clean Neighborhoods Challenge, as well as seeking philanthropic support from local foundations.

Figure 11. East Side Bike Club Showcases Pilot E-bikes

The collaboration with ESBC was particularly significant following a tragic, racially-motivated attack at the Jefferson Avenue Tops Friendly Market on May 14. The incident targeted Buffalo's Black community, resulting in the closure of the only full-service grocery store on Buffalo's East Side, exacerbating longstanding issues of limited access to fresh and healthy foods. In response, SMI sought to mobilize its staff and resources to support efforts to increase transportation options for East

Side residents. Following ESBC's leadership, SMI increased its efforts to provide e-bikes throughout the library pilot program area and used a newly launched workshop space as a hub for food distribution and other community relief and healing efforts. This work was part of a broader initiative of Buffalo-based community organizations to provide relief and assistance to residents in underserved areas that include transportation, food distribution, health access, and more.

1.1.2.2 Buffalo E-bikeshare Pilot

In addition to developing the e-bike library program, SMI used its donated JUMP e-bikes for an e-bikeshare pilot through the Reddy Bikeshare program, which SMI has operated since its launch in 2016. For the pilot, 25 e-bikes were added to Reddy's fleet of 400 classic pedal bikes. SMI sought ways to incorporate e-bikesharing into the existing Reddy program as a complementary program model to the e-bike library model. Whereas the library offers members access to e-bikes via weekly loans, the e-bikeshare model provides short-term access where users pay per minute of use. The model offers flexibility, enabling users to end their rentals and return their e-bikes at any of the Reddy system's 100+ bikeshare stations across the region.

For the 2022 e-bikeshare pilot, the Reddy team collaborated with private and public sector partners in the city of Buffalo to develop a pilot program that would maximize service quality. SMI capped the pilot at 25 e-bikes, deploying them strategically for a variety uses, such as recreational use, first and last mile connector to transit, and so forth. The goal was to use the pilot's results to inform SMI's interproject results while supporting the EMM policy development led by Buffalo's Office of Strategic Planning. After this planning, the Reddy team deployed e-bikes at the following six docking stations:

- 201 Ellicott Mobility Hub (downtown Buffalo)
- Seneca One (downtown Buffalo)
- Innovation Center (BNMC)
- H. H. Richardson Complex (Buffalo's West Side)
- Buffalo Museum of Science (Buffalo's East Side)
- Delaware Park (Buffalo Olmsted Park System)

Figure 12. E-bikeshare Pilot Station at the Buffalo Niagara Medical Campus's Innovation Center

The e-bikeshare pilot was launched in early August, granting access to any Reddy Annual pass members, and ran for 10 weeks through mid-October. The SMI/Reddy team examined usage data, survey responses, and direct feedback from system partners. These insights will be used in planning for future e-bikeshare initiatives beyond the project term, as well as providing vital information to the city of Buffalo to inform its related policy development.

Figure 13. Reddy Bikeshare Members at Group Ride Event

1.1.2.3 New York Clean Transportation Prizes

In early 2021, SMI partnered in the development of two proposals for NYSERDA's Clean Neighborhoods Challenge, which contained core concepts that the current project was simultaneously developing. One of these initiatives, Accelerating E-bike Adoption for Clean, Equitable Communities, led by ICF International, pioneered a statewide network of e-bike library programs in conjunction with innovative workforce development opportunities to help train the next generation of EMM technicians. The project would collaborate with local community-based organizations in each of the project's target areas to engage community members.

The second proposal, Centering People, Place, and Policy for Buffalo's Clean Mobility Future, by Local Initiative Support Corporation Western New York (LISC WNY) focuses on implementing numerous community-based initiatives throughout Buffalo's East Side. The main objective is to improve personal mobility and increase access to essential services, economic opportunities, and other vital resources for community members. In both proposals, SMI facilitates the mobility programs that form the foundation for the proposed initiatives, including the development and implementation of e-bike libraries and e-bikesharing programs.

Figure 14. Buffalo-based Partners Brainstorming Session

In November 2022, NYSERDA announced the selection of the LISC-led proposal as a recipient of the Clean Neighborhoods Challenge. This initiative will provide direct funding to expand the Reddy Bikeshare program with additional e-bikes, as well as funding for the ESBC E-bike Library, among other key community and transportation developments.

2 Electric Micromobility State of the Industry and Best Practices

2.1 State of the Industry

Research for this project began with examining leading EMM operators, such as Lime, Uber, and Bird, to establish a baseline understanding of the market landscape. This was paired with a review of relevant mobility and tech-focused media, including CityLab, Wired, Smart Cities, and others. Results of this work were compiled into white paper reports and presented to various stakeholders statewide. These reports were updated periodically during the project to reflect ever-changing market conditions within the EMM industry.

SMI used industry-focused research as the basis for working with specific partners in their efforts to explore developing and deploying EMM systems in their respective regions. Conversations with the city of Syracuse, Bike Walk Tompkins, and the Capital District Transportation Authority, among others, helped to inform SMI's understanding of the relationships between local partners and EMM vendors. Additionally, the SMI operations team studied nontraditional operating models, including not-for-profit and publicly-owned operational structures, to determine how EMM systems could be adapted to be community-focused and partner-driven.

2.2 Best Practice Policies

To gather best practices in EMM policies, SMI analyzed the deployment of EMM systems in several major cities, including San Francisco, California; Seattle, Washington; Portland, Oregon; Detroit, Michigan; New York, New York; Denver, Colorado; Austin, Texas; and Baltimore. Maryland, among others. Information was sourced from various materials, including news stories, policy briefs, pilot program reports, academic papers, personal interviews, and legislation, among others. Case studies from each city were analyzed and distilled into major categories to guide program implementation based on the cumulative lessons learned from successful and unsuccessful programs nationwide.

2.3 EMM Demonstrations

As discussed earlier, SMI hosted public demonstrations to raise awareness and educate the public about EMM devices, as well as to gather community feedback on experiences and perceptions of using EMM devices in everyday life. Demonstrations ranged from small group meetings to large-scale public events. In total, SMI held 45 demonstrations between 2020 and 2022.

In 2020, 21 demonstrations took place, followed by 22 demonstrations in 2021, and 2 demonstrations in 2022. Throughout these events, 690 surveys were administered. Locations for the demonstrations were chosen based on partnerships and the ability to maintain social distancing and small groups sizes. Tabling events were facilitated with team assistance, offering QR codes for survey access, as well as survey paper copies. SMI observed strict safety protocols, including wearing masks, social distancing, and sanitizing regularly. Surveys were then compiled into a spreadsheet, organized into tables, and analyzed.

2.4 Greenhouse Gas Emissions Projections

In June 2020, SMI began working with University at Buffalo Regional Institute (UBRI) to develop a joint research and evaluation process using real-world feedback from prospective EMM users to inform mode-shift projections. Additionally, the project sought to understand the degree to which individuals would transition their travel mode to EMM alternatives if given the opportunity.

To best measure the impacts of EMM in Upstate New York, the UBRI research team developed a methodology for the Greenhouse Gas Emissions Project. SMI chose UBRI to develop this report because of its established reputation and expertise in regional research. The methods document, "Methods to Estimate Environmental Impacts of E-bikes and E-scooters in Upstate New York," which UBRI authored, provides a framework for obtaining data sources and demonstrating the potential environmental impacts of privately- or self-owned EMM device usage. SMI and UBRI then developed short and long surveys, which were administered at EMM demonstrations to gather accurate local data for estimates. UBRI's methodology employs the motor vehicle emission simulator (MOVES3), a transportation emissions simulation software developed by the U.S. Environmental Protection Agency. This tool was selected for its accuracy in estimating and providing detailed data on GHG emissions.

Following the methodology guidelines, the SMI team compiled survey and public traffic data, including vehicle miles traveled, average speeds, distribution of road types, types of cars driven, age of cars driven, meteorological conditions, and fuel data to create the needed inputs for MOVES3. County-level data was collected from the NYS Department of Motor Vehicles, the NYS Department of Transportation (DOT), and the U.S. Bureau of Transportation Statistics National Household Travel Survey. The county-level data was synthesized into inputs and simulated using the MOVES3 software for regional baseline emission estimates. The inputs were then adjusted for EMM usage and rerun through the simulation model. The baseline and EMM usage data were extracted and reduced for the absolute difference in vehicle emissions from the simulation. After taking the difference from vehicle emissions, the outcomes were adjusted for the trips where EMM devices replaced trips made on foot or using traditional bicycles. This was then applied across our focus regions to reflect real-world impacts.

3 Project Limitations

3.1 COVID-19 Pandemic

The proposal for this project was written in August 2019, about six months before the start of the COVID-19 pandemic. A major focus of this proposal was on community engagement strategies, including pop-up events, ride-and-drive–style demonstrations, and surveys. The SMI team anticipated hosting 11 community events across Upstate New York State from Buffalo to Albany and up to the North Country. These events were intended to be hosted in collaboration with community partners to maximize reach, exposure, and usage of EMM devices. However, due to the restrictions necessitated by the pandemic, the project's numerous large-scale demonstrations were reconfigured as smaller meetings, some of which were conducted virtually, which inhibited ridership. In spite of these challenges, SMI was able to conduct several smaller events adhering to strict safety protocols that included masking, sanitization, and maintaining proper distancing. Despite the setbacks, SMI met the project goals in terms of surveys administered, although the execution looked exceedingly different from what initially planned.

3.1.1 Projecting Potential Greenhouse Gas Emissions Reductions

In the early stages of the project, SMI identified several potential challenges in accurately projecting the complete environmental impacts of increased EMM usage in Upstate New York. The onset of the COVID-19 pandemic significantly disrupted the shared EMM landscape, causing multiple Upstate New York bikeshare system operators to abruptly withdraw from local markets. Additionally, with statewide EMM legislation enacted only weeks prior to the project's kick-off, SMI identified the impracticality of linking any GHG impact assessment with shared EMM systems in the project's target geography given the uncertainty in when they would be deployed.

After discussions with UBRI, SMI decided that in order to meet the project's goal of assessing EMM's potential net-positive environmental impact, the survey and environmental projections would focus on personally-owned EMM devices. Using survey data from demonstration events, SMI assessed participants' mobility needs and gathered feedback on participants' willingness to use EMM as part of their daily travel routines in lieu of single-use automobile trips.

3.2 Changing Electric Micromobility Industry Landscape

Reporting on the state of the EMM industry was an ongoing deliverable for SMI due to the industry's rapid change and growth. The primary purpose was to provide clear and concise information to project partners regarding relevant industry developments. However, staying current with the rapidly changing industry was a significant challenge, despite efforts to stay updated with the latest information.

At the beginning of 2018, large device-sharing companies such as Lime, Bird, JUMP, and Spin invested millions of dollars into the emerging EMM industry and technology, looking to make a profit. By 2019, however, the return on investment began to slow, falling short of projections. The onset of the COVID-19 pandemic exacerbated the situation, prompting several major companies to drastically reduce their operations, pausing or eventually ceasing service in nearly all of their markets. This left communities without the transportation options that people had come to depend on. During 2020 Rochester (Zagster), Syracuse (Gotcha), and Ithaca (Lime) all lost their bikeshare programs as their for-profit operators abandoned the markets.

The constantly changing nature of EMM, coupled with the sudden departure of major companies from communities, posed challenges for industry and community partnerships. Market fluctuations periodically forced EMM industry partners into difficult financial positions causing them to respond by reducing their presence in smaller, less profitable markets. Because of this dynamic, community partners had difficulty developing policies and programs in their communities due to the lack of successful models operating at the time.

4 Results and Benefits

4.1 Electric Micromobility Demonstration Findings

As part of the project's engagement efforts, SMI successfully hosted 45 EMM demonstration events throughout Upstate New York where participants were given the opportunity to test e-bikes and e-scooters and provide feedback to SMI's research team via pre- and postdemonstration surveys.

Demonstration activities adhered to all public-health recommendations set forth by State and local authorities to minimize the spread of COVID-19. These precautions included limiting the overall event size and requiring participants and staff to wear face masks, maintain social distancing, and sanitize EMM devices between participants.

Survey results from these demonstrations show positive responses from participants toward adopting EMM as a regular travel mode. These results vary across people of all ages and incomes, with the vast majority being automobile users. This suggests that interest in EMM as a standard mode of transportation spans diverse ages, demographics, and transportation preferences, as Tables 1–3 illustrate. The following is an overview of key findings gathered from surveys administered during the demonstration events.

Table 1. Presurvey Question Number 10: Age of Demonstration Participants

Age	Percent	Total
18–25	10.4	42
26–35	27.2	110
36–45	15.6	63
46–55	16.0	65
56–65	21.2	86
66–75	7.9	32
76+	0.7	3

Table 2. Presurvey Question Number 14: Household Income of Demonstration Participants

Household Income	Percent	Total
$15,000–$29,999	11.1	45
$30,000–$49,999	21.0	85
$50,000–$74,999	18.3	74
$75,000+	27.2	110
Prefer not to say	16.3	66
Less than $15,000	6.2	25

Table 3. Presurvey Question Number 3: Primary Mode of Travel for Demonstration Participants

Travel Mode	Percent	Total
Walking	5.2	21
Bicycling	11.8	48
Driving	74.6	303
Taking Public Transportation	4.2	17
Taking Uber, Lyft, or Taxi	2.2	9
Carpooling	0.7	3
Other	1.2	5
Total		**406**

Table 4 shows that 95% of riders indicated they felt safe while using e-bikes and fewer than 4% of riders indicated they felt unsafe in any way. This feedback suggests that users would welcome EMM devices as a transportation option. This is supported by 42% of participants who said that they would be willing to ride an e-bike for a typical one-way trip of 45 minutes or more and another 36% of participants who would be willing to ride an e-bike for a 15- to 30-minute ride, as shown in Table 6.

Table 4. Postsurvey Question Number 5: Perceived Level of Safety Riding an E-bike

Perceived Level of Safety	Percent	Total
I've never used an e-bike	1.8	3
Somewhat safe	26.5	45
Somewhat unsafe	1.8	3
Very safe	68.8	117
Very unsafe	1.2	2
Total		**170**

Table 5. Postsurvey Question Number 6: Perceived Level of Safety Riding an E-scooter

Perceived Level of Safety	Percent	Total
I've never used an e-scooter	31.0	52
Somewhat safe	28.6	48
Somewhat unsafe	9.5	16
Very safe	28.0	47
Very unsafe	3.0	5
Total		**168**

Table 6. Long-form Survey Question Number 45: Average One-Way Distance E-bikers Are Willing to Travel

Travel Distance	Percent	Total Response
0 minutes (Not at all)	0	0
15 minutes or less	9	5
15 to 30 minutes	32	17
30 to 45 minutes	17	9
45 minutes or more	42	22
Total		**53**

Additionally, 98% of respondents indicated that they would ride an e-bike during the fall, spring, and summer seasons, as shown in Table 7. Furthermore, despite the challenges of winter conditions, 27% indicated that they would ride during winter, showing that the e-bikes could be feasible year-round in New York State. The number of people willing to ride during the winter would most likely increase as education, awareness, and familiarity increase.

Table 7. Long-form Survey Question Number 62: Seasonal Willingness to Ride E-bikes

Season	Percent Affirmative Responses	Total Response
Summer	98	40
Fall	98	40
Winter	27	11
Spring	98	40
I wouldn't consider using an e-bike.	0	0

Table 8 shows that most respondents feel safest when riding on a bike-dedicated infrastructure and within painted bike lanes. Nearly 3 out of 4 respondents feel safe when riding on streets marked with "sharrow" lanes, which designate that part of the driving lane needs to be shared with active mobility users.

Table 8. Long-form Survey Question Number 63: Perceived Level of Comfort in Different Setting while Riding E-bikes

Setting	Percent	Total Response
In a vehicle lane on the street	46	19
On a street with "sharrows"	73	30
In a painted bike lane	85	35
In a physically-separated bike lane	85	35
On a sidewalk	34	14
On an off-road bike path	95	39

Table 9 shows a 12% increase in the number of people willing to purchase an e-bike among participants after riding them, which indicates that participants like riding e-bikes more than they initially expected.

Table 9. Presurvey Question Number 5 and Postsurvey Question Number 1: Amount Users Are Willing to Spend to Purchase an E-bike

Amount	Presurvey		Postsurvey	
	Percent	Total	Percent	Total
Unsure	2.2	90	14.6	25
Less than $500	21.2	86	22.8	39
$500–$1,000	24.4	99	29.2	50
$1,000–$2,000	10.9	44	17	29
$2,000 or more	4.0	16	3.5	6
Wouldn't buy	17.3	70	12.9	22
Total		**405**		**171**
Total percent would:	**60.5**		**72.5**	

The comparison of pre- and postsurvey responses in Table 10 show the same conclusion: riders enjoy e-bikes more than expected. After testing bikes, participants are more willing to adopt e-bikes as a regular mode of transportation in their everyday lives. The posttest shows that 8.7% of people are willing to replace 100% of their daily trips with e-bikes. Additionally, riders showed a 10% increase in willingness to replace 51%–75% of their trips with e-bikes.

Table 10. Postsurvey Question Number 3 and Presurvey Question Number 8: Percentage of Trips Users Are Willing to Replace with E-bikes

Number of Trips	Presurvey		Postsurvey	
	Percent	Total	Percent	Total
0–10	11.1	45	4.1	7
11–25	18.0	73	16.3	28
26–50	41.1	167	31.4	54
51–75	14.5	59	24.4	42
76–99	10.1	39	15.1	26
100	5.2	21	8.7	15
Total		**404**	**172**	

The survey data shows a positive and encouraging response from a wide range of people, reflecting a public willingness to transition to a different mode of transportation regardless of income, job, or typical commute mode. This data is particularly significant for SMI, serving as a gauge of public awareness and interest in this and future projects.

4.2 Electric Micromobility Best Practices

This report underscores the critical role of municipalities in leading the policy and partnerships for effective EMM deployment within their communities. The main policies and safety precautions municipalities need to be aware of are device speed, device parking, general rider safety, and data management. Without policies in place that address these issues, shared EMM system operations can result in a disarray of devices and poor relationships between municipalities and operators. Operators can leave the municipality at any time or implement procedures that prioritize their company's agenda over the interest of the community they operate in.

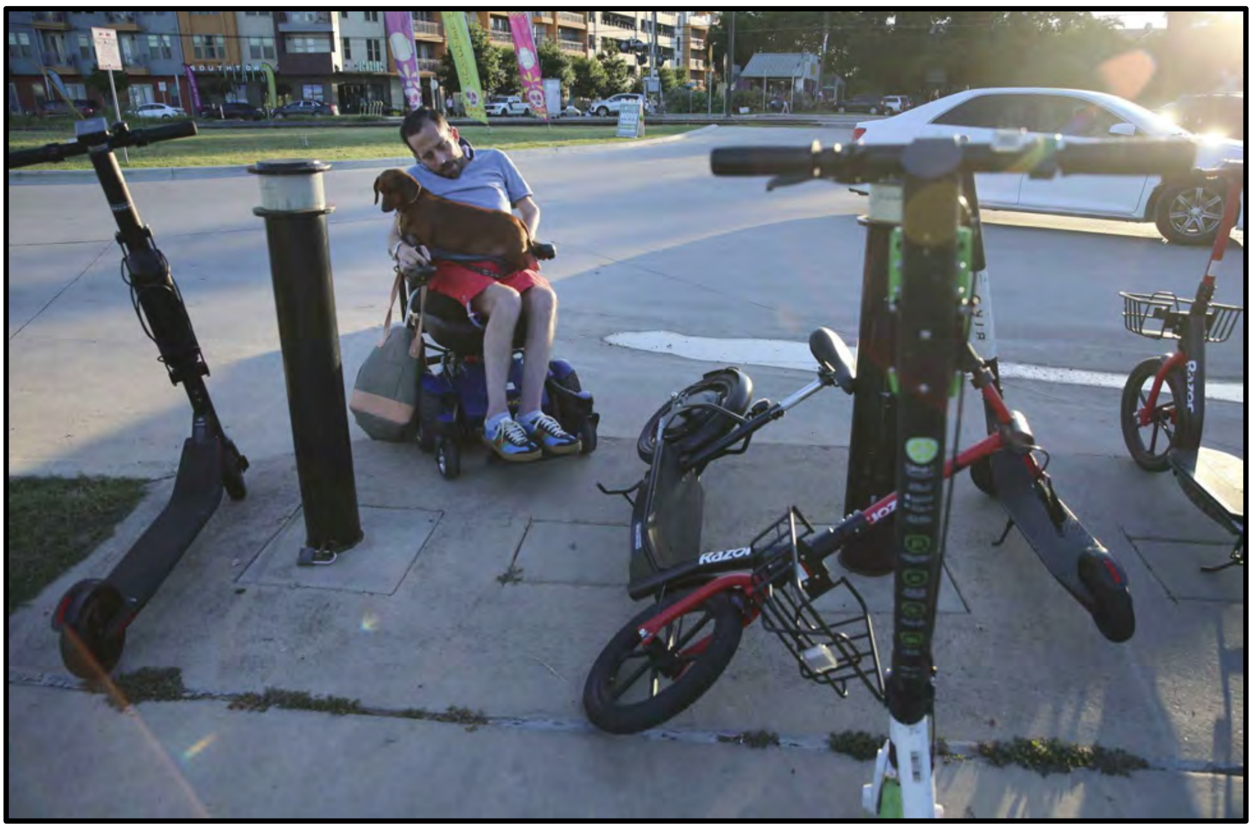
Initial pilot deployments of e-scooters and e-bikes in cities such as San Francisco and Santa Monica, California; Atlanta, Georgia; and Nashville, Tennessee, often occurred without established regulations. The shared systems did not have proper operational policies in place, which resulted in unsafe conditions for users and non-users, public confusion, and obstructed sidewalks. Additionally, the EMM vehicles themselves were damaged. Best practices indicate that for ensuring user safety and maintaining a safe, organized, and functioning area for e-bikes, municipalities need to lead the way in managing relationships and EMM device deployments. Policies addressing each operation area are important for a well-functioning shared system.

4.2.1 Device Speed

The speed of EMM devices has been a major concern for many cities nationwide. New users of e-scooters or e-bikes are often unfamiliar with the devices that can accelerate to 15 or 20 miles per hour (mph), resulting in a disproportionate number of injuries that occur on users' first rides. To mitigate this issue, first-time riders should receive guidance on how to safely operate EMM devices to prevent injuries. Furthermore, E-bike riders' speeds should be capped at around 20 mph, which is the legal limit in New York State, and 15 mph for e-scooter users. Additionally, careful consideration must be given to where and how EMM devices can operate to avoid unnecessary injuries. Municipalities can create "no ride zones" to designate areas where device use is prohibited, such as on high-speed roads, small parks, and areas with high pedestrian traffic. Finally, EMM devices should not be allowed on sidewalks to prevent collisions and injuries.

Figure 15. Wheelchair User Navigates Sidewalk Cluttered with Improperly Parked E-scooters

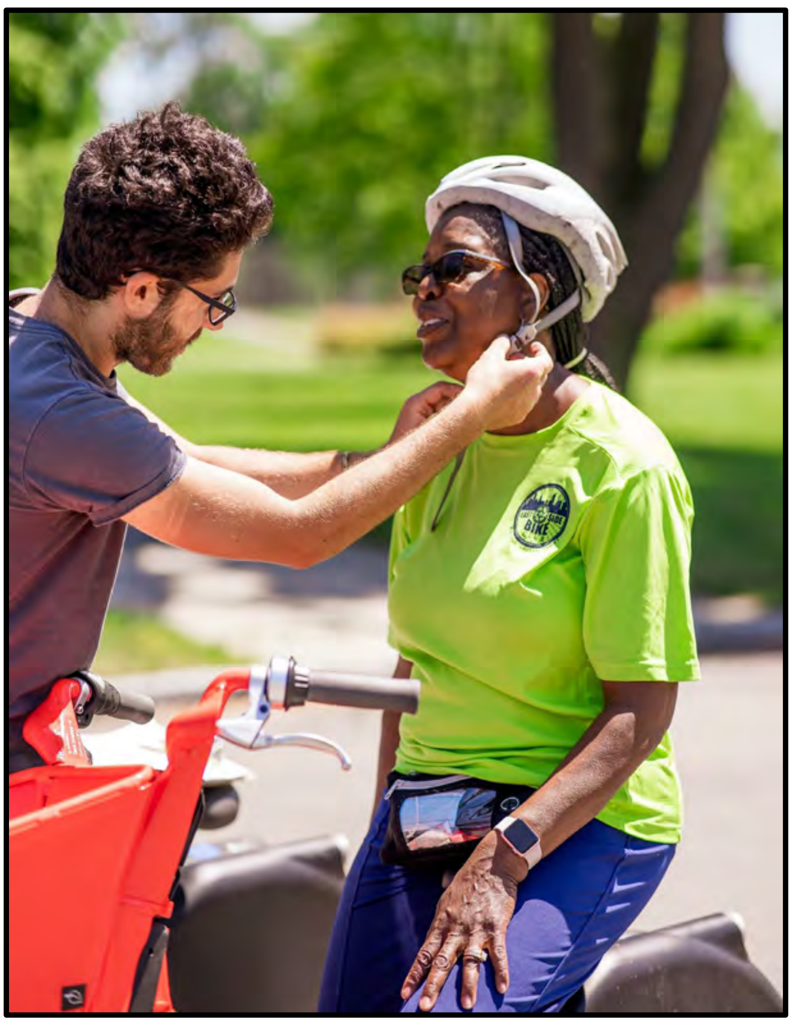
Photo credit: San Antonio Express-News (July 2019).



4.2.2 Device Parking

Poor parking practices of EMM devices can have negative impacts on vulnerable communities. Improperly parked EMM devices can obstruct sidewalks, blocking the path for pedestrians, which is especially dangerous for older adults and people with disabilities. To address these parking issues, operators have equipped their scooters with lock-to capabilities, using cable locks to affix scooters to bike racks to ensure they stay upright. Some cities, like Phoenix, Arizona, have designated specific e-scooter parking zones, which are displayed on a map available on the city's website. These parking zones are on the edge of the sidewalk closest to the road or clearly marked sections of the road next to the curb. Using specially allocated curbside space in the road or edges of the sidewalk is intended to discourage e-scooter users from riding on the sidewalk. Local jurisdictions in New York State should prioritize public safety by working with vendors to enforce responsible e-scooter parking practices.

Figure 16. ESBC Library Member Assisted with Fitting a Bike Helmet at Orientation



4.2.3 Rider Safety

From 2018 to 2020, the first two years of e-scooter systems operations, at least 29 rider deaths occurred, compared with just 3 over the 12 years of bikeshare operations nationwide. While jurisdictions largely agree that these devices should be prohibited on sidewalks, policymakers have diverged regarding helmet safety. Most U.S. states and localities have been reluctant to require all e-scooter and e-bike users to wear helmets. Safety for these new users should be a primary concern of state and local level policymakers. Encouraging and even requiring helmet use for EMM users, especially for e-scooters riders, should be a top safety priority across New York State. In addition to promoting and possibly requiring helmet usage, expanding safe infrastructure for EMM users is an important component for ensuring public safety. Most e-scooter fatalities have involved collisions with motor vehicles, and highlighting the need for policymakers to prioritize the expansion of bicycle lanes and paths.

4.2.4 Data Management

Bikeshare and scootershare systems collect vast quantities of data on users, including credit card information, which is protected under the recently enacted New York State Shield Act. New York State is one of a growing number of states requiring stricter security measures for businesses handling consumer data. When individuals rent e-scooters from a scootershare, the system operator collects information on the trip. Municipalities have the authority to revoke permits of operators who do not comply with data-sharing requirements. Despite the desires of large mobility companies to retain control over trip data, policymakers must access EMM usage generated data while also safeguarding privacy concerns. Robust state-level policy on trip data management for shared micromobility companies would establish minimum data-sharing requirements for trip data. Municipalities in New York State would benefit from this trip data in order to effectively plan for multimodal infrastructure and enhanced user safety. Statewide guidance and coordination would facilitate managing and requesting this data with regard to EMM data management.

4.3 Electric Micromobility State of the Industry

SMI’s EMM state-of-the-industry white paper was written as a dynamic document to record and monitor the continuously evolving industry. Distributed to relevant partners, the guide pertains to their work. This research started at the project’s beginning and continued throughout, reflecting EMM industry changes from 2020 through 2022. The research information came from ongoing news monitoring and discussions with SMI's EMM vendor partners, along with a variety of public-sector stakeholders. Partners have reported that the information has been helpful in gaining a better understanding of the market forces influencing EMM services.

SMI found that many private-sector EMM operators have followed the growth-focused approach Uber's former CEO, Travis Kalanick, favored. They prioritized expanding services into new markets, often scaling quickly without focusing on long-term financial and operational sustainability. In some cases, EMM units were deployed in cities without municipal operating permits. In addition to noncompliance, operators had a mixed record with regard to maintaining their devices in the early years. Among other issues, brake malfunctions caused e-bikes and e-scooters to stop abruptly, leading to numerous accidents. Operators were often slow to respond and, too often, were more reactive rather than proactive in addressing the issues. SMI hoped to proactively engage with Upstate New York municipal and community leaders to help prepare them to engage with EMM operators after New York State legalized shared EMM programs.

The economic impacts of the COVID-19 pandemic had devastating impacts on the EMM industry. By 2021, nearly 40% of docked and dockless bikeshare systems and 20% of scootershare systems that existed in 2019 had failed. At the onset of the pandemic, shared EMM operators Lime and Bird drastically reduced their workforces in response to significant revenue loss. Under more severe circumstances, midsized EMM share systems such as Zagster and Gotcha completely halted operations.

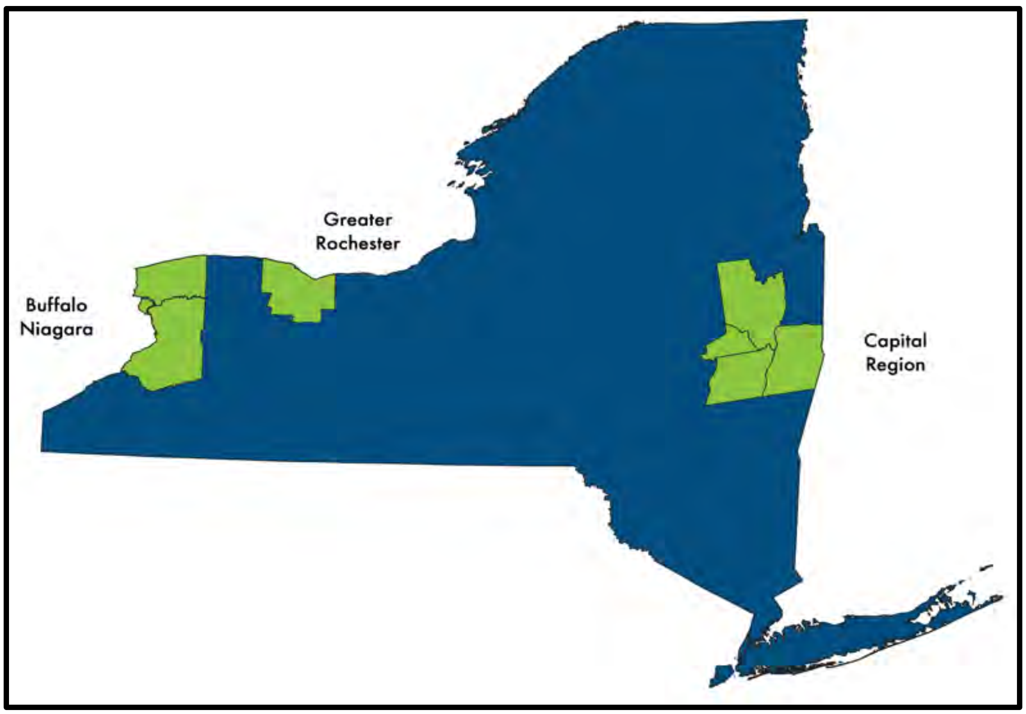
Another challenge the industry faced was the trend for companies to manufacture their own technology and EMM vehicles to streamline services. However, smaller operators had difficulty competing with the technology of larger companies. The shared mobility industry continued to evolve over summer 2020, and many operators altered their program models in response to the ongoing COVID-19 crisis and the surge in EMM use during this time.

As is the case often in the shared transportation landscape, the private sector is not the only catalyst for long-term mobility solutions. The COVID-19 pandemic highlighted that cities could not rely solely on startup EMM operators to provide sustainable services. Collaboration among the private, public, and not-for-profit sectors is key for local leaders, community stakeholders, and their constituencies to create lasting, long-term shared EMM solutions.

4.4 Greenhouse Gas Emissions Projections

EMM has the potential to offset carbon emissions by decreasing the number of automobile trips, particularly short trips in urban areas, leading to the reduction in GHG emissions from the State's transportation sector. This study evaluated the amount of carbon emissions that EMM could prevent by applying survey data from demonstration events and existing regional and State transportation data. The study focused on the Buffalo-Niagara, Capital Region, and Greater Rochester metropolitan areas, the three largest urban cores in Upstate New York. Each region was categorized based on the Metropolitan Planning Organization's jurisdiction. Buffalo-Niagara comprises Erie and Niagara counties; the Capital Region includes Albany, Schenectady, Rensselaer, and Saratoga counties; and the Greater Rochester metropolitan area includes Monroe County.

Figure 17. Focus Regions for Shared Mobility Inc.'s Greenhouse Gas Emissions Analysis



Based on demonstration survey data and local inputs, the MOVES3 software projects that EMM could significantly reduce carbon emissions in the target areas studied. The Buffalo-Niagara region produces an estimated 17,715 metric tons of carbon emissions annually. The impact grows in Rochester with a calculated savings of 55,635 metric tons and 94,929 metric tons in the Capital Region. Combined, these efforts can reduce emissions by an estimated 168,279 metric tons for these areas of New York State, as shown in Table 11.

Table 11. Total Estimated Emissions Saved in with Electric Micromobility Adoption with Regional Focus Areas

Metropolitan Area	GHG Emissions Prevented by Using EMM (metric tons)
Buffalo-Niagara	17,715
Greater Rochester	55,635
Capital Region	94,929
Total	168,279

As indicated in Table 12, using EMM devices in place of vehicles in these regions alone is equivalent to removing 36,267 automobiles from the road.

Table 12. Estimated Number of Automobiles Removed from the Road

Metropolitan Area	GHG Emissions Prevented by Using EMM (metric tons)	Equivalent Amount of Automobiles
Buffalo-Niagara	17,715	3,818
Greater Rochester	55,635	11,990
Capital Region	94,929	20,459
Total	168,279	36,267

As gasoline prices topped $4 per gallon at times during this project, trips replaced by EMM could potentially save $118.5 million in reduced gasoline purchases. These emission reductions have the environmental impact of planting more than 2.8 million trees in one year, as shown in Table 14. Additionally, this reduction equates to the environmental impact of recycling 58,228 tons of waste instead sending it to landfills, and the energy produced by 45.7 windmills running for one year.

Table 13. Estimated Barrels of Oil Not Used

Metropolitan Area	GHG Emissions Prevented by Using EMM (metric tons)	Equivalent Number of Barrels of Oil Consumed
Buffalo-Niagara	17,715	41,198
Greater Rochester	55,635	129,383
Capital Region	94,929	220,765
Total	168,279	391,347

Table 14. Estimated Equivalent Urban Trees Grown

Metropolitan Area	GHG Emissions Prevented by Using EMM (metric tons)	Equivalent Amount of 10-Year Old Urban-Environment Trees
Buffalo-Niagara	17,715	295,252
Greater Rochester	55,635	927,248
Capital Region	94,929	2,804,650
Total	168,279	4,027,150

The equivalencies of GHGs show the significant impact that automobiles and their fuel sources have on emissions rates. While this study focused on the private adoption of EMM, additional carbon savings could be achieved through developing, deploying, and expanding shared EMM programs across New York State. Further research is needed to evaluate these impacts as shared EMM programming continues to grow and evolve in communities statewide.

4.5 Upstate New York Regional Assistance

As part of the research project, SMI was tasked with assisting community partners across Upstate New York to better understand, develop, and implement approaches to expand access to EMM programming. The following outlines the support the SMI team provided its stakeholder partners throughout the project and details the outcomes of this work.

4.5.1 Western New York: Key Outcomes and Primary Partners

In Western New York, the project achieved the following key outcomes:

- Received donation of approximately 3,100 JUMP E-bikes from Uber
- Conducted EMM demonstration events across the region over a three-year period
- Implemented Reddy bikeshare e-bike pilot program in 2021 and 2022
- Launched E-bike library pilots in Buffalo and Niagara Falls
- Awarded the Clean Neighborhoods Challenge prize for Buffalo's East Side, led by LISC WNY

The project collaborated closely with the following primary partners:

- East Side Bike Club
- Create a Healthier Niagara Falls Collaborative
- City of Buffalo
- LISC WNY
- GObike Buffalo
- Niagara River Greenway Commission
- BNMC
- National Grid

Due to SMI's being headquartered Buffalo and coupled with public health and travel restrictions related to the COVID-19 pandemic, Western New York was the focus area for much of the technical assistance provided throughout the project.

Beginning in summer 2020, SMI conducted a series of local demonstration events designed to spread awareness of EMM options and give Western New Yorkers the opportunity to experience the devices firsthand. Because of the suspension of major events and festivals in accordance with guidance from public health officials, SMI worked with its network of local partners to host targeted events across the region. Local demonstration partners and events include, among others:

- GObike Buffalo: Hosted demonstrations at annual SkyRide event on Buffalo's waterfront and various open streets events
- Niagara River Greenway Commission: Supported stakeholder engagement events with municipalities seeking to expand the region's multiuse trail network
- BNMC: Hosted demonstrations at BNMC's open streets events, National Bike Month programs, and the first and second annual Electrify Buffalo events co-hosted by National Grid
- City of Buffalo: Collaborated with the City's Office of Strategic Planning to host a public demonstration event in September 2020 as part of a broader push by local leaders to gauge interest and collect feedback for new mobility initiatives

Figure 18. East Side Bike Club Member Using E-bike at SkyRide 2021

Figure 19. COVID-safe E-bike Demonstration in Niagara Falls

Figure 20. Shared Mobility Inc. Electric Micromobility Demonstration at Electrify Buffalo

To support the development of local EMM policy, SMI continued its work with the city of Buffalo beyond the demonstration event. SMI provided overall guidance by sharing best practices from cities nationwide. The team also wrote a policy memorandum, which analyzing existing city codes. Buffalo representatives from the Office of Strategic Planning reported that SMI's assistance has been instrumental in catalyzing policy discussions within the city administration. Further policy development, aligning with the city's 2023–2027 Four-Year Strategic Plan, is currently underway.

Figure 21. Buffalo Safe E-scooter Demonstration Event Attendees

Figure 22. City of Buffalo Council Member Mitch Nowakowski and Council Staff Member on E-bikes

Additionally, the e-bike library pilots and Reddy e-bikeshare pilot are a significant portion SMI's initiatives in Western New York. As detailed in phase 2 of the project timeline, the e-bike library and e-bikeshare pilots were conducted in partnership with local community leaders. SMI used the JUMP bike donation stock to support these programs, which aimed to expand resident access to EMM devices. The e-bike libraries focused on loaning e-bikes free of charge to residents living in disadvantaged communities, and the e-bikeshare program allowed any Reddy user with an annual membership to access e-bikes. Feedback from both programs provided valuable insights for future expansion of EMM across Western New York.

4.5.2 Capital Region: Key Outcomes and Primary Partners

In the Capital Region, the project achieved the following key outcomes:

- Consulted with Capital District Transportation Authority (CDTA) on expanding its Cycle! program with e-bikes
- Assisted with demonstrations for CDTA's SCOOT e-scooter pilot
- Partnered with Drop Mobility to retrofit and expand the Cycle! program

The project collaborated closely with the following primary partners:

- CDTA
- Capital District Transportation Committee (CDTC)
- Drop Mobility

SMI's relationship with CDTA, the Capital Region's public transit provider and lead agency for shared transportation programming, began years prior to the inception of this project. In 2016, SMI collaborated with CDTA to develop and deploy their CDPHP Cycle! bikeshare program with additional assistance provided for the program's 2017 expansion. Leveraging its existing relationship, SMI initiated discussions with CDTA to explore ways SMI could continue to provide technical assistance, specifically aimed at expanding CDTA's programming to include EMM options.

Figure 23. Shared Mobility Inc. and Capital District Transportation Authority Staff Meet Prior to Electric Micromobility Demonstration

Figure 24. Capital Region Stakeholders Use Electric Micromobility Devices at Demonstration Event

A major milestone in the process occurred October 2020 with an EMM demonstration event held at CDTA's maintenance facility in Albany. SMI worked with CDTA and the Capital District Transportation Committee (CDTC), the region's metropolitan planning organization, to coordinate participation from their agencies and other municipal leaders from across the region, providing an opportunity for attendees to explore and experience EMM options. Following this, SMI worked with CDTA to develop its own strategies and protocols for continued engagement and demonstrations with residents across the region. Based on SMI's own demonstration activities to host their meetings and ensure a safe and health-conscious environment, including assistance in planning for CDTA's SCOOT pilot, a limited e-scooter pilot program throughout the region. CDTA remains committed to full implementation of the SCOOT program.

In 2022, SMI resumed collaboration with CDTA as the authority began evaluating options to transition Cycle! program operations to a new partner and expand the program with pedal-assist e-bikes. In early 2023, SMI agreed to assume the role of CDTA's micromobility program operator in partnership with hardware and software supplier Drop Mobility. CDTA selected SMI based on its successful track record in implementing and deploying new mobility technologies, as well as its experience operating the Social Bicycles-based hardware currently used by the Cycle! program. In spring 2023, SMI began collaborating with Drop Mobility to retrofit CDTA's existing bikeshare fleet with Drop Mobility's software and telematics, and Drop Mobility e-bikes will be added to the Cycle! fleet throughout 2023 and 2024.

4.5.3 Central New York: Key Outcomes and Primary Partners

In Central New York, the project achieved the following key outcomes:

- Supported Bike Walk Tompkins in implementing a community-led bikeshare program in Ithaca
- Assisted the city of Syracuse in developing a request for proposals (RFP) for micromobility services
- Consulted with Binghamton University after Gotcha Mobility/Bolt Mobility bikeshare ceased operations

The project collaborated closely with the following primary partners:

- Bike Walk Tompkins
- City of Syracuse
- Binghamton University

At the onset of the pandemic in 2020, Central New York saw the departure of two EMM service providers. Lime announced in June 2020 that it would permanently leave the Ithaca market, and in November of that same year, Gotcha announced the end of its SYNC bikeshare service in Syracuse. Both companies cited financial reasons for their decisions, and their departures left their respective communities without any micromobility service providers during a time when the COVID-19 pandemic spurred a renewed public interest in biking and active transportation.

To help develop alternatives, SMI collaborated with lead stakeholders in both communities to provide guidance on best practices for EMM system development. In Ithaca, led by local not-for-profit Bike Walk Tompkins, stakeholders expressed their desire to create a locally controlled EMM system to safeguard against future market shifts that would cause private operators such as Lime to leave the area.

As a fellow mobility-focused not-for-profit, SMI shared with Bike Walk Tompkins the program strategies and business models SMI used for the Reddy Bikeshare program in Western New York. This, in turn, helped Bike Walk Tompkins, Ithaca's Center for Community Transportation, and other local partners to collaborate with Drop Mobility and successfully launch a 100-shared e-bike program in November 2022.

SMI offered assistance to Syracuse's Department of Public Works in developing its February 2021 Shared Micromobility Provider RFP, which resulted in the selection of Veo to provide shared e-bike and e-scooter services throughout the city. Veo launched its programs in Syracuse in September 2021 and has since expanded from 50 units to 350.

Figure 25. Binghamton-area Stakeholders Test E-bikes at Local Demonstration Event

Lastly, SMI consulted with Binghamton University in August 2022 following the sudden departure of its bikeshare service provider, Bolt Mobility. The university had previously partnered with Gotcha Mobility until Bolt acquired Gotcha's failed holdings in January 2021. The university sought consultation regarding potentially repurposing its campus fleet. After further discussion, the university decided to pursue a new operator instead of pursuing a retrofit solution, and SMI committed to continuing support moving forward. This work was done in addition to a regional stakeholder demonstration for Binghamton-based partners held in October 2021.

4.5.4 North Country: Key Outcomes and Primary Partners

In the North Country, the project achieved the following key outcomes:

- Collaborated with the Volunteer Transportation Center to form North Country EMM stakeholders' group
- Conducted stakeholder demonstrations and engagement to support ICF-led application to NYSERDA's Clean Neighborhoods Challenge

The project collaborated closely with the following primary partners:

- Volunteer Transportation Center of Watertown
- Clarkson University and other local universities
- St. Lawrence County

In an effort to expand the focus of work beyond Upstate New York's core urban areas, SMI collaborated with its longstanding partner, the Volunteer Transportation Center (VTC) of Watertown, to facilitate discussions among transportation and institutional partners in the North Country interested in developing EMM programs for the region. SMI and VTC had previously collaborated on developing volunteer transportation service programs across New York State.

VTC and its local partners focused on the potential to leverage local universities in Potsdam and Canton as the hubs for shared EMM services. Clarkson University in Potsdam expressed interest in expanding its existing bike library program to include e-bikes and other EMM options. Due to the region's limited warm weather periods, private mobility operators had shown little interest in providing services, prompting stakeholders to explore a local solution. Clarkson collaborated with the State University of New York at Potsdam, St. Lawrence University, and the State University of New York at Canton to secure their involvement and interest in potential EMM system development. VTC facilitated the coordination of these university partnerships with St. Lawrence County and other local service providers to form a regional steering committee. This committee collaborated with SMI on demonstration efforts, culminating in a stakeholder demonstration in October 2021.

Figure 26. North Country Stakeholders Pose in Front of E-bikes after Demonstration and Discussion on E-bike Libraries

SMI leveraged the North Country's strong interest in pursuing EMM as a key element in ICF International's application to NYSERDA's Clean Neighborhoods Challenge, Accelerating E-bike Adoption for Clean, Equitable Communities. The initiative would have supported the expansion of e-bike library programs and other key infrastructure to support EMM usage in the area. While NYSERDA opted to support other proposals in the final round of the challenge, SMI remains committed to working with North Country partners to advance EMM programming in nontraditional settings.

4.5.5 Greater Rochester: Key Outcomes and Primary Partners

The project achieved the following key outcomes:

- Conducted EMM demonstrations with local transportation stakeholders
- Consulted with the city of Rochester for an RFP shared micromobility services for 2023

The project collaborated closely with the following primary partners:

- City of Rochester
- Rochester Genesee Regional Transportation Authority (RGRTA)
- Regional Transit Service (RTS)

From the early stages of this project, SMI sought to engage with Greater Rochester area stakeholders to assist with the development of new mobility service programs for the city and surrounding areas. Rochester's initial bikeshare provider, Zagster, abruptly suspended its PACE bikeshare program in spring 2020. This decision followed a period of operational challenges for the program during which Zagster reported the loss of nearly 250 of its 350 shared e-bikes due to technical issues related to the e-bikes' lack of GPS-tracking capabilities.

SMI initially collaborated with Rochester stakeholders as they prepared for a regional expansion of bikeshare services using Congestion Mitigation and Air Quality (CMAQ) funding administered by DOT. DOT awarded 2018 CMAQ funding to RGRTA to implement this expansion.

In July 2020, SMI met with staff from the city of Rochester and the Regional Transit Service (RTS; a division of RGRTA) to demonstrate EMM capabilities and discuss various services model. This meeting helped to shape discussions on which EMM solutions would be best suited not only for Rochester, but also for neighboring villages and towns interested in joining RGRTA's regional expansion. At the time of the meeting, RGRTA had already identified micromobility service provider HOPR as its preferred operator, but were still working with HOPR to determine the scope and service typology, while the city of Rochester was still considering its options for an operational partner. Both parties reported that the demonstration and subsequent conversations helped frame their approach for service development.

Figure 27. City of Rochester Staff Meet with Shared Mobility Inc. for an Electric Micromobility Demonstration

In the weeks following the demonstration, Rochester announced a partnership with HOPR for bikeshare and scootershare services. SMI then contacted HOPR with an offer to coordinate additional public demonstration engagements to support the rollout of its system in the region. Unfortunately, these efforts were unsuccessful due to a lack of interest from the operator.

In August 2022, RTS and the city of Rochester reengaged with SMI to discuss the future of shared micromobility services in the region. During this meeting, both parties expressed concerns about the financial viability of HOPR. City officials sought information from SMI about the practices and financial models used in the Reddy Bikeshare program as they evaluated options for a potential RFP that would solicit a new operator. The city did issue an RFP for a new shared micromobility program operator and is currently evaluating their options at the time of writing.

During the project, SMI forged relationships across New York State, which have had a significant impact on advancing EMM. Not only are these beneficial to the communities receiving the new programs, but these relationships also build strong networks of services providers in the major regions of New York State. SMI looks to further develop these connections and relationships in future projects to improve the accessibility of EMM devices and highlight their importance as a transit option.

5 Conclusion

Throughout the “Informing Electric Micromobility Policy through Demonstrations and Planning” project, SMI consistently sought to leverage EMM’s innovative potential to continue building a clean, accessible, and equitable mobility landscape throughout Upstate New York. Despite challenges posed by the COVID-19 pandemic and the initial uncertainty in the mobility industry, SMI continued to collaborate with municipal and community partners. This important engagement allowed work on developing, building, and deploying EMM programs to continue during such an unprecedented time.

The EMM programming landscape in Upstate New York has changed significantly since the project’s inception in April 2020. With support from NYSERDA, SMI has advanced and refined the e-bike libraries concept in partnership with local community organizations. The collaboration has empowered municipal partners to develop localized, community-focused mobility solutions and is working to expand e-bikeshare access through direct program support. These program models are well-positioned to enhance mobility access statewide as the EMM industry evolves and adapts.

This research and engagement approach yielded several key findings including:

- Encourage informed and engaged municipal policies to increase EMM usage while making streets safer and the environment cleaner
- Highlight Upstate New York’s small and midsize communities demonstrable need for innovative mobility programs while acknowledging vulnerability to EMM industry downturns
- Demonstrate widespread public interest in EMM technologies through interactive demonstrations that, when given the opportunity to try out EMM in a controlled environment, individuals are more likely to use EMM for their daily mobility needs
- Catalyze a sizable reduction in GHG emissions by encouraging personal adoption of EMM devices and shifting away from single-occupancy automobiles
- Explore opportunities for further EMM development in Upstate New York through community-centric mobility program development

At this project’s conclusion, SMI has clearly achieved its primary goal of advancing clean mobility options in New York State, positioning itself and its partners to continue expanding the availability and use of EMM in the future.

Appendix A. University at Buffalo School of Urban Planning Graduate Studio Report

Electrifying the Urban Fabric: Applying a Mobility Justice Framework to EMM in Buffalo, NY

ELECTRIFYING THE URBAN FABRIC: APPLYING A MOBILITY JUSTICE FRAMEWORK TO EMM IN BUFFALO, NY

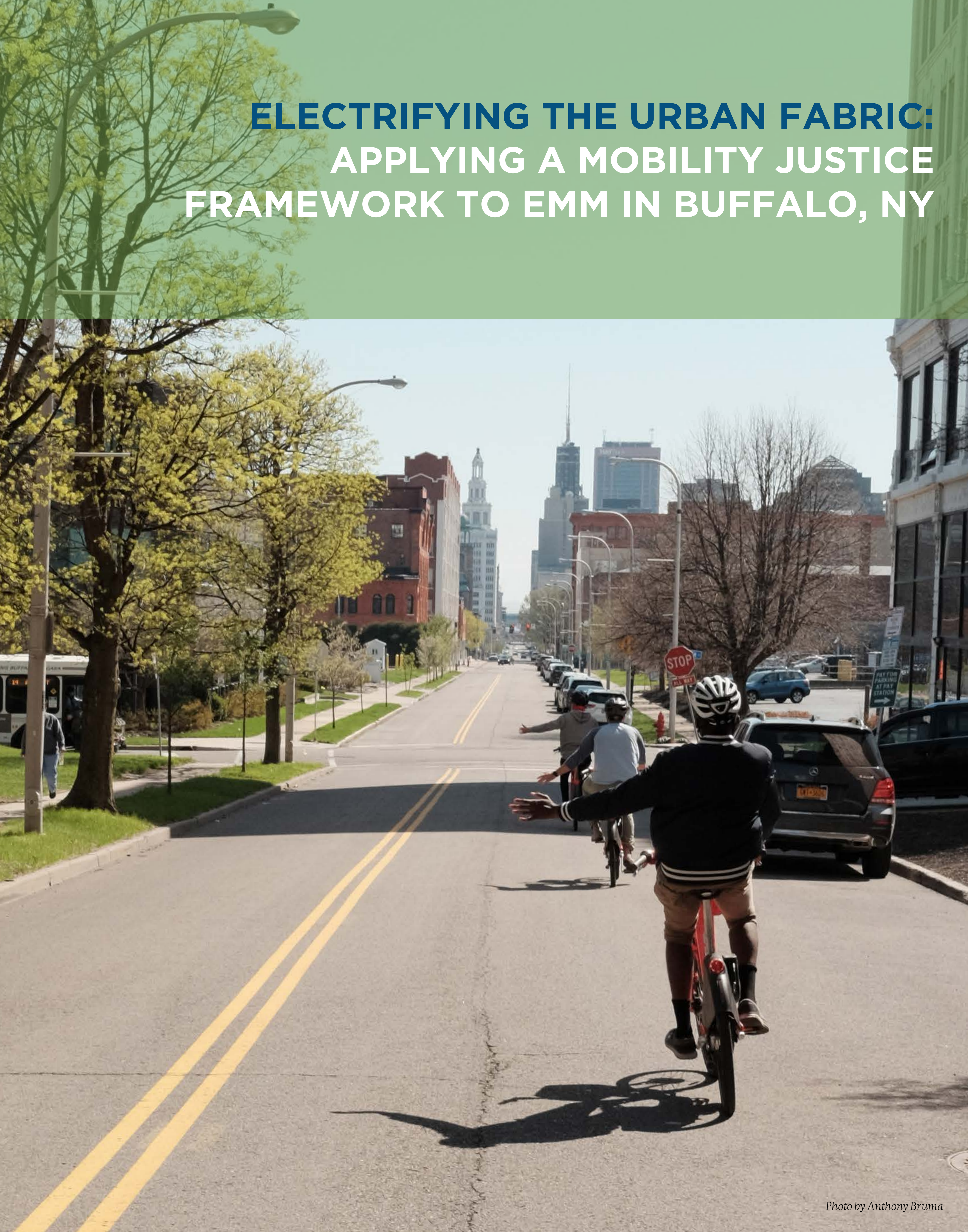


Photo by Anthony Bruma

STUDIO URP581 / URP582 | SPRING 2021

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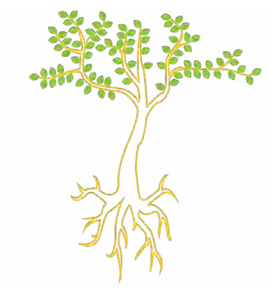
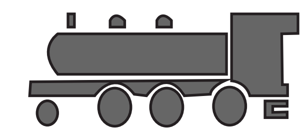
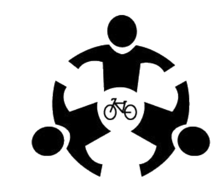
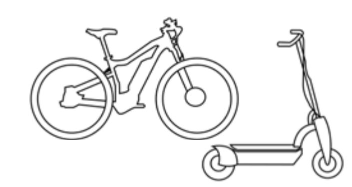








University at Buffalo
School of Architecture and Planning

WHY THIS REPORT?

In response to the popularity and growth of electric micromobility (EMM), New York legalized EMM devices in April 2020. To ensure public safety, EMM devices were divided into three classes to assure responsible usage. Class 1 specifically classifies e-bikes as devices that receive assistance from an electric motor when users are pedaling, ceasing to assist riders when they reach 20 MPH. Class 2 details throttled-assisted electric vehicles whose motors cease when riders reach 20 MPH. Class 3 includes the same as Class 2 but vehicles can reach speeds up to 28 MPH. The bill legalizing EMM stipulated that municipalities may further regulate the time, placement, and manner of operation of these devices.

Due to their novel quality and unique vehicle designation, oversight into the implementation of EMM devices has been limited. This lack of oversight has led to shocking, controversial, and life-threatening results, as several cities have experienced spikes in EMM-related injuries, sidewalk obstructions, and ticketing. These controversies malign EMM usage and prevent the public from developing a deeper understanding of EMM's potential to alleviate congestion and promote environmentally sustainable mobility. As such, there is a need for municipal governments to proactively and responsibly plan for EMM, as the unchecked introduction of these devices has the potential to alienate the public from using them.

To counteract these issues, a proactive guide to introduce EMM devices in Buffalo and other cities in Upstate New York is essential. When implemented in a manner that prioritizes people, EMM has the potential to encourage more sustainable transportation, healthier lifestyles, and improved travel efficiency.

Planning for a new travel mode also affords space to spark dialogue. In particular, this report utilizes a mobility justice framework to draw attention to the unequal distribution of safe infrastructure in minority and low-income neighborhoods, potentially limiting EMM usage in these areas. Actionable goals and strategies are proffered to engender safer, more equitable, and more sustainable EMM transportation.

Ultimately, to proactively plan for EMM, planners, policymakers, and other stakeholders must embrace and leverage the tenets of mobility justice to address the complex relationship between transportation and forms of systemic inequities related to issues such as health, housing, and policing in Buffalo. More importantly, mobility justice attends to the structural and systemic processes limiting the movement and safety of people of color, women, disabled persons, and children.

A mobility justice ethos sets the foundations upon which transparent, sincere, and consistent efforts can be developed with the public to initiate dialogue, self-reflect, and co-produce actionable planning efforts around the implementation of EMM and future transportation innovations in Buffalo.

Photo by Cynthia Wood

CHAPTER ONE

ELECTRIC MICROMOBILITY (EMM): THE NEW SURGE IN THE STREETS

Photo by Anthony Bruma

EMM AS A CATALYST

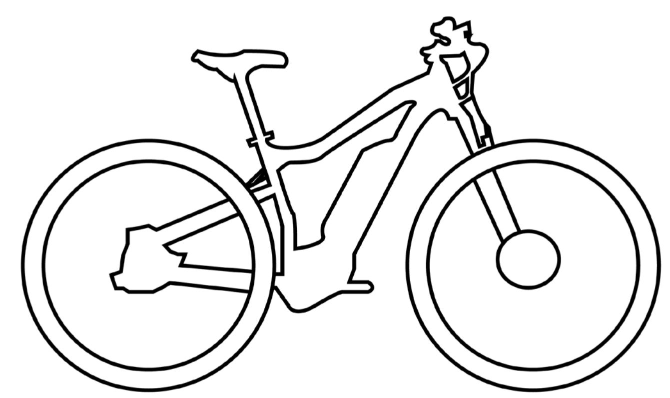
The EMM Landscape

Electric Micromobility (EMM) is adding on to the suite of emerging mobility options in cities. These devices consist of small, lightweight electric-powered devices ideal for trips up to 6 miles. There are various types of EMM devices, but the most common, the focus of this report, are electric scooters (e-scooters) and electric bikes (e-bikes). These electric devices can attain speeds between 15-25 mph.

As they become an increasingly popular mode of travel, EMM devices have the potential to confront the challenges of an increasingly dense urban fabric, reduce carbon emissions, and encourage more active lifestyles.[1,2] As well, the deployment of EMM devices in shared mobility systems, such as bikeshares, may promote the usage of EMM and amplify these benefits by providing affordable and equitable access to EMM devices.

E-Bike

A bicycle that can either be propelled partially (pedal assist) or completely (throttle controlled) with an electric motor.

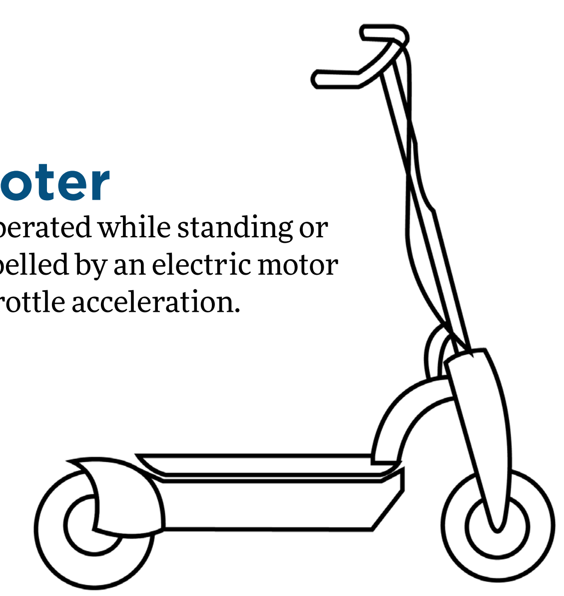


Infographic by Allison Smith

Photo by Anthony Bruma

E-Scooter

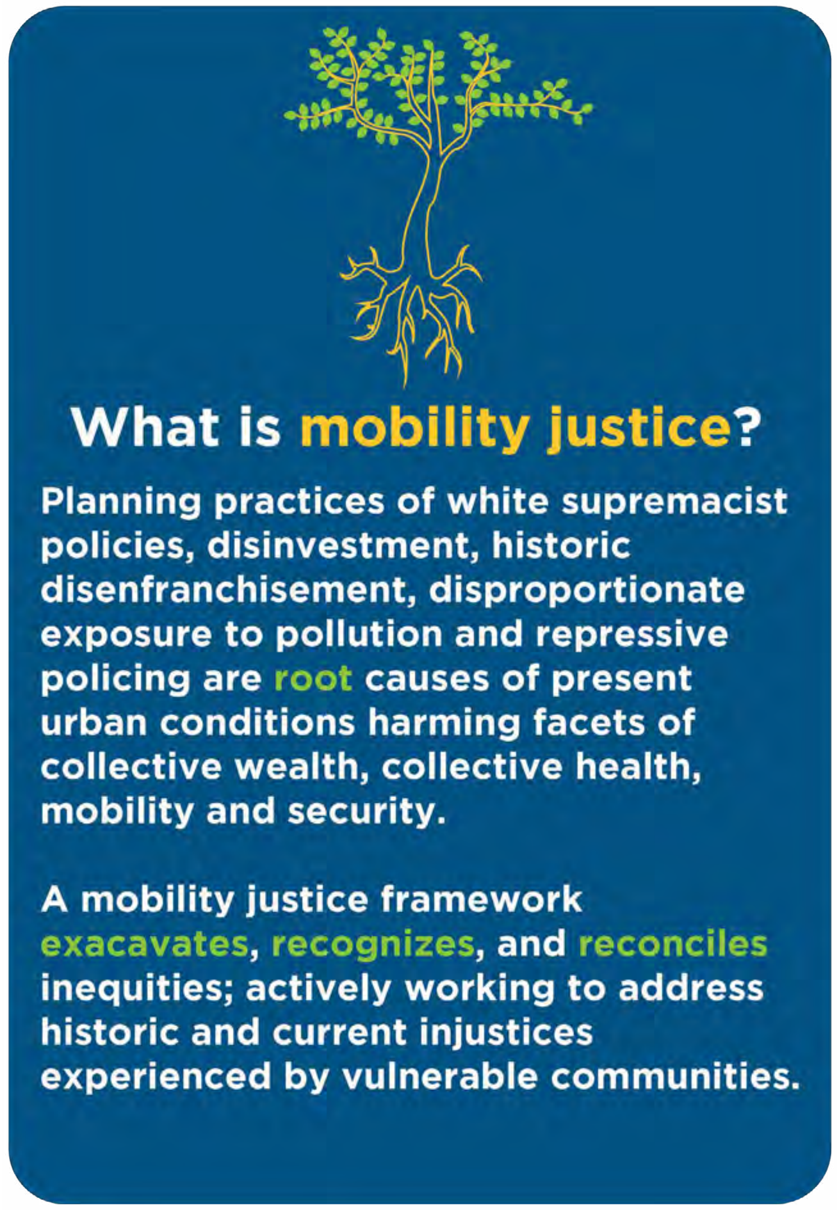
A scooter operated while standing or sitting, propelled by an electric motor that uses throttle acceleration.



Infographic by Allison Smith

Photo by Anthony Bruma

EMM FOR MOBILITY JUSTICE

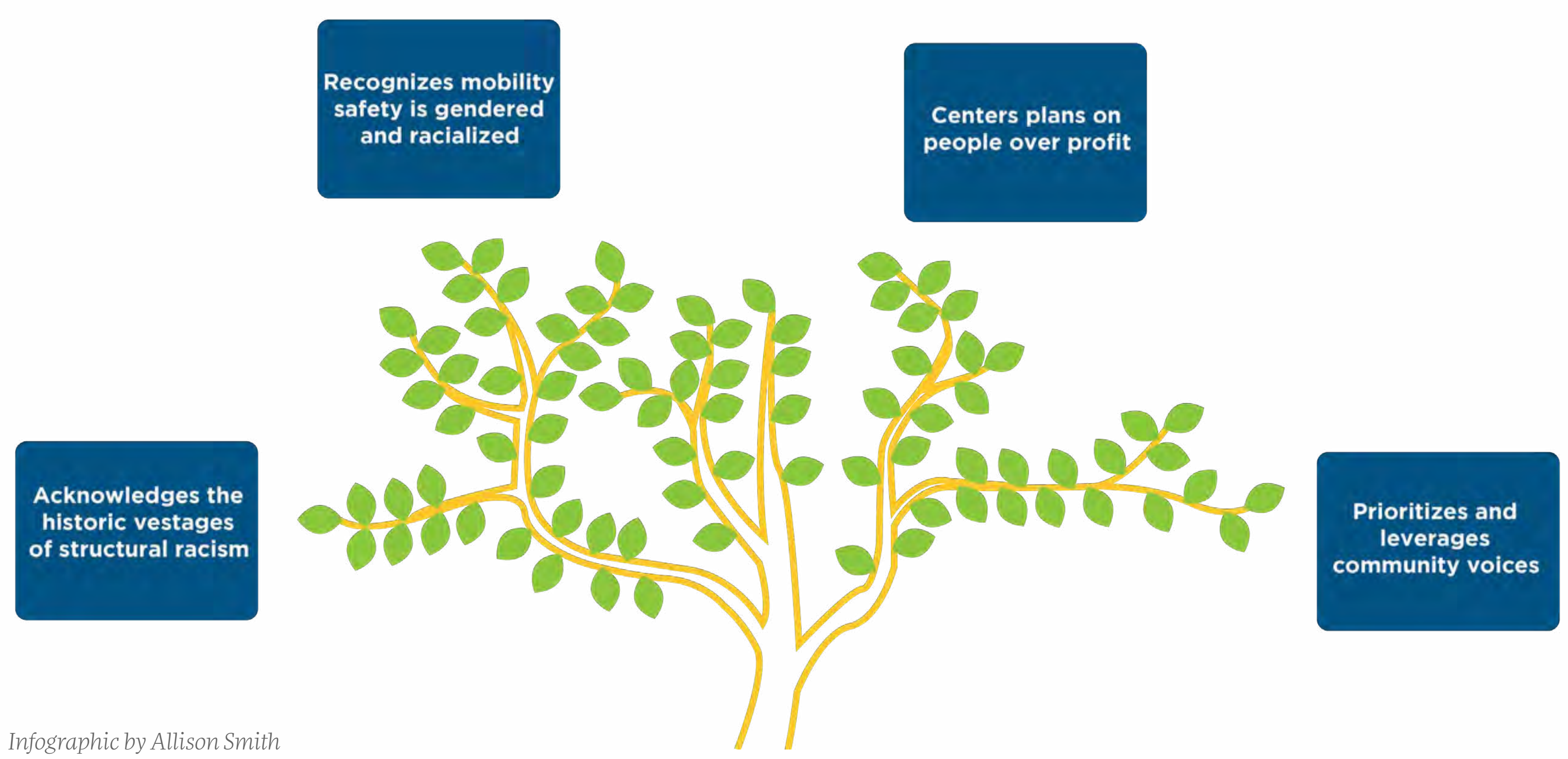


Infographic by Allison Smith

In recent years, planners and researchers have developed the concept of mobility justice to relate urban inequality to the design and implementation of transportation systems. Mobility justice considers issues such as uneven access to services, housing displacement, and the policing of an individual's movement.[3] It addresses how transportation planning relates to the larger political, social, and land use patterns that reinforce economic, housing, and health disparities experienced by historically disenfranchised communities.

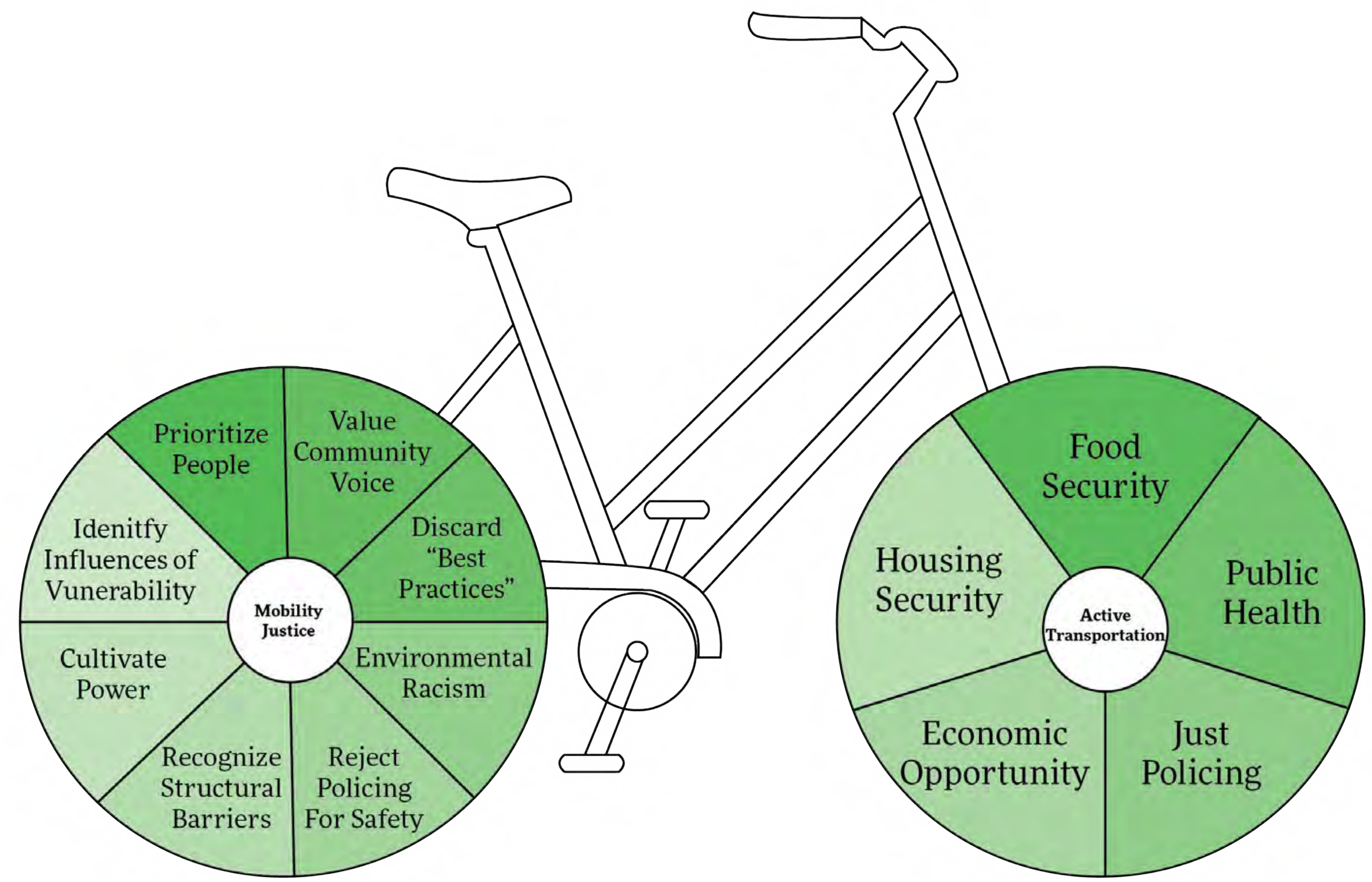
When it comes to planning for novel technologies in a manner that prioritizes people, it becomes imperative for planners to emphasize mobility justice, remaining aware of the lines between transportation access, socio-economic inequality, and identity. Doing so ensures cities where all have the opportunity to comfortably move, establish neighborly bonds, and access the services needed for a healthy, safe, and happy life.

A Mobility Justice Approach to Electric Micromobility



Infographic by Allison Smith

CONNECTING MOBILITY JUSTICE AND ACTIVE TRANSPORTATION



Infographic by Allison Smith

While discerning whether or not to implement EMM devices into our communities, it is imperative to consider the larger picture of transportation happening *globally*. Alongside discussions of mobility justice, conversations around *active transportation* (AT) have taken root in many large cities. Specifically, AT is defined as "transportation activities that are human-powered" that public health experts believe can establish healthier lifestyles within cities.[4] The two travel modes most associated with AT include cycling and walking. Coupled with a mobility justice framework, these trends underscore the important relationship between transportation and personal well-being.

While AT addresses more explicit health concerns within transportation planning, mobility justice expands the meaning of well-being to consider the larger economic and political structures that unevenly distribute these health benefits. Synthesizing mobility justice with AT presents an understanding of public health that relates economic opportunity, housing and food security, and the policing of neighborhoods to transportation concerns. EMM devices have the potential to push mobility justice and AT in cities as these devices are mostly human powered, quick and efficient, and are an affordable means to improve public transportation systems. These benefits, however, are not imminent but instead rely upon slow, intentional, considerate and proactive planning that centers itself around a city's historical and community context.

WHEN CITIES REACT TO EMM

San Francisco, CA Case Study

Unsurprisingly, the line between Silicon Valley and micromobility led San Francisco to become one of the first American cities to pilot and implement e-scooters into their transit network. EMM services are part of a new generation of urban mobility, led by tech-based ride-hailing apps, Uber and Lyft. Similar to ride-hailing services, smartphones act as the central interface for the public to locate and register EMM devices. Between 2019 and 2020 Uber acquired both JUMP and Lime, underscoring a tie between micromobility and the growth of venture capital within the tech industry. This quality exposes the tense nature of EMM, leading to concerns of whether these devices were initially developed to improve public transportation or act as a new for-profit endeavor. In San Francisco, rather than improving the city's transit, streets became ground for competition as companies rapidly deployed EMM units. The city became so over-saturated with dockless e-scooters that it led to their temporary ban after residents complained of obstructed sidewalks and careless vehicle maintenance. Issues like these arise in the absence of any deliberate planning or community consultation around EMM and other emerging transportation devices.[5]

Reactive planning around EMM and other emerging transportation devices often occurs when stakeholders (e.g., profit-motivated actors) introduce these devices into communities without thoughtful conversations with and inputs from community members and other stakeholders.

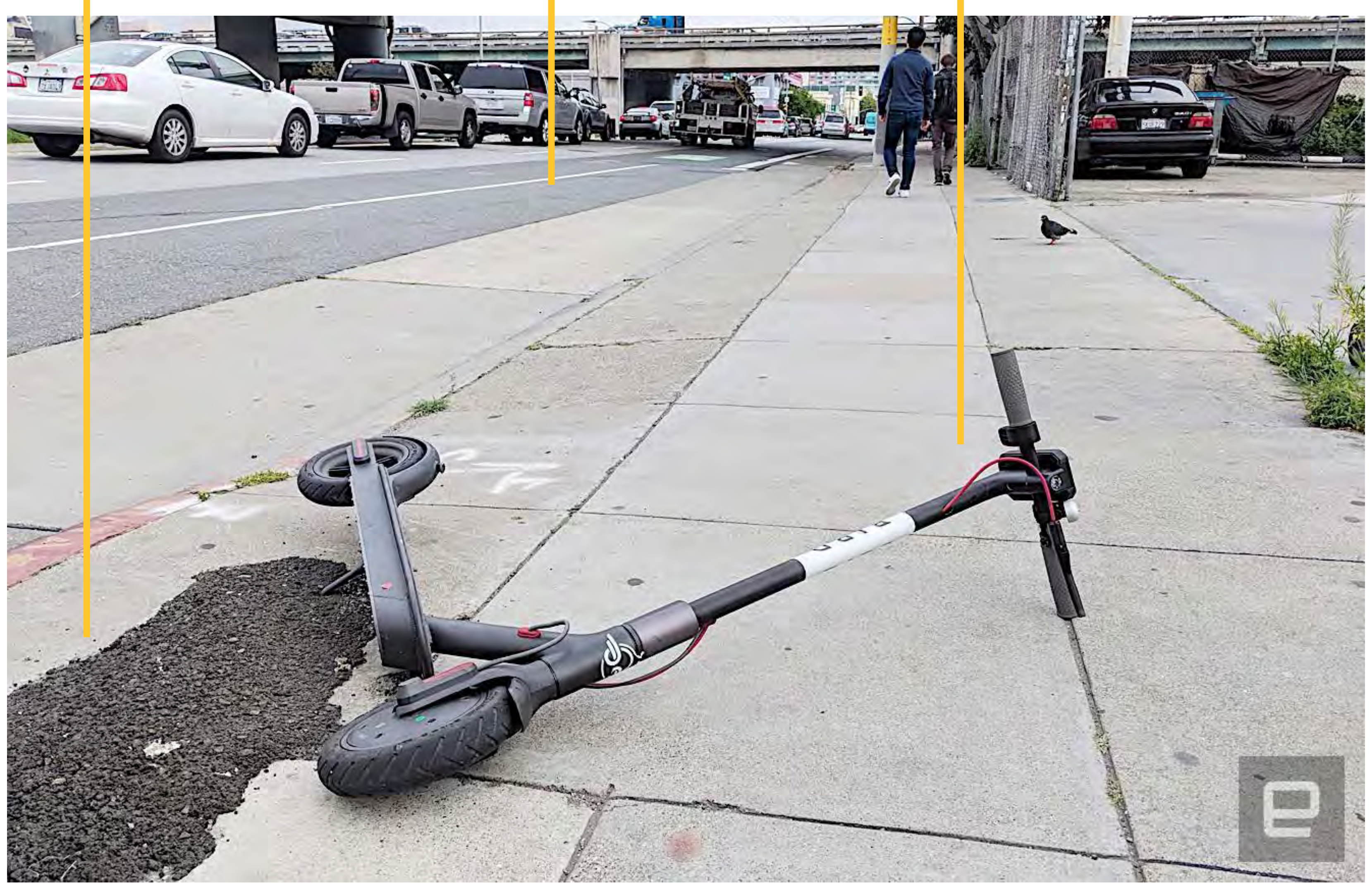


Image source: engadget.com

WHEN CITIES PLAN AHEAD FOR EMM

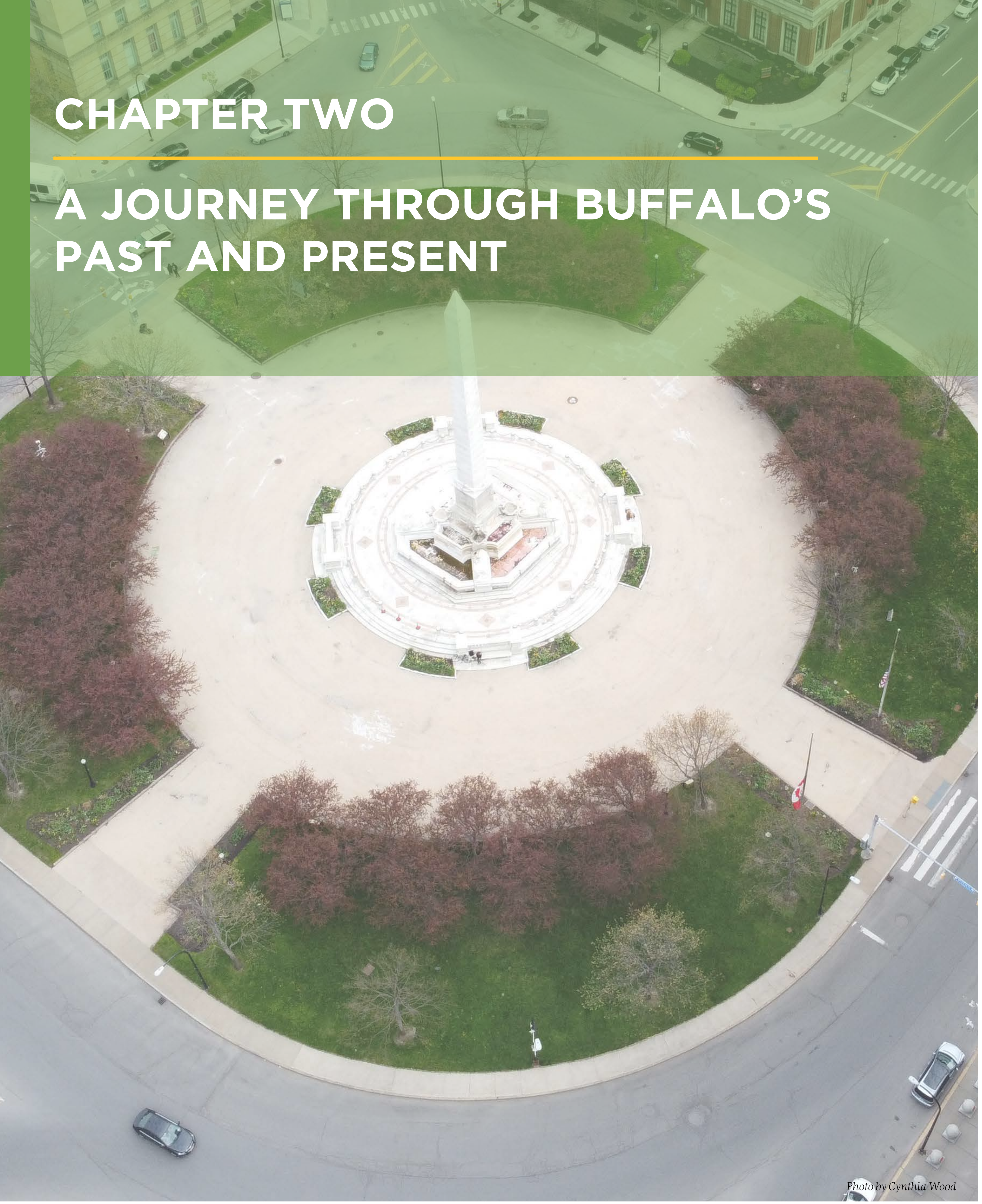
Baltimore, MD Case Study

On the other side, through transparent interactions with community members, family-friendly events and educational opportunities, and the hiring of a paid coordination office, the city of Baltimore's Department of Transportation set a strong example for implementing EMM devices into the city. It is very clear in Baltimore's reports and pilot programs that access for low-income and historically underserved residents is a top priority. The Baltimore Police Department also received handouts and fliers on proper EMM usage to better inform users, resulting in positive feedback. These set of proactive initiatives help establish a precedent that builds lasting trust with the public. Baltimore's example represents the level of dialogues, collaborations, and interventions necessary to effectively introduce EMM to a city and encourage mobility justice.[6]

Proactive planning for EMM considers building collaboration between community members and other stakeholders (e.g., private sector actors, planners, and other officials) to dialogue, build trust, and explore strategies to ensure that the introduction of EMM devices offers the maximum and equitable benefits to the public.

Image source: Bikemore.net

Image source: Bikemore.net



CHAPTER TWO

A JOURNEY THROUGH BUFFALO'S PAST AND PRESENT

Photo by Cynthia Wood

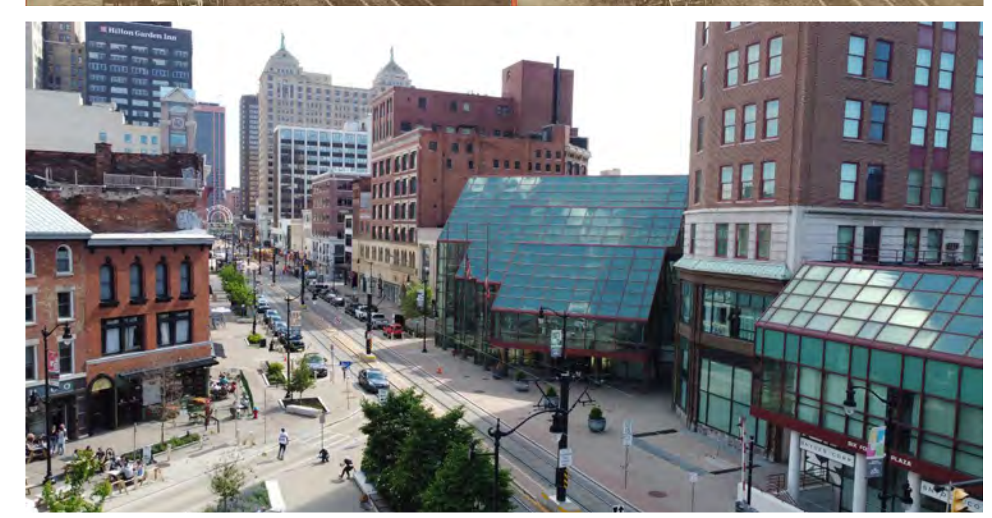
> **"You can't really know where you are going until you know where you have been."**
> **- Maya Angelou**

Image source: Library of Congress

Photo by Cynthia Wood

Advancements in transportation set the foundations for Buffalo's industrial legacy. The Erie Canal's completion in 1825 catalyzed the city into the largest inland port in North America. Other transportation innovations reinforced Buffalo's prosperity, including the introduction of the city's commuter streetcar system and the Belt Line Railroad. By the midway point of the 19th century, city streetcars enhanced residential connectivity while the Beltline Railroad decentralized industrial development and fostered connection between factories.

Outside factors also evolved Buffalo's urban fabric. By the early 20^{th} century Buffalo gained an influx of Black residents as a result of the Great Migration which saw the mass transition of Southern Blacks to Northern, industrial cities. However, a combination of White Flight and rapid suburbanization facilitated demographic and geographic shifts, as White residents abandoned Buffalo's central city for the suburbs via new highway systems like the Kensington Expressway.[7-13]



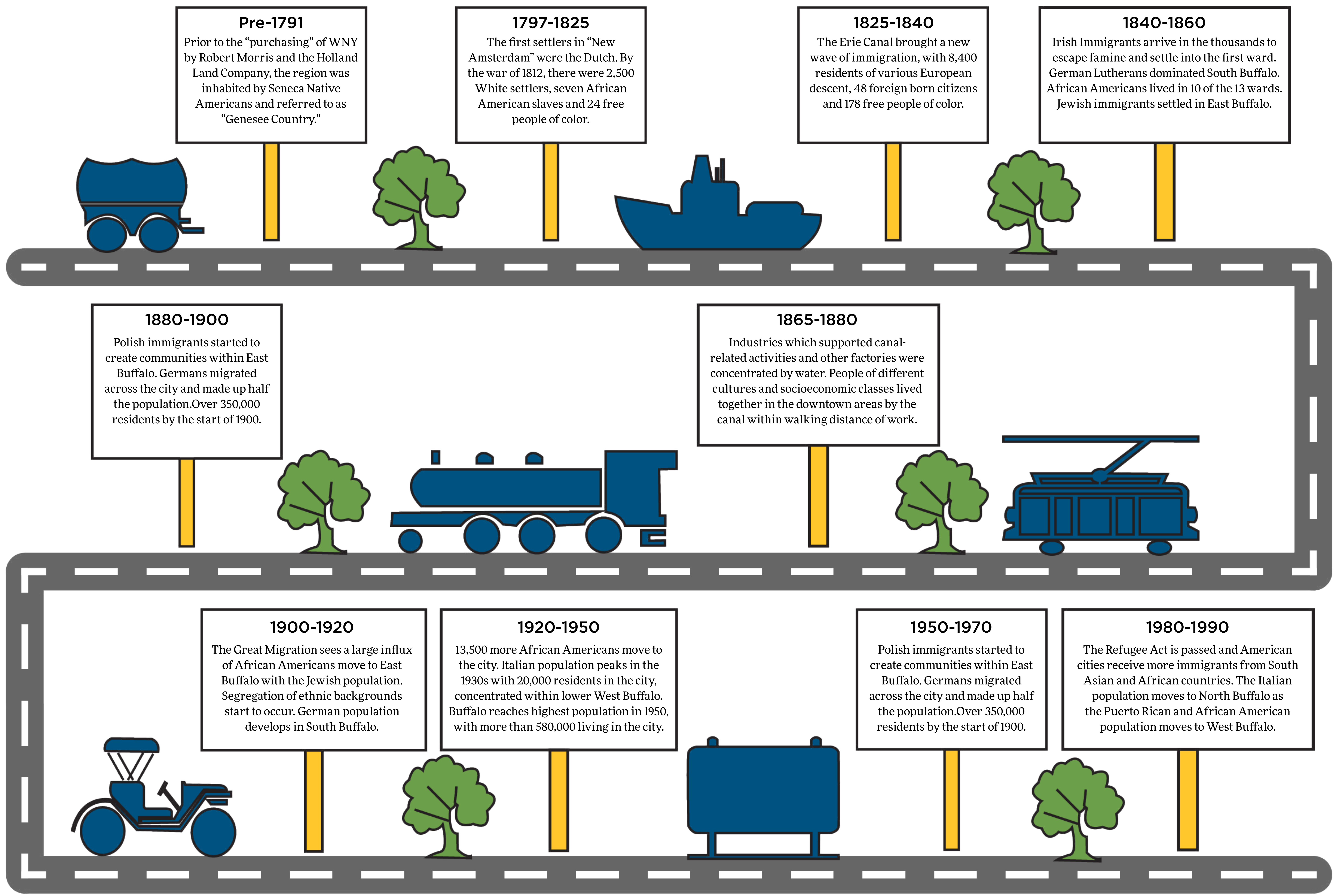
Top image source: Library of Congress; Bottom photo by Cynthia Wood

200 YEARS OF SHIFTING URBAN CONDITIONS AND EVOLVING TRANSPORTATION IN BUFFALO, NEW YORK

Buffalo's industrial and manufacturing legacy stemmed from transportation innovations like the Erie Canal and the Belt Line Railroad (see Appendix 1 for details). The storyline highlighted in the infographics showcase transportation's ability to radically change urban space and should be considered when conceiving plans for new transportation technologies like EMM. The implementation of these transportation technologies has potential to reproduce privilege and further disadvantage historically marginalized communities. How we implement these emerging transportation devices express our biases and intentions - these technologies, such as EMM devices, cannot be implemented neutrally.

Moreover, EMM should not be viewed as a cure-all for urban sprawl and unsustainable car usage. Yet, how we plan for this technology can express a new type of thinking that draws on history to self-reflect and conceive of a wider picture that relates transportation to broader issues like economic development and community prosperity.

Proactively planning for EMM requires considerate and critical thinking, sensitive to Buffalo's complex history, and capable of describing the peoples and spaces that define our cities before prescribing our solutions.



Infographic by Allison Smith

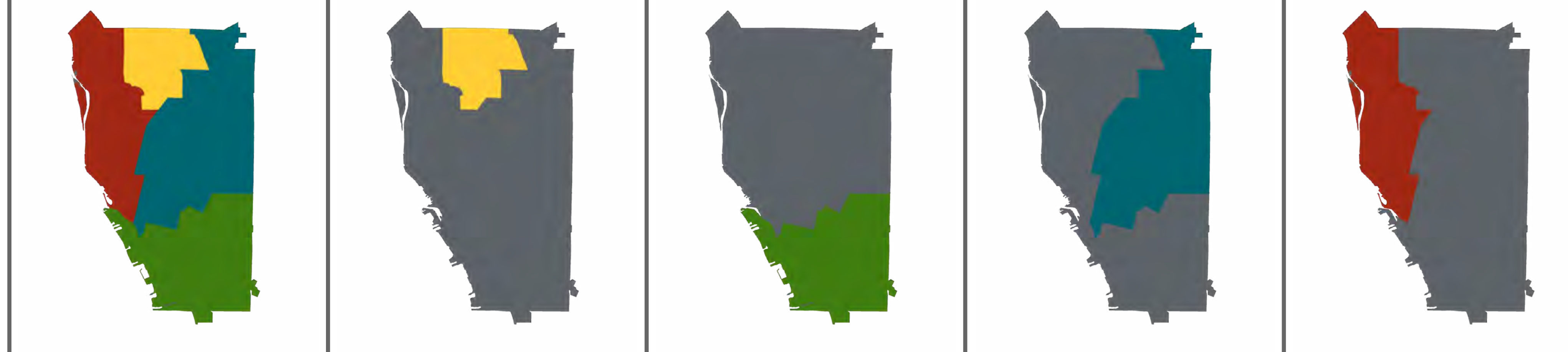
DEMOGRAPHIC AND SOCIO-ECONOMIC CONDITIONS OF BUFFALO

To highlight the disparate demographic and socio-economic conditions in Buffalo, the analysis conducted herein splits Buffalo into four main geographic sections (using the city's planning district boundaries): North, South, East, and West.

East Buffalo has the largest population at 103,704 - tripling Buffalo's Northern (30,600) and Southern sections (39,142). East Buffalo has the highest poverty rate at an alarming 62%. The Western section follows closely with 49% in poverty, followed by the Southern (39%) and Northern (29%) sections.

East Buffalo's high poverty rate and low median income illustrates this community's historic disinvestment and isolation from resources. The Western section also has the highest foreign born population and the second lowest median income. This is likely due to the Far-West side's concentration of refugees, contrasting to the higher incomes and predominantly white population of the Central West/Elmwood areas.

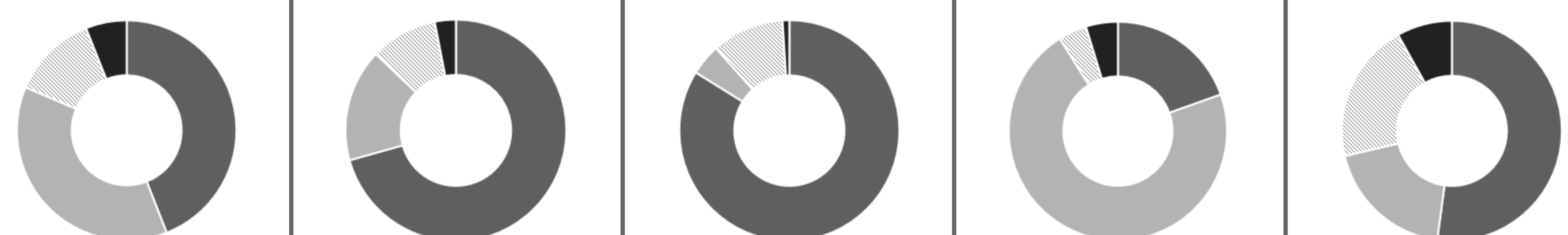
Photo by Emma Cook



	City of Buffalo	North Buffalo	South Buffalo	East Buffalo	West Buffalo
Total Population	256,480	30,600	39,142	103,704	82,369
Population Density per Square Mile	7,041	7,541	3,575	6,746	10,423
% Population Change (2015-2019)	-2.3%	2.8%	-6.2%	0.9%	-1.2%
% Foreign Born	11%	8%	4%	9%	16%
Median Age	35 years	36 years	38 years	33 years	32 years
Poverty Rate	45%	29%	39%	62%	49%
Median Household Income	$37,354	$61,780	$50,233	$28,269	$38,822

Race

- White
- Black
- Hispanic
- Asian/Multiple/Other



Maps by Cynthia Wood, Infographics by Emma Cook

Source: American Community Survey, 5-Year Estimates, 2014-2019

HOUSING CONDITIONS OF BUFFALO

Housing disparities is a significant marker of Buffalo's urban fabric. The housing characteristics of the East Buffalo exemplify the instability and economic challenges facing the residents of this area.

Most notably, the median housing value in East Buffalo is substantially lower than the other regions of the city: about three and half times less than in North Buffalo, and $30,000 less than Buffalo's average median housing value. This can be also be seen through a low percentage of homeowners and family style housing within East Buffalo, as well as the highest rate of housing cost burden among residents.

Photo by Emma Cook

	City of Buffalo	North Buffalo	South Buffalo	East Buffalo	West Buffalo
Total Population	**256,480**	**30,600**	**39,142**	**103,704**	**82,369**
Vacancy	28,285	7,541	3,575	6,746	10,423
Median Housing Value	$89,800	$213,000	$85,955	$58,901	$150,973
Housing Tenure – Renters	59%	50.2%	42%	61%	70%
Housing Tenure – Homeowners	41%	49.8%	58%	39%	30%
Housing Type – Family	48%	51%	43%	44%	54%
Housing Type – Non-Family	52%	49%	57%	56%	46%
Housing Cost Burden (% HH Spending >30% Income) – Renters	47%	40%	44%	55%	47%
Housing Cost Burden (% HH Spending >30% Income) – Homeowners	18%	18%	16%	21%	19%

Maps by Cynthia Wood, Infographics by Emma Cook

Source: American Community Survey, 5-Year Estimates, 2014-2019

TRANSPORTATION CONDITIONS OF BUFFALO

Buffalo's transportation conditions highlight East Buffalo's dependence on public transportation, highlighting high usage rates of public transit among residents. The relationship between existing transit infrastructure and usage rates are best exemplified by the transportation data from East Buffalo, where the amount of infrastructure and rates of usage are much higher than any other region in the city.

East Buffalo contains nearly half of the City's NFTA Bus Stops and is home to more than half of the city's daily public transit commuters. East Buffalo also contains the largest percentage of households without personal vehicle access. High usage rates and reliance on public transit signify the applicability of and potential need for EMM devices and supporting infrastructure in this area.

Photo by Anthony Bruma

	Miles of Bike Lanes per Square Mile	NFTA Bus Stops	Bicycle Facilities	Daily Public Transit Commuters	Average Commute Time (Minutes)	Walk Score	Percent of HH Without Vehicles	Commute By Type
City of Buffalo	2	2,011	58	12,912	21 min	67	28%	10% / 9%
North Buffalo	2	160	5	1,097	21 min	72	15%	6% / 10%
South Buffalo	2	271	2	1,093	20 min	50	17%	6% / 6%
East Buffalo	1	905	18	6,584	21 min	72	37%	18% / 7%
West Buffalo	4	675	33	4,138	21 min	82	27%	14% / 11%

Maps by Cynthia Wood, Infographics by Emma Cook

Public Transit

Walking/Biking/Other

Source: American Community Survey, 5-Year Estimates, 2014-2019; GBNRTC; NYSDOT; NFTA; WalkScore

CHAPTER THREE

COMPARATIVE POLICY ANALYSIS: LEARNING FROM OTHER CITIES

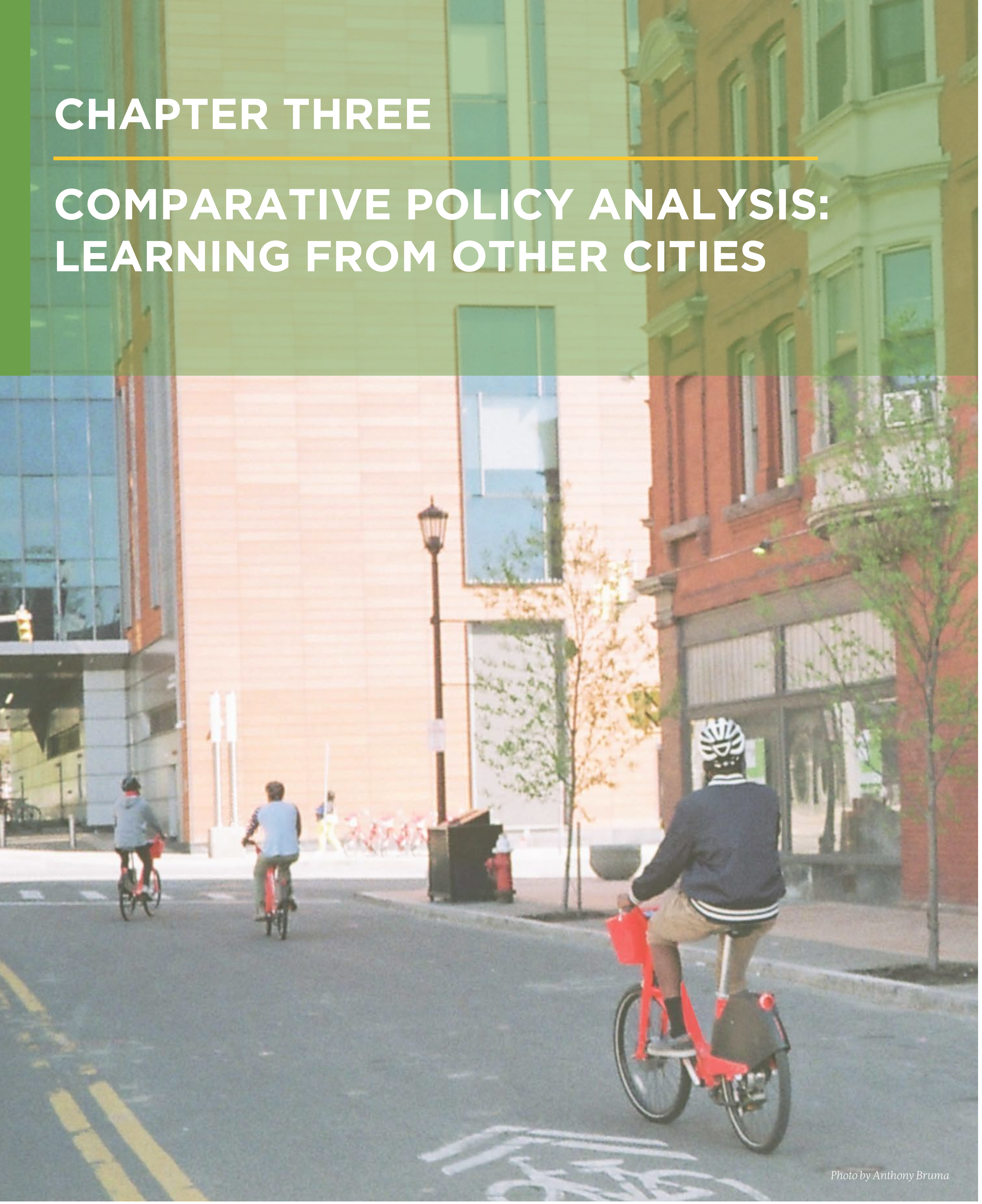


Photo by Anthony Bruma

OBJECTIVES AND GOALS

> **“The core purpose of a high-quality plan is to provide a clear and convincing picture of the future, which strengthens the plan’s influence in the land planning arena.”**
>
> **- Philip Berke**

Strong principles are essential to guide and help EMM flourish in a city. The following principles come from the mobility justice framework and are informed by precedent studies from other cities implementing EMM programs across the country.

Considering the successes and failures of other programs alongside the mobility justice tenets provide foundational lessons for cities to think through how best to integrate EMM devices into their communities, paying to each city’s unique context-specific conditions. These principles set a precedent for strengthening alignments between residents, service providers, and public officials.

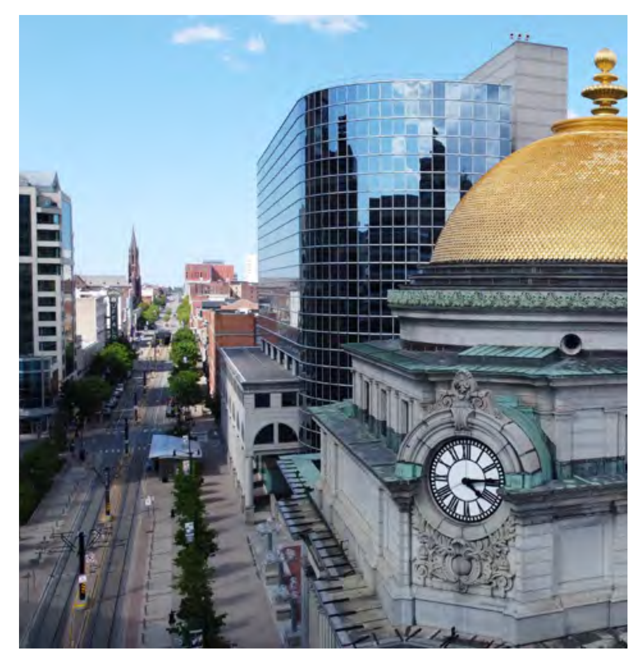
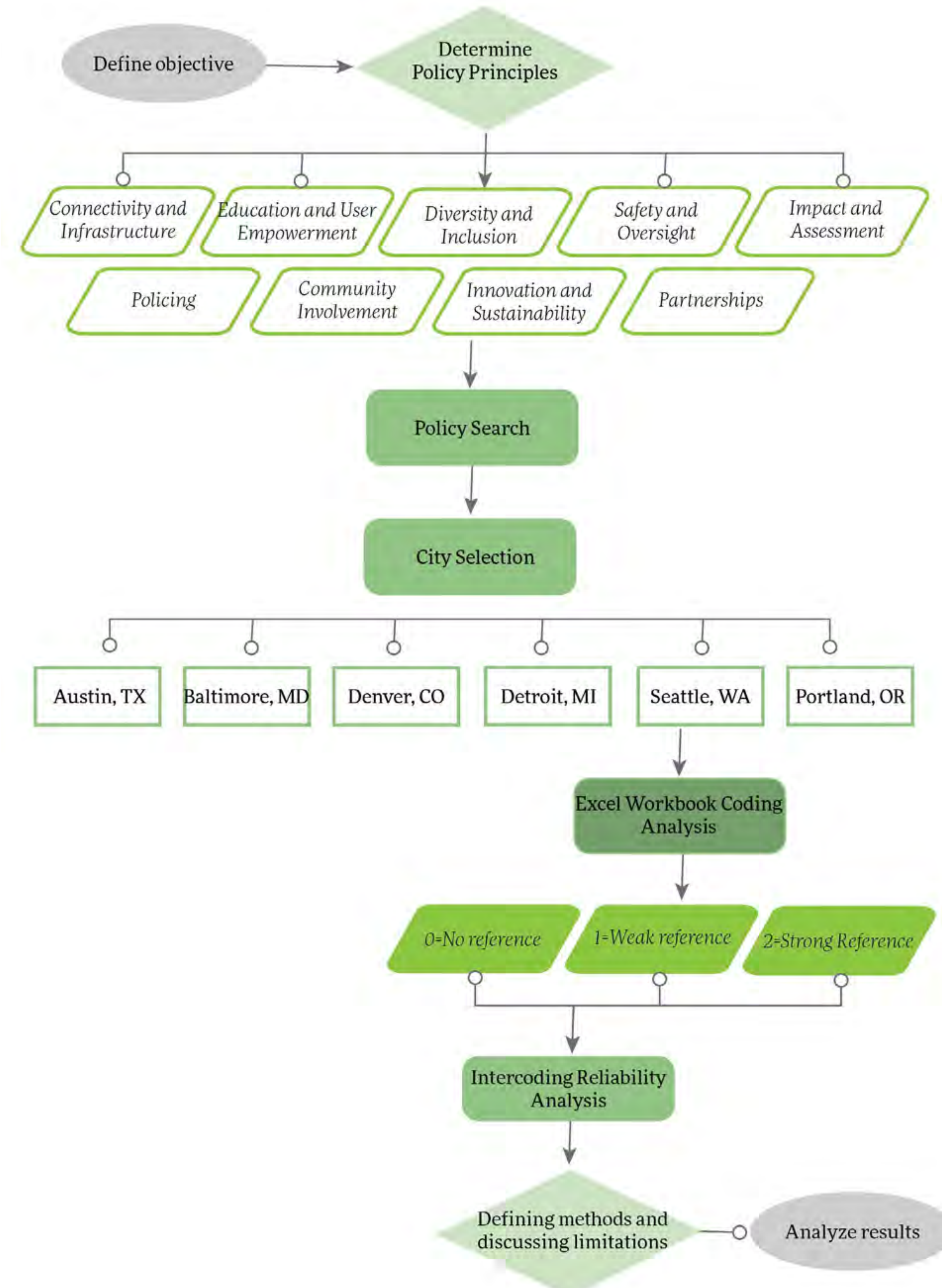


Photo by Cynthia Wood



EMM Policy Analysis Framework Graphic by Allison Smith

REPORT CARD FOR POLICY ANALYSIS

The comparative policy analysis highlights six cities that exemplify best practice in regards to EMM deployment. Six cities were considered for this analysis due to time constraints.[14-32] A scorecard was developed to compare the implementation of EMM across other cities with the aim of providing lessons for future EMM planning and policymaking in Buffalo and Upstate New York. Future studies may expand this analysis by considering more cities and more principles.

Map by Cynthia Wood

	Austin, TX	Baltimore, MD	Denver, CO	Detroit, MI	Portland, OR	Seattle, WA
Connectivity and Infrastructure	Strong Reference	Weak Reference	Strong Reference	Weak Reference	Weak Reference	Weak Reference
Education and User Empowerment	Strong Reference	Strong Reference	Strong Reference	Weak Reference	Strong Reference	Weak Reference
Diversity and Inclusion	Strong Reference	Strong Reference	Weak Reference	Weak Reference	Strong Reference	Strong Reference
Safety and Oversight	Strong Reference	Weak Reference	Strong Reference	Strong Reference	Weak Reference	Weak Reference
Impact and Assessment	Weak Reference	Weak Reference	Strong Reference	Strong Reference	Strong Reference	Weak Reference
Policing	Weak Reference	Weak Reference	No Reference	Weak Reference	No Reference	Strong Reference
Community Involvement	Strong Reference	Strong Reference	Weak Reference	No Reference	Weak Reference	Weak Reference
Innovation and Sustainability	Strong Reference	Weak Reference	Strong Reference	No Reference	Weak Reference	Weak Reference
Partnerships	Strong Reference	Weak Reference	Weak Reference	No Reference	No Reference	Weak Reference

Strong Reference · Weak Reference · No Reference

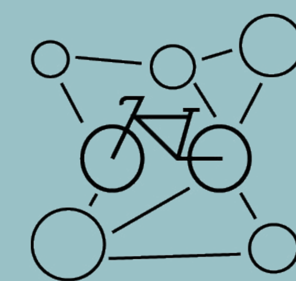
In this comparative analysis, the effectiveness of EMM policies were measured according to their fit to nine principles developed within the city selection process. EMM policy in each city varies, as some cities showed weak references to select principles, while others had no references. The comparative policy analysis report card provides a framework to show these differences at which the principles are referenced in each city's policy. Cities with strong references to a principle are shown in green, cities with weak references are shown in yellow, and cities with no references are shown in red.

SUMMARY FINDINGS FOR THE PRINCIPLES

The summary of findings under the nine principles highlight a number of lessons for envisioning EMM planning and policymaking in Buffalo and Upstate New York. Under diversity and inclusion, a fair amount of the cities studied addressed issues of equity and barriers to ridership in various policies. The City of Baltimore acknowledges the potential for EMM devices to reduce racial, generational, and geographical transportation disparities, and created a smartphone application for the visually impaired to use EMM and other transportation services. Appendix 2 provides detailed summaries of lessons learned under each of the nine principles.

Connectivity and Infrastructure

Implementation of EMM that supports other forms of public transportation within existing infrastructure to promote connectivity



- Austin, TX
- Denver, CO

Education and User Empowerment

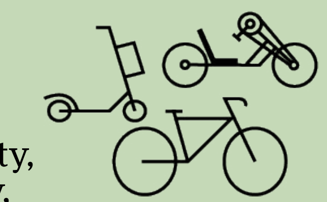
Promotion of EMM resources and education to enhance user freedom, security, mobilization, transparency, and empowerment

- Austin, TX
- Baltimore, MD
- Denver, CO
- Portland, OR

Diversity and Inclusion

Consideration for different needs and wants of a diversity of users to promote inclusion

Groups may include: age, sexual orientation, gender, ethnicity, physical ability, and income



- Austin, TX
- Baltimore, MD
- Portland, OR
- Seattle, WA

Safety and Oversight

Installation of programmatic education and regulatory oversight surrounding safety of EMM

Maintenance of systems and accountability mechanisms for success should be included

- Austin, TX
- Denver, CO
- Detroit, MI

Policing

Proactive approaches to addressing over policing of people of color while using EMM systems equity

- Seattle, WA

Impact and Assessment

Maximizing positive impacts of community benefits from EMM and assessment of equal distribution

Environmental impact and sustainability are also considered within the context of this principle

- Denver, CO
- Detroit, MI
- Portland, OR

Community Involvement

Community partnership in decision around and control of EMM

- Austin, TX
- Baltimore, MD

Innovation and Sustainability

Implementation of EMM that continues to progressively innovate transportation and considers longevity of operations

- Austin, TX
- Denver, CO

Partnerships

Forming strong collaborations and strong partnerships to increase community reach and involvement with local organizations, businesses and elected leaders

- Austin, TX

CHAPTER FOUR

SUITABILITY ANALYSIS: MAPPING EQUITY AND OPPORTUNITY

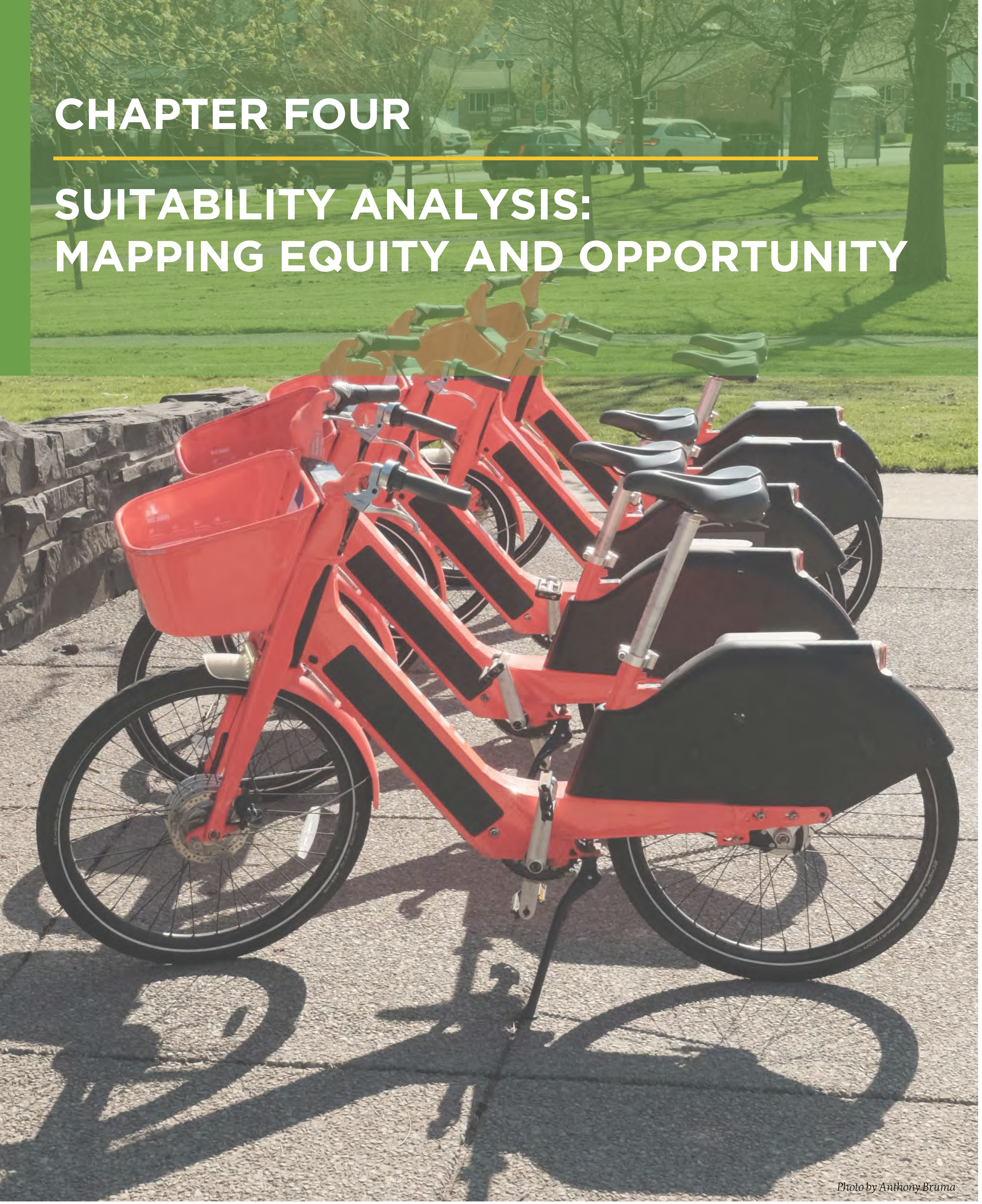


Photo by Anthony Bruma

OBJECTIVES AND GOALS

A suitability analysis was conducted to identify the census tracts best suited for EMM implementation. This suitability analysis functions as the reference point to determine what streets could act as candidates to pilot EMM devices in Buffalo. Admittedly, there are very few mapping and GIS-based methods to measure the suitability of emerging transportation technologies like EMM. Therefore, the suitability analysis conducted follows methods often used in land use and soil analysis.

Altogether, three suitability analyses were performed. Two suitability maps present a physical- and equity-based understanding of EMM "opportunity." Variables were ranked twice and differently to reflect the varied perceptions of these two lenses. In regard to physical opportunity, variables were weighted according to the physical environment's ability to facilitate EMM implementation. An equity-based outlook ranked variables according to EMM's ability to ameliorate barriers in public transportation access for communities in Buffalo. A third suitability map contains equally weighted variables to act as a control.

Census Tracts within the highest third of rankings are determined to be highly suitable for EMM Implementation, census tracts in the middle third were considered moderately suitable for EMM, and census tracts ranking in the bottom third were determined not suitable for EMM. This information was used to conduct site visits and identify the strengths and weaknesses for EMM implementation in our selected tracts.

A suitability analysis for this EMM study ranks and weighs different variables to help assess diverse socio-economic and infrastructure variables to consider in order to improve transportation services within neighborhoods.

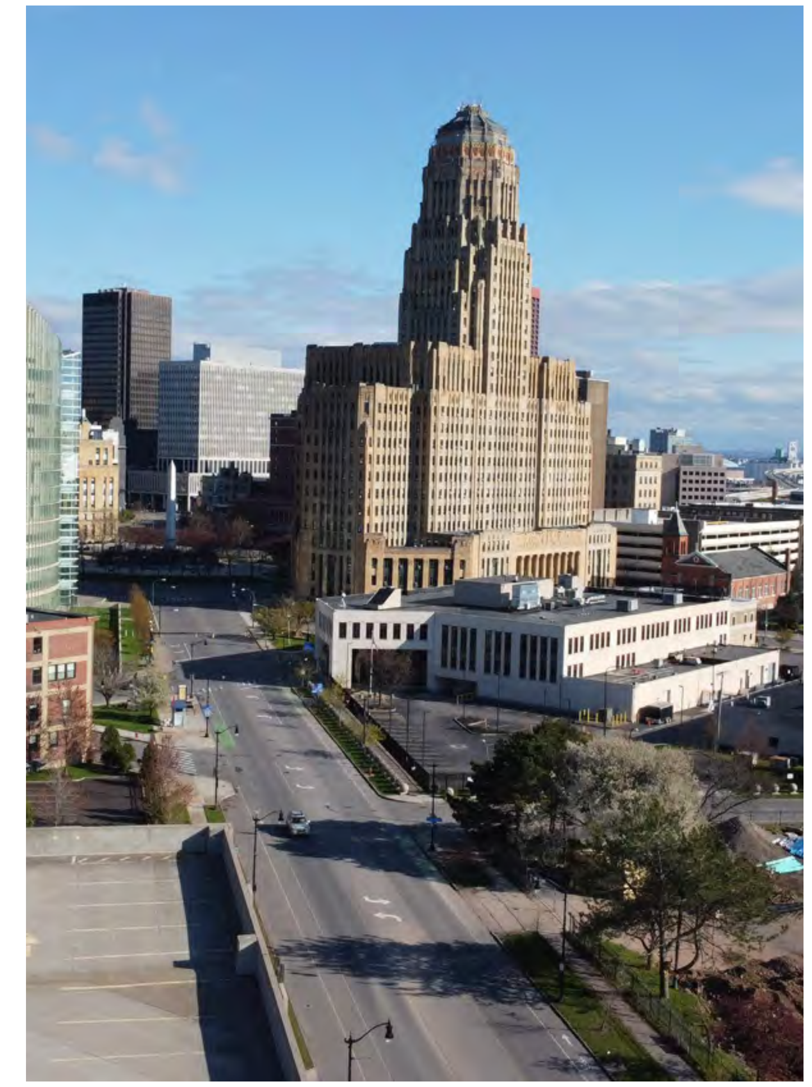


Photo by Cynthia Wood

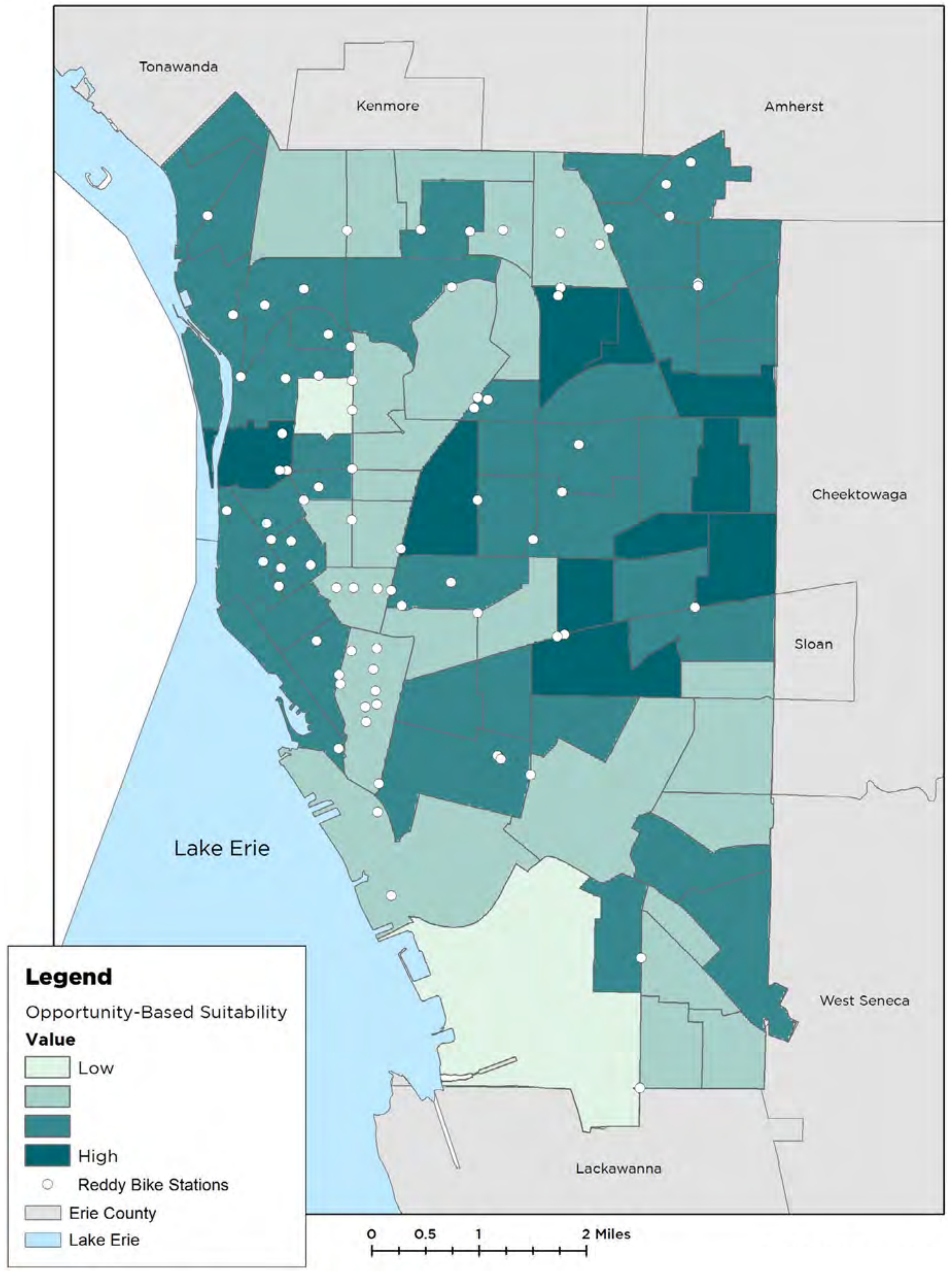
VARIABLES
Minority Population
Vehicle Access
Crash Data
Bicycle Facilities
Jobs per Census Tract
NFTA Bus Stops
Poverty Level

OPPORTUNITY-BASED LENS

The opportunity-based suitability map shows area with existing infrastructure and street conditions conducive for EMM devices. For this map, the heaviest weighed variables were crash data, bike facilities, and jobs.

This opportunity-based map represents areas with the greatest opportunity to capitalize EMM devices. However, this mapping lens fails to consider EMM and its ability to act as a lever to address systemic inequities within the distribution of Buffalo's transportation infrastructure.

VARIABLES	OPPORTUNITY WEIGHT
Minority Population	10%
Vehicle Access	11%
Crash Data	16%
Bicycle Facilities	18%
NFTA Bus Stops	18%
Jobs per Census Tract	17%
Poverty Level	10%



Map by Sadie Kratt

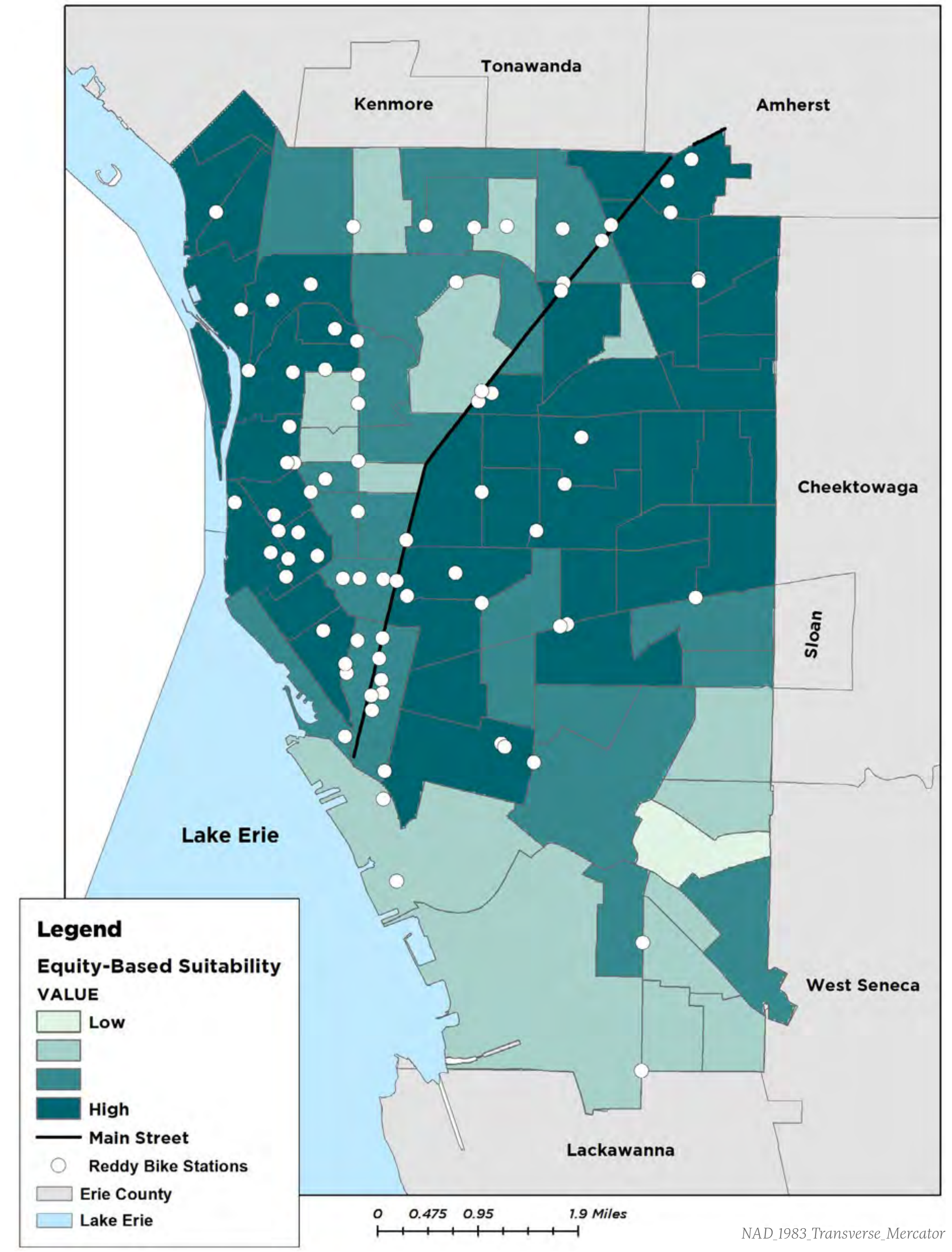
EQUITY-BASED LENS

The equity-based suitability map shows areas that lack the infrastructure to support EMM devices. The heaviest weighed variables for this map were vehicle access, minority population, and poverty level.

Reddy Bikeshare stations were overlaid on this map to highlight existing efforts by stakeholders to address transportation equity.

Most significantly, these findings denote a significant gap in access to safe transportation infrastructure, especially between East and West Buffalo. This pattern highlights the need for stakeholders to acknowledge these mobility inequities when implementing new technologies like EMM.

VARIABLES	EQUITY WEIGHT
Minority Population	18%
Vehicle Access	19%
Crash Data	12%
Bicycle Facilities	10%
NFTA Bus Stops	15%
Jobs per Census Tract	8%
Poverty Level	18%



Map by Sadie Kratt

NAD 1983 Transverse Mercator
Data Source: ACS 5-Year Estimates, GBNRTC, NYSDOT

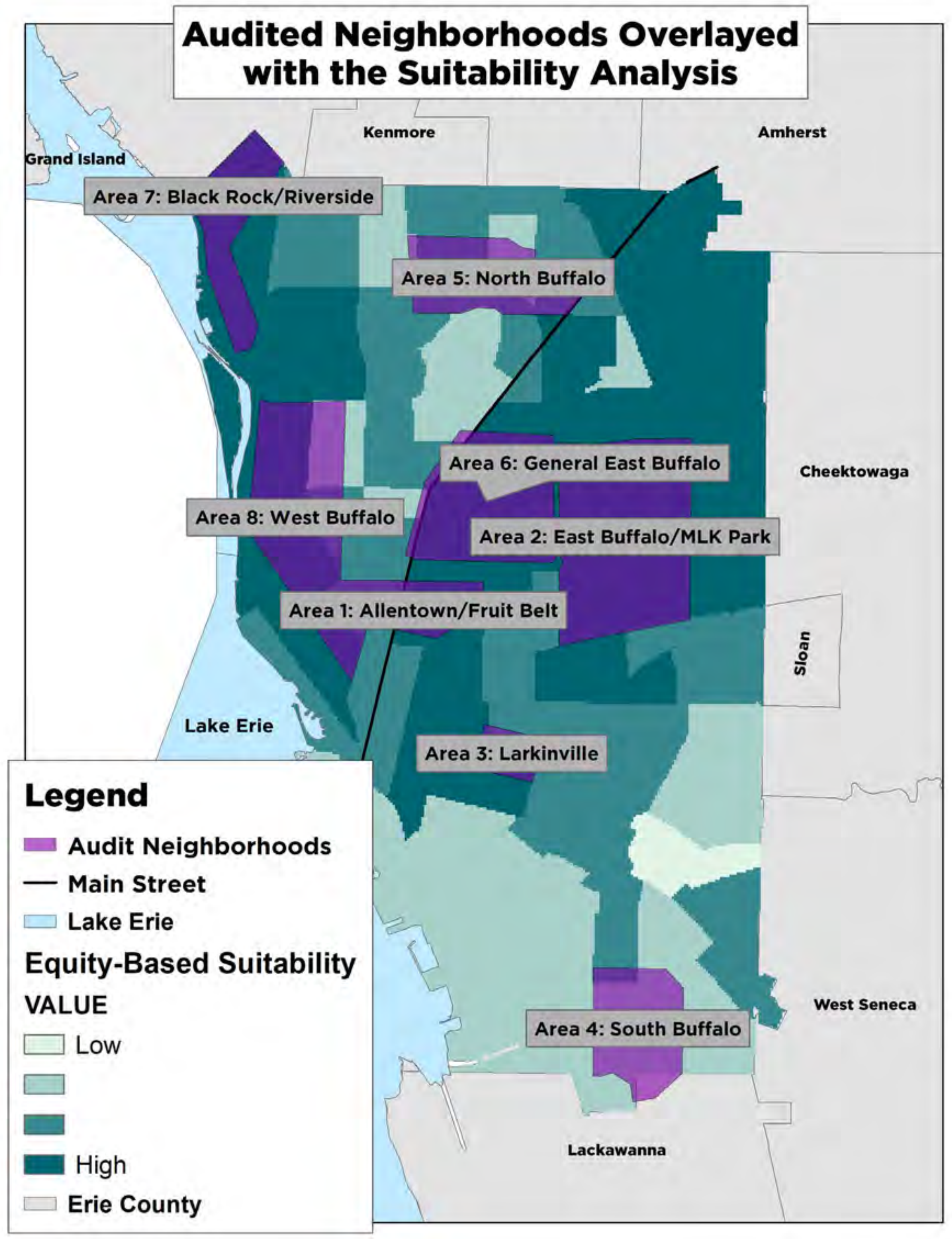
FINDINGS AND LIMITATIONS

Both the equity and opportunity-based maps expose parallels between Buffalo's distribution of infrastructure to its demographic and socio-economic disparities.

The equity map highlights more suitable areas within East Buffalo. This trend may be due to the inequitable distribution of Reddy Bikeshare stations and bicycle facilities within this section of the city.

The suitability analysis was limited by the use of a data-only approach, biases in survey feedback, and limitations in scale (census tracts are too large to generalize).

These limitations were addressed by performing a neighborhood and street audit.



Map by Sadie Kratt

Photo by Cynthia Wood

VARIABLES	EQUITY WEIGHT	OPPORTUNITY WEIGHT
Minority Population	18%	10%
Vehicle Access	19%	11%
Crash Data	12%	16%
Bicycle Facilities	10%	18%
Jobs per Census Tract	15%	18%
NFTA Bus Stops	8%	17%
Poverty Level	18%	10%

CHAPTER FIVE

CONTEXT MATTERS: NEIGHBORHOOD AND STREET AUDIT

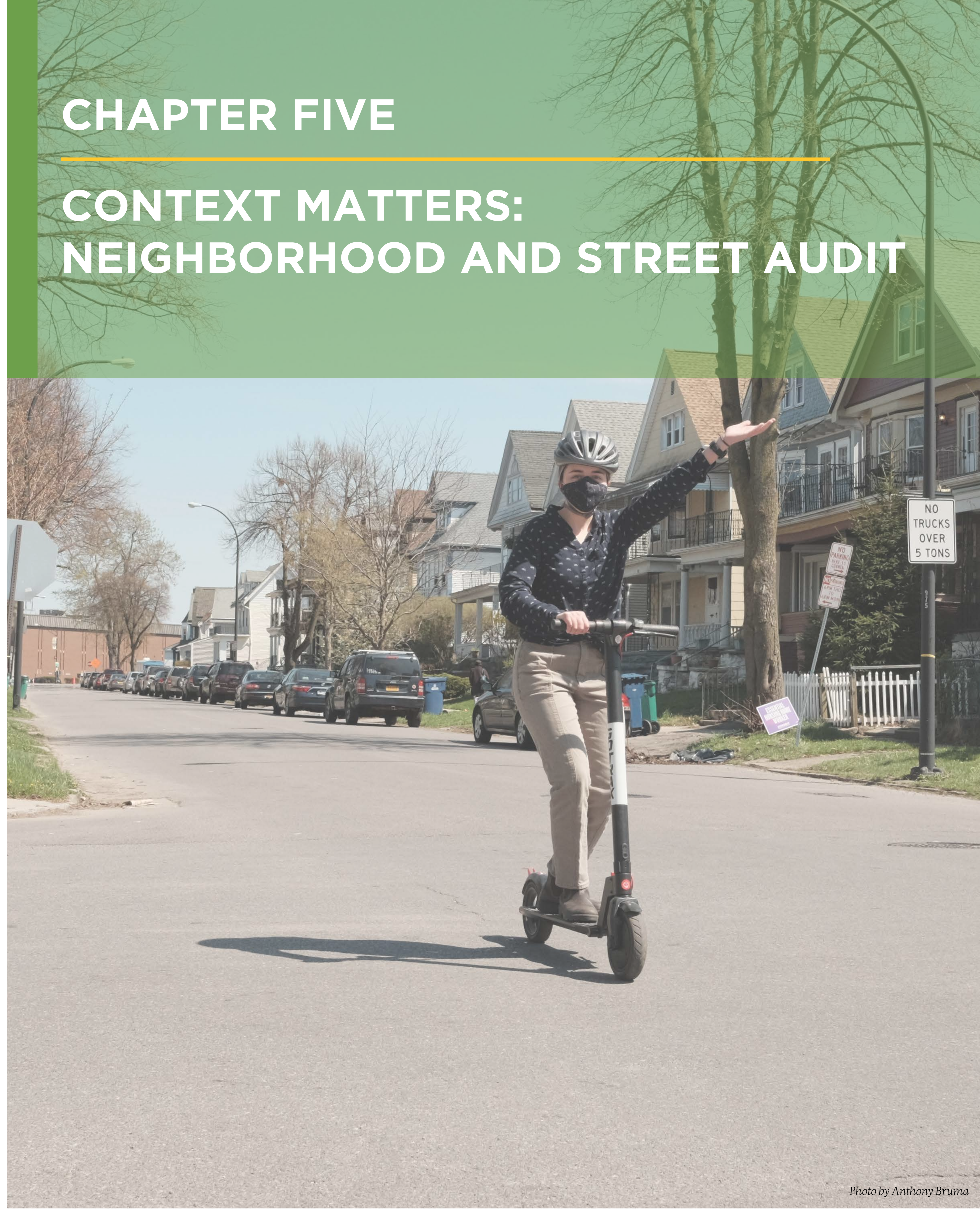
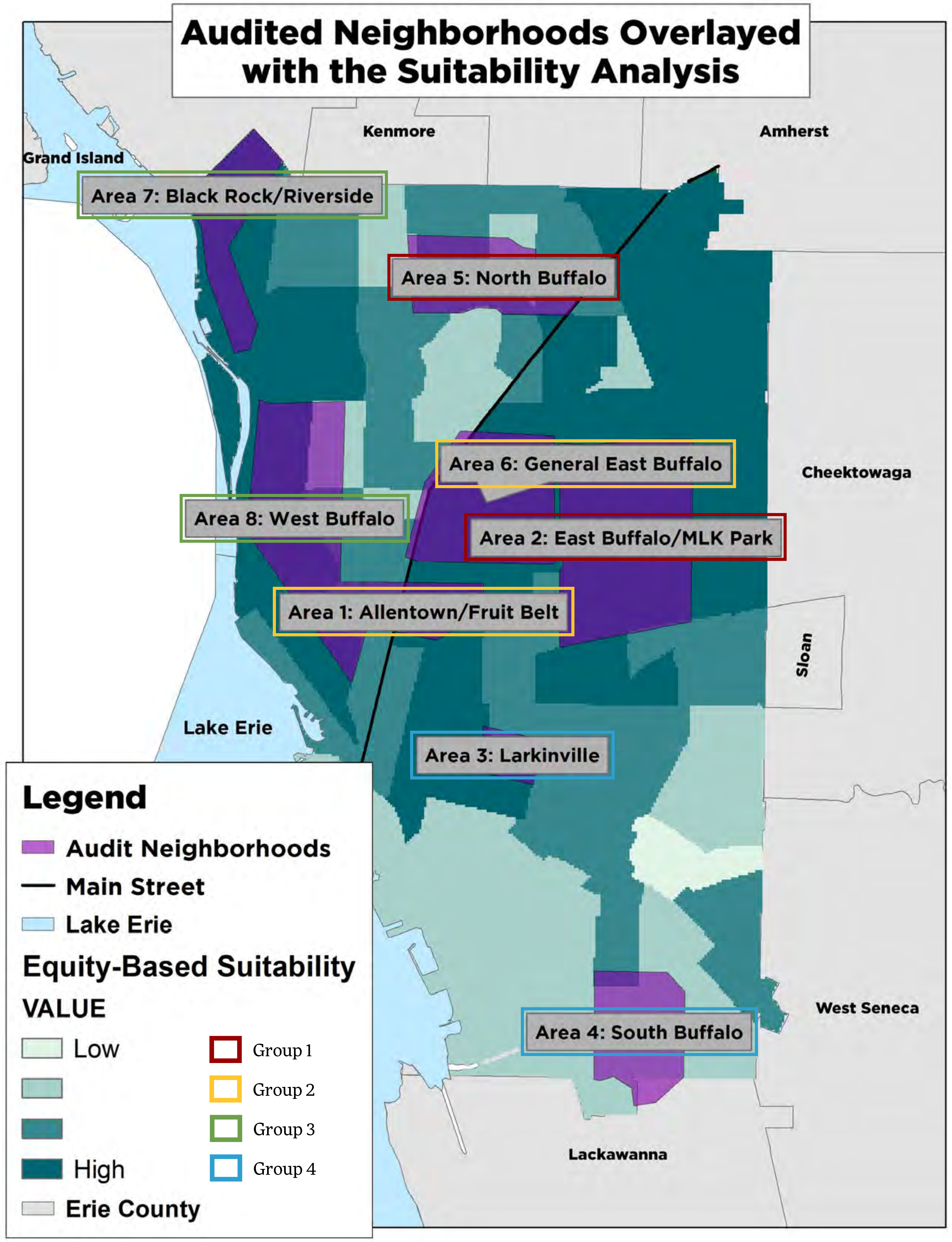


Photo by Anthony Bruma

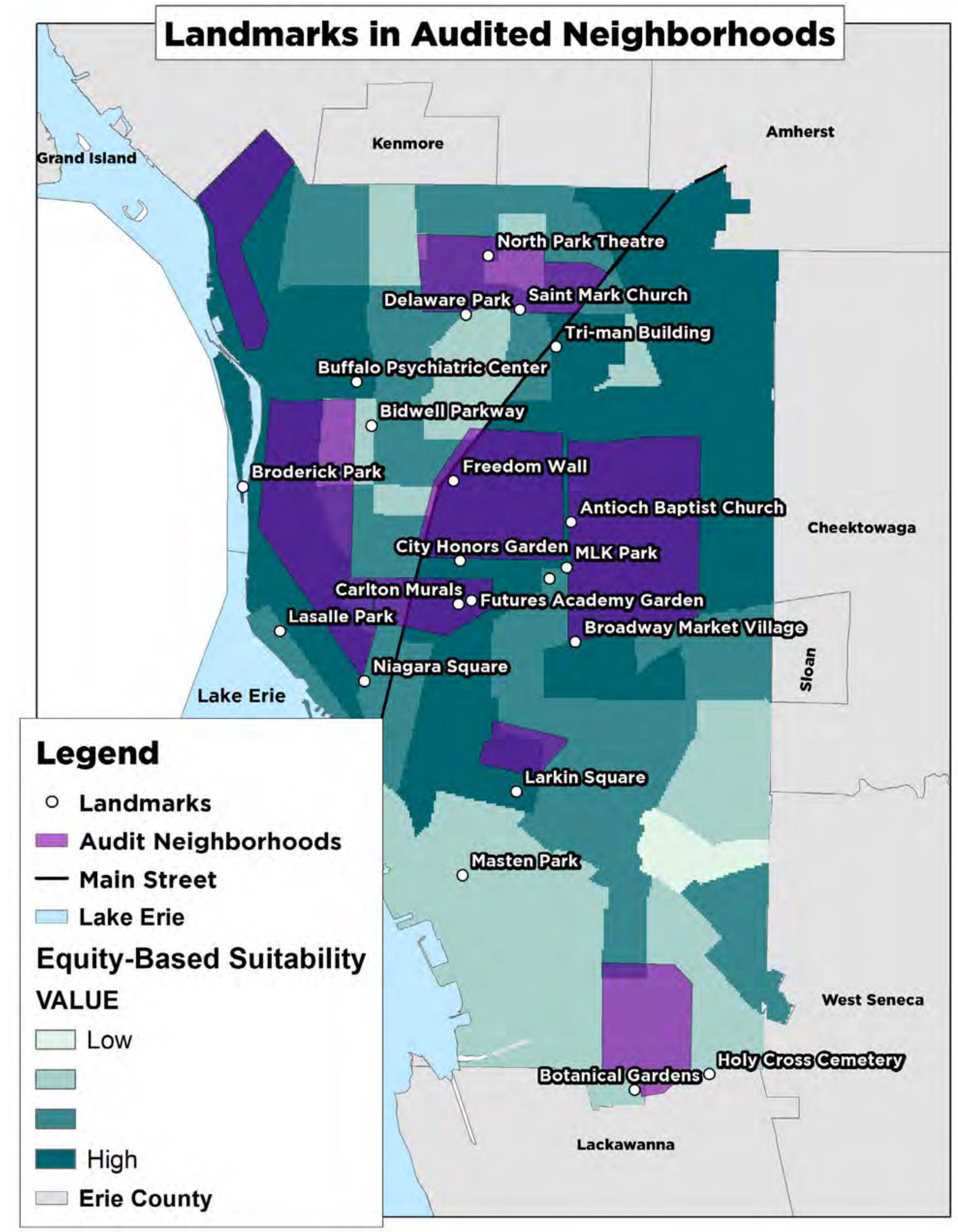
NEIGHBORHOOD AND STREET AUDIT OVERVIEW

An important piece to our studio was performing a streets audit. Based on our findings in the suitability analysis, we selected streets and neighborhoods within our analysis area to audit to better understand real-world conditions. Areas of low, medium, and high suitability were chosen to make sure a diverse understanding of these neighborhoods was developed.

We split our class into four groups of three people and allocated each group to two different neighborhoods in Buffalo. Additionally, we developed a survey for each person to take after observing the street conditions. The survey was based on the points of view of pedestrian, cyclist, driver, and e-scooter/e-bike users' in order to acquire a multi-modal understanding of the existing conditions. The following maps overlay the location of neighborhood audits over the equity-based suitability analysis map, as well as prominent landmarks from each area. The locations included North Buffalo, two sections of East Buffalo, Allentown, the Fruit Belt, Riverside, West Buffalo, South Buffalo, and Larkinville.



Map by Sadie Kratt



Map by Sadie Kratt

NORTH BUFFALO / EAST BUFFALO AUDIT

The following photos represent key aspects of each area. North and East Buffalo are shown with the North Park Theater, Antioch Baptist Church, and MLK Park.

The presence of public parks and wide streets pose opportunity for EMM, but the absence of road markings are an issue.

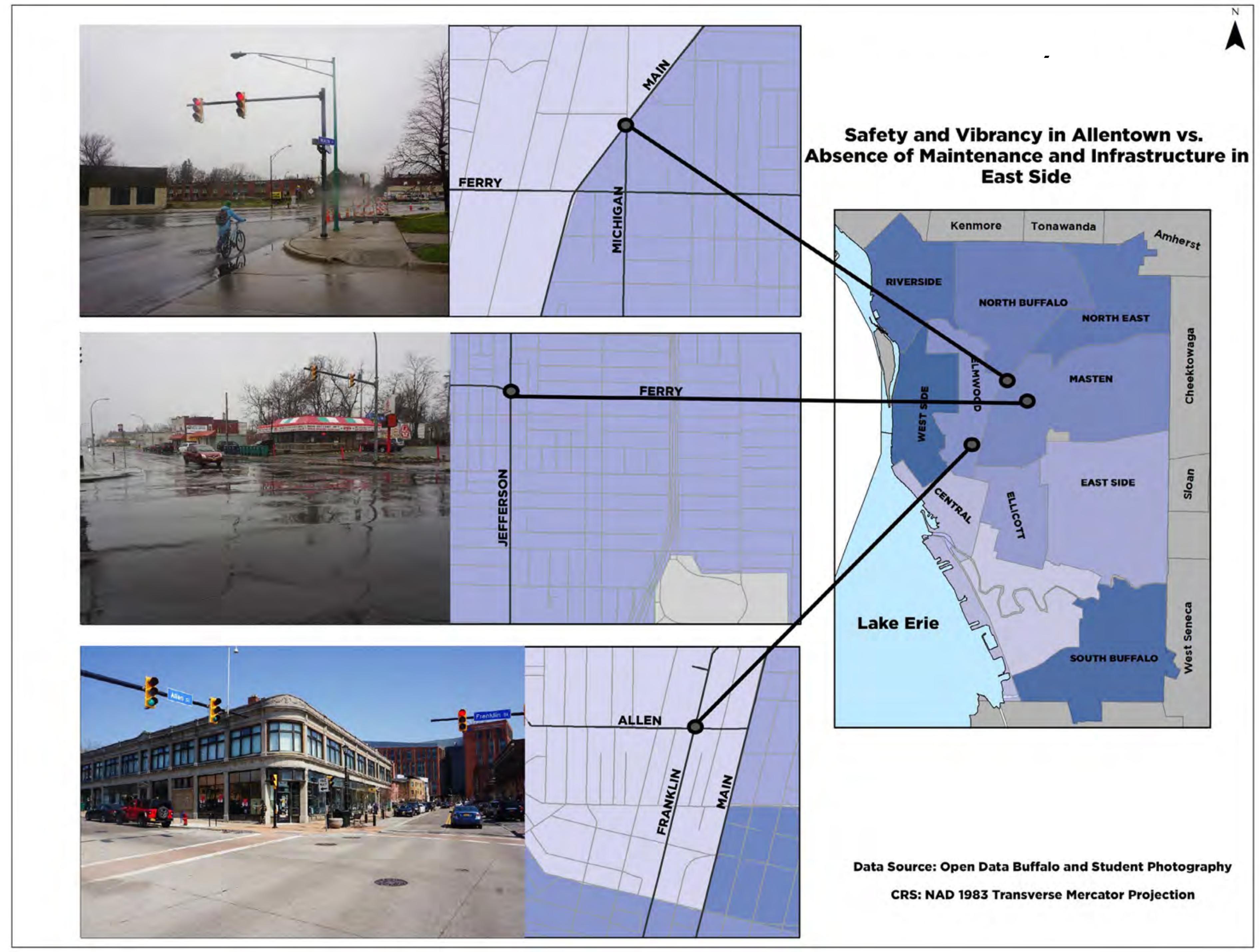
Photo by Anthony Bruma

Map by Sadie Kratt, Photos by Anthony Bruma

ALLENTOWN / EAST BUFFALO AUDIT

These neighborhoods revealed inconsistencies between street quality. Allentown had vibrant and safer streets making them good candidates for EMM while the Fruitbelt lacked basic and safe infrastructure. These two areas are geographically close, but show a severe difference in resources.

Photo by Emma Cook



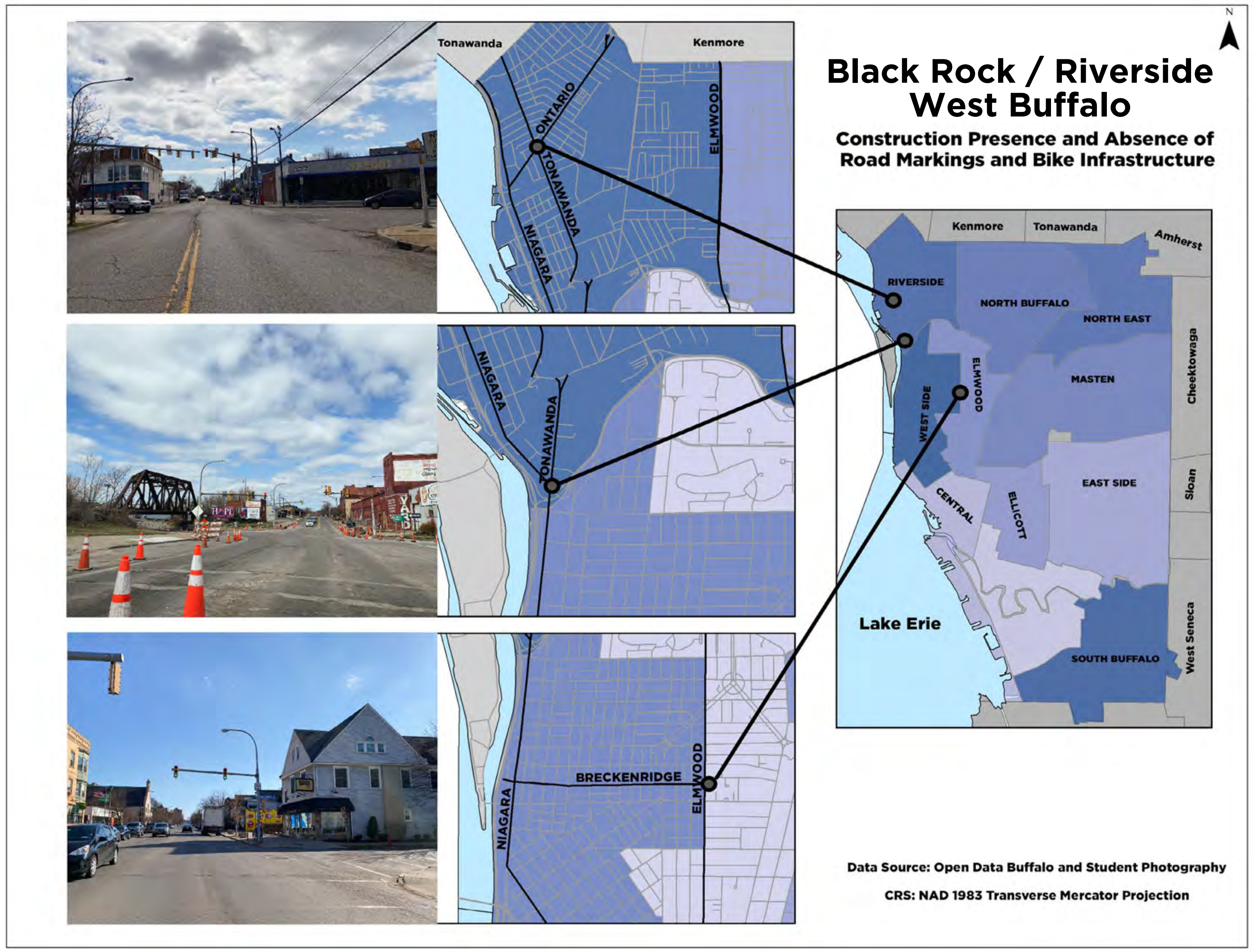
Map by Sadie Kratt, Photos by Emma Cook

WEST BUFFALO AUDIT

Important issues to note include ongoing construction, lack of bike infrastructure and inconsistent road conditions.

The current construction being done on Niagara Street is a specific concern for this area because the construction presence reroutes traffic and puts cyclists at a safety risk. However, once the cycle track is completed, Niagara Street is likely to be well-suited for EMM.

Photo by Cynthia Wood



Map by Sadie Kratt, Photos by Cynthia Wood

SOUTH BUFFALO AUDIT

South Buffalo and Larkinville are two areas of the city that are very spread out. This area lacks safe bike infrastructure and has minimal street vitality.

EMM would pose the most opportunity in activity centers such as Larkin Square, Cazenovia Park, or residential sections.

Photo by Sean McGranaghan

Map by Sadie Kratt, Photos by Photos by Ethan Fogg and Sean McGranaghan

EMM ON THE GROUND

Part of the audit included riding e-bikes and e-scooters in Buffalo to experience existing street conditions. Riding bikes is an essential step to redress a data-only approach which does not develop a complete story.

The following observations were made:

- E-Bikes are extremely user friendly and efficient for commuters of all skill levels, especially for longer distances;
- Smart cycling education is essential within the development of EMM to ensure riders know the rules of the road, such as the use of turn signals and lane placement, and for car-users to be aware of EMM right-of-way; and
- Scooters have more of a learning curve compared to bikes and are more vulnerable on streets, making it even more important for car-users to be aware of their presence.

Riding on roads that are well maintained decreases stress and poses a lower risk for accidents and injuries. Therefore, infrastructure status should be considered in tandem with this program.

Photos by Anthony Bruma

CHAPTER SIX

THINKING AHEAD: POLICY RECOMMENDATIONS

OVERVIEW OF POLICY STRATEGIES

These recommendations are firmly grounded in the urban conditions of Buffalo, relying on a strong contextual base to envision policies that implement EMM proactively with communities in mind.

A SWOT analysis was conducted to thoroughly assess the strengths, weaknesses, opportunities, and threats to implementing EMM in the City of Buffalo. Five major themes were developed from this analysis.

Five Major Themes

- Community Strengthening
- Infrastructure Quality and Neighborhood Form
- Fair Policing and Public Safety
- EMM Maintenance and Data Management
- Gentrification and Environmental Impact Mitigation

SWOT Analysis

Internal	External
Strengths	**Opportunities**
College campuses Wide sidewalks and streets around more active blocks Vibrant park system Historic architecture Niagara Falls and tourism Community pride Strong grassroots activities Well-established public transportation Bike culture Vacant lots Existing plans targeting other infrastructure expansion/investment	Relatively progressive state government Proximity to Canada Sports teams/entertainment Affordability Access to the Great Lakes E-Bike Act New Federal Administration (Build Back Better)
Weaknesses	**Threats**
Lack of street and sidewalk connectivity Trash/Litter Lack of defined lines (biking / driving) Deteriorated roads / sidewalks Lack of traffic calming measures Income inequality Gentrification Segregated neighborhoods Structural racism	Cold weather climate Pollution exposure Potential cuts in the state budget Discriminatory policing practices Crime Over-policing Pandemics Financial

COMMUNITY STRENGTHENING

Community strengthening aims to bolster community interactions. The first goal within this initiative is to expand community involvement and dialogue within the EMM implementation process. Planners and officials must centralize the input of community members in the deployment of EMM devices. To achieve these ambitions, it is recommended that a paid EMM taskforce be established that lead public sector efforts on issues related to EMM. Alongside collaboration with private EMM stakeholders, the taskforce will be responsible for holding multiple community meetings annually to encourage transparent engagement with citizens. This taskforce would work alongside service providers to formulate an equitable pricing/payment system that increases accessibility for people of color and low-income groups.

EMM devices can also be implemented in a manner that increases economic activity within communities. This can be accomplished by connecting residents to neighborhood institutions and businesses with planned EMM rides and tours. This can be a valuable opportunity for EMM stakeholders to connect with community members, spread tips on best practices, and help residents visualize regular use of these devices. Additionally, the integration of EMM within the planning of city-wide events can broaden community engagement and support local economic activity.

Lead & Implementing Partners

City of Buffalo, Shared Mobility, Neighborhood Block Groups, Partnership for the Public Good, Preservation Buffalo Niagara, Buffalo Niagara Partnership

Timeframe: 2025 - 2029

1 10

Goal 1

Community Involvement and Dialogue in EMM Implementation

Action 1	Establish paid EMM taskforce
Action 2	Conduct multiple annual community meetings
Action 3	Develop innovative and equitable pricing and payment system with the EMM task force and service providers to increase access to EMM devices among low-income households

Goal 2

Increase Economic Activity through EMM Usage

Action 1	Connect residents to neighborhood businesses/restaurants through the use of EMM rides and tours
Action 2	Integrate use of EMMs in planning for city wide events (e.g, Elmwood/Allentown Art Festivals, Taste of Buffalo, Canalside concerts)

INFRASTRUCTURE QUALITY AND NEIGHBORHOOD FORM

As the demographic overview and suitability analysis highlighted, racial residential segregation is prevalent throughout Buffalo. One of the many ways it transpires and exacerbates is through the unequal distribution of safe infrastructure. For this reason, the City of Buffalo must improve its existing infrastructure. A community-made list would be established to spotlight infrastructure issues in need of repair, including sidewalks, bike lanes, and signage. A policy action under this goal includes the installation of green traffic calming measures, including urban canopy and protected bike lanes, to encourage sustainable methods of traffic safety.

The implementation of shared mobility hubs must occur alongside these efforts, targeting areas that lack transportation options and utilizing vacant lots in underdeveloped areas. This will work to combat issues of mobility injustice as well as provide quality investment to these areas.

Photo by Cynthia Wood

Lead & Implementing Partners

City of Buffalo Department of Public Works, Erie County Department of Public Works, GObike, Buffalo Biking Coalition, Niagara Frontier Transportation Authority

Timeframe: 2025 - 2029

1 10

Goal 1

Improve the Quality of Existing Transportation Infrastructure

Action 1	Create a community-centered list of deteriorating infrastructure (e.g., sidewalks, roads, bike lanes, signage) to be targeted for repairs
Action 2	Install traffic calming measures along major roads using green-infrastructure
Action 3	Design bike lanes to accommodate additional forms of active transportation (blading, boarding)

Goal 2

Implement More Shared Mobility Hubs in Buffalo

Action 1	Install at least two shared mobility hub (similar to the 201 Ellicott Street mixed use complex) in areas lacking transportation options
Action 2	Build at least two shared mobility hubs that integrate urban agriculture projects using available vacant lots

Communities of color - in particular, Black communities - have been systematically targeted by police since the inception of organized law enforcement in the United States. This context must be considered when introducing new transportation technologies in cities. The first goal under this theme is to establish a traffic advisory board that centers nonviolent tactics when interacting with community members. Planners and officials would work with neighborhoods to set up a community-led public safety taskforce. This taskforce will hire traffic management positions from the community. This will ensure community oversight and representation in the policing of traffic violations, stopping EMM implementation from exacerbating issues of discriminatory policing and police brutality.

Another goal is to eliminate unneeded and discriminatory traffic ticketing. Several studies have highlighted that low-income and people of color are disproportionately ticketed. The introduction of EMM may further these regressive outcomes. To avoid excessive ticketing, citizens should have more options to address their traffic violations, such as either participating in an educational course on EMM safety or engaging in community service as additional options to fine payments. The establishment of a graduated fine system would assign traffic fines as a percentage of an individual's personal income. This will serve to reduce the disproportionate burden of fines on low-income communities.

Lead & Implementing Partners

City of Buffalo - Traffic Management, Buffalo Police Department, Buffalo Public Library

Timeframe: 2023 - 2025

1 10

Goal 1

Establish a Trained Traffic Advisory Board to Teach Non-Violent Tactics to Resolve Conflicts

Action 1 Work with neighborhoods to establish a community-led and city-funded public safety taskforce (PST)

Action 2 Coordinate with PST to hire and train members from respective neighborhoods for compensated traffic management positions

Goal 2

Eliminate Unnecessary and Discriminatory Traffic Ticketing

Action 1 Establish a graduated fine system that assigns traffic fines proportional to a person's income

Action 2 Provide citizens with three options to address their driving penalty: fine payment, educational course, community service

EMM MAINTENANCE AND DATA MANAGEMENT

The first goal under this theme is to create an EMM tool library similar to the Buffalo Tool Library. This library would provide educational services and technical support to community members with EMM devices.

A second goal is to increase the frequency by which city active transit lanes and areas around charging stations are plowed for snow removal. This will help to ensure ridership is not limited by winter weather conditions. A potential way to aid in this is by incentivizing business owners to remove snow by providing snow removal equipment, such as shovels and sidewalk salt. Year-round EMM accessibility can be a boon to business, especially when eliminating the economic barrier to winter maintenance.

The last goal under this theme is to improve data sharing amongst EMM stakeholders. This would be done by developing an agreement between city officials and service providers to exchange EMM user data. This would allow for better understanding of transportation patterns, thus helping transportation planners meet the needs and desires of the communities they serve.

Lead & Implementing Partners

City of Buffalo Department of Public Works, Shared Mobility Inc., Buffalo Tool Library, Buffalo Public Library, GObike, NYSDOT, NYSERDA

Timeframe: Recurring, beginning 2022

1 10

Goal 1

Make EMM Tool Library Available for Public Use

Action 1 Build an EMM tool library to provide tools and support services with partnerships from the City of Buffalo, Shared Mobility Inc., Buffalo Tool Library, and Buffalo Public Library

Action 2 Develop a tool library educational program where the EMM task force educates, mentors, and provides technical support to community members

Goal 2

Expand Snow Removal Strategies for Active Transportation Methods

Action 1 Bicycle facilities and sidewalks should be actively plowed and conditioned; EMM devices must be consistently de-iced and accessible

Action 2 Supply property and business owners with snow removal equipment (e.g. shovels, salt)

Goal 3

Improve Fair Data Use and Sharing Arrangement Among Multiple Stakeholders

Action 1 Develop an agreement between city officials and EMM service providers for transparent user data exchange

Action 2 Create a data dashboard to visualize EMM related data and other relevant transportation data for informed policy decisions

GENTRIFICATION & ENVIRONMENTAL IMPACTS MITIGATION

Any policy analysis or recommendation surrounding EMM has to acknowledge and actively confront the impact of rising property values displacing residents. The displacement of lower income residents (often of color) paves the way for increased levels of private sector investment in communities, as new residents of higher incomes are more attractive to business. The first goal to mitigate this issue is to transparently assess and address gentrification resulting from EMM interventions.

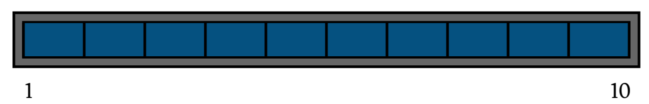
To do this, a gentrification impact assessment would be conducted, examining the relationship between EMM devices and surrounding property values. Furthermore, the EMM taskforce would engage with and pressure policy makers to develop tangible solutions to the gentrification problem. Some potential policy prescriptions include targeted rent control, or direct payments to residents tied to net increases in property values/rents. Additionally, a concerted move towards community ownership in the form of land trusts can be effective. It is vital that stakeholders play a central role in this policy advocacy, promoting values of social justice and responsibility.

Proactively tracking the relationship between EMM devices and the surrounding environment is the final goal under this theme. This would be done through a robust environmental impact assessment surrounding device use, maintenance, device disposal, etc. The EMM taskforce would play a major role in formulating solutions to the issues raised in the Environmental Impact Assessment.

Lead & Implementing Partners

City of Buffalo, PUSH Buffalo, Fruitbelt Community Land Trust, LeChase Construction Services LLC, Hamister Group LLC, RP Oak Hill, Ellicott Development

Timeframe: Recurring, beginning 2022



Goal 1

Assess and Remediate the Impact of Gentrification Resulting from EMM

Action 1 Conduct a Gentrification Impact Assessment (GIA) to quantify potential impacts of EMM devices in Buffalo

Action 2 Work with EMM taskforce to create and implement an action plan to address the gentrification issues raised in the GIA

Goal 2

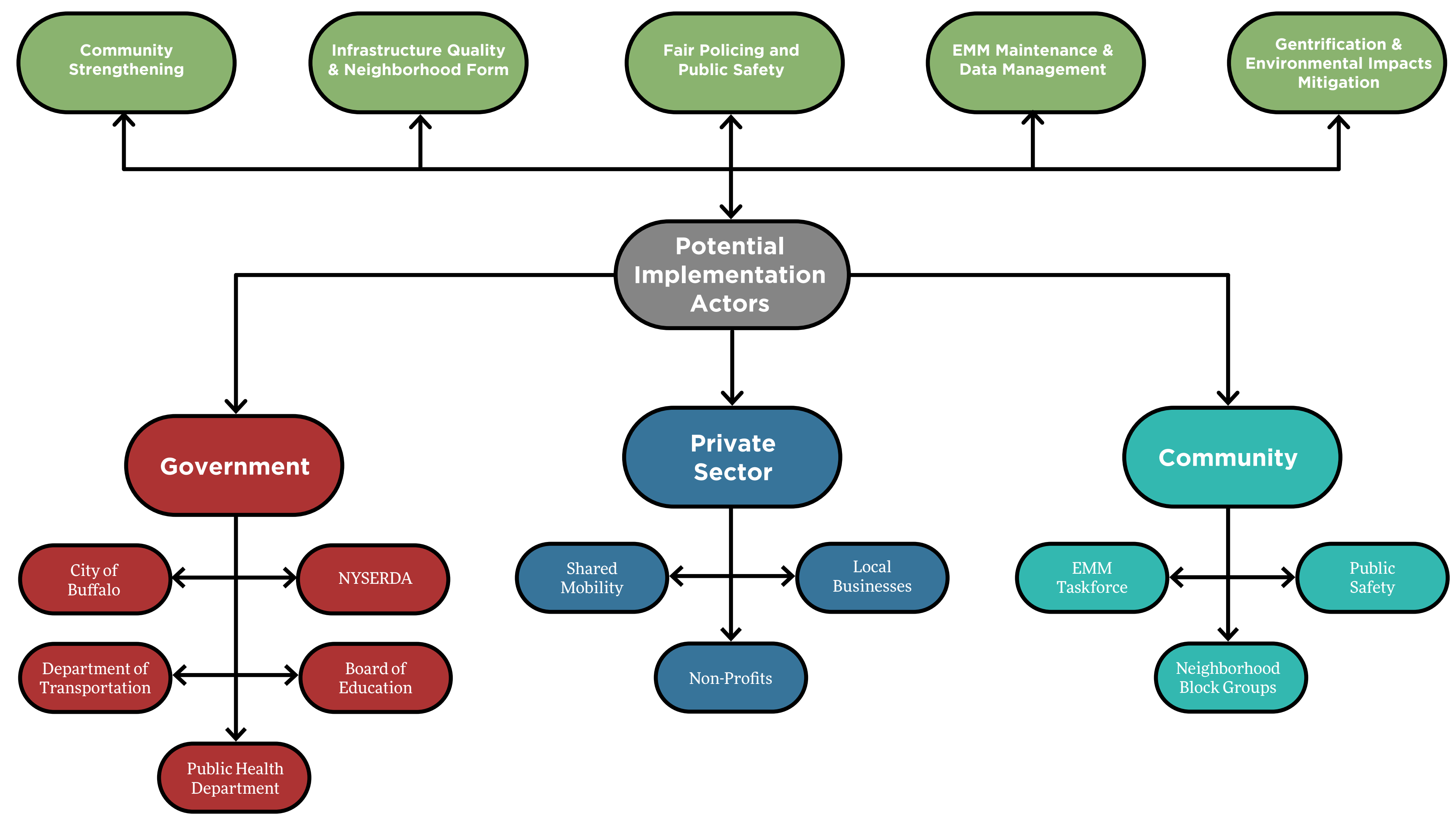
Assess and Remediate the Environmental Impacts Resulting from EMM

Action 1 Conduct an Environmental Impact Assessment (EIA) to quantify potential impacts of EMM devices (e.g., disposal of EMM wastes) in Buffalo

Action 2 Work with EMM taskforce to create and implement and action plan to address the environmental issue raised in the EIA raised in the GIA

POTENTIAL IMPLEMENTATION ACTORS

This flowchart details the relationship between the above themes and the various actors involved in EMM deployment within Buffalo. Government, community, and the private sector will all play a vital role in the successful implementation of the aforementioned goals under each theme. As such, communication and cross-collaboration between these potential actors is vital in order for smooth and equitable implementation of EMM.



Infographic by Cynthia Wood

CHAPTER SEVEN

LOOKING AHEAD: DESIGN RECOMMENDATIONS

Photo by Cynthia Wood

DESIGN RECOMMENDATION LOCATIONS

Five main intersections were selected as potential areas for design interventions. These intersections include Fillmore Avenue and Best Street, Jefferson Avenue and Best Street, Jefferson Avenue and East Utica Street, Main Street and Ferry Street, and Lincoln Parkway. They were chosen because they are central commute points in the city, focusing on those which have suffered from severe disinvestment. These intersections were also chosen because they can be applied to intersections, parks, and institutions found on the West, North, and South sides of Buffalo. The designs for these intersections stem from recommendations found in the National Association of City Transportation Officials Global Street Design Guide, Buffalo Bicycle Master Plan, and Institute for Transportation and Development Policy.

1. **Fillmore Avenue / Best Street**
2. **Jefferson Avenue / Best Street**
3. **Jefferson Avenue / E. Utica Street**
4. **Main Street / Ferry Street**
5. **Lincoln Parkway**

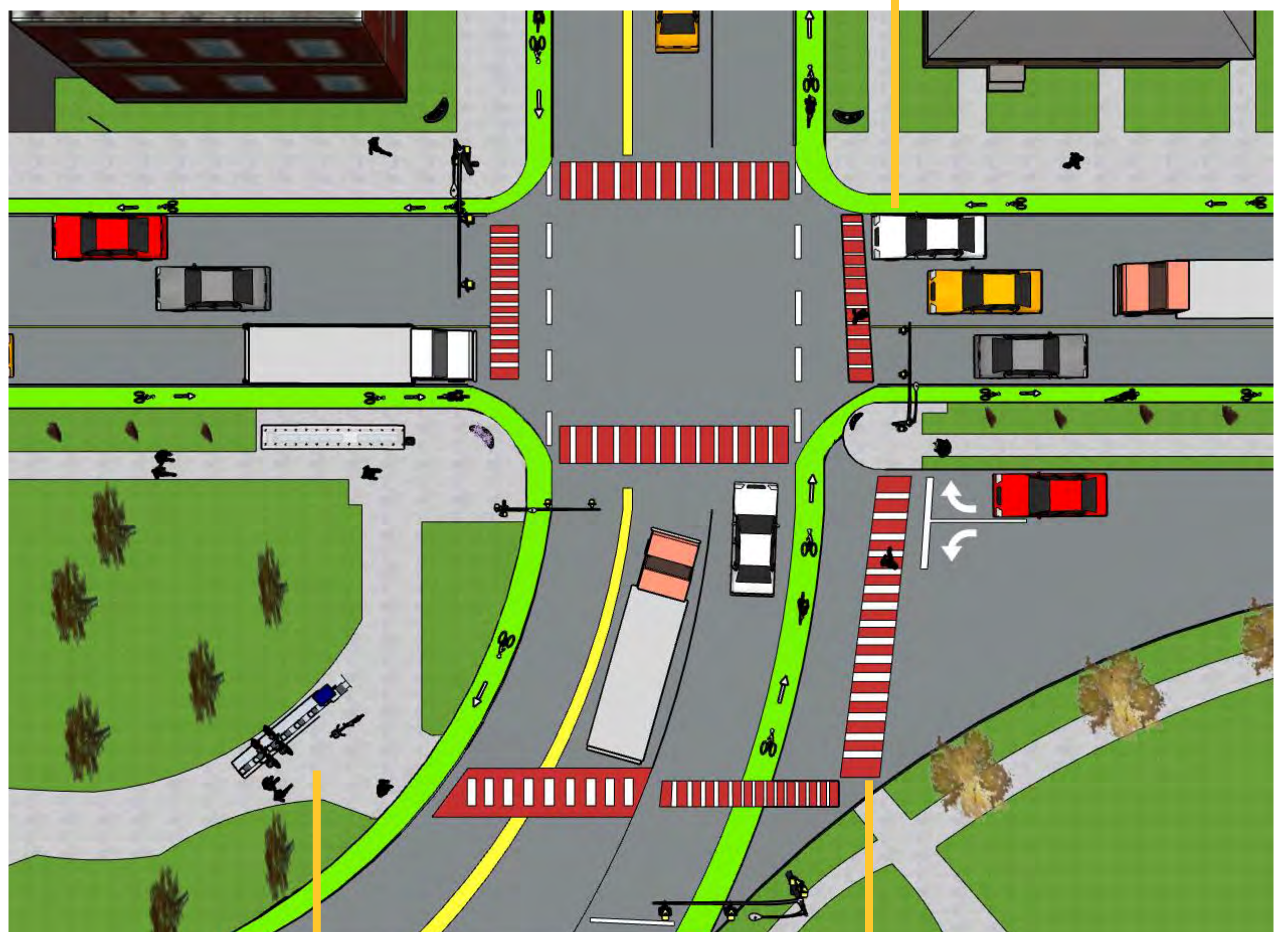
Map by Cynthia Wood

FILLMORE AVENUE / BEST STREET


Photos by Cynthia Wood

At the intersection of Fillmore Avenue and Best Street is MLK Park, which is historically significant, a source of civic pride, and home to the Buffalo Science Museum. Additionally, the intersection has physical space to accommodate the introduction of bike facilities.

Rendering by Rey Medina



Rendering by Rey Medina

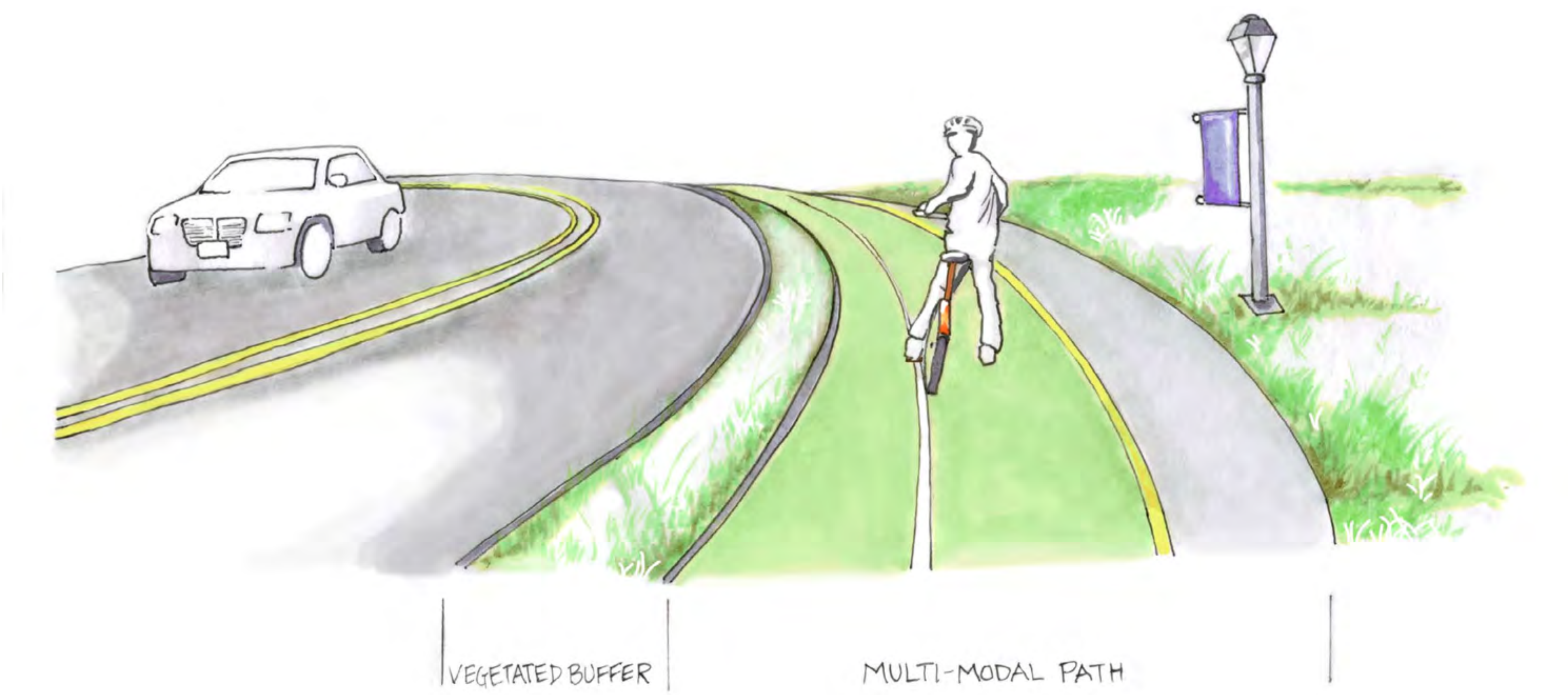
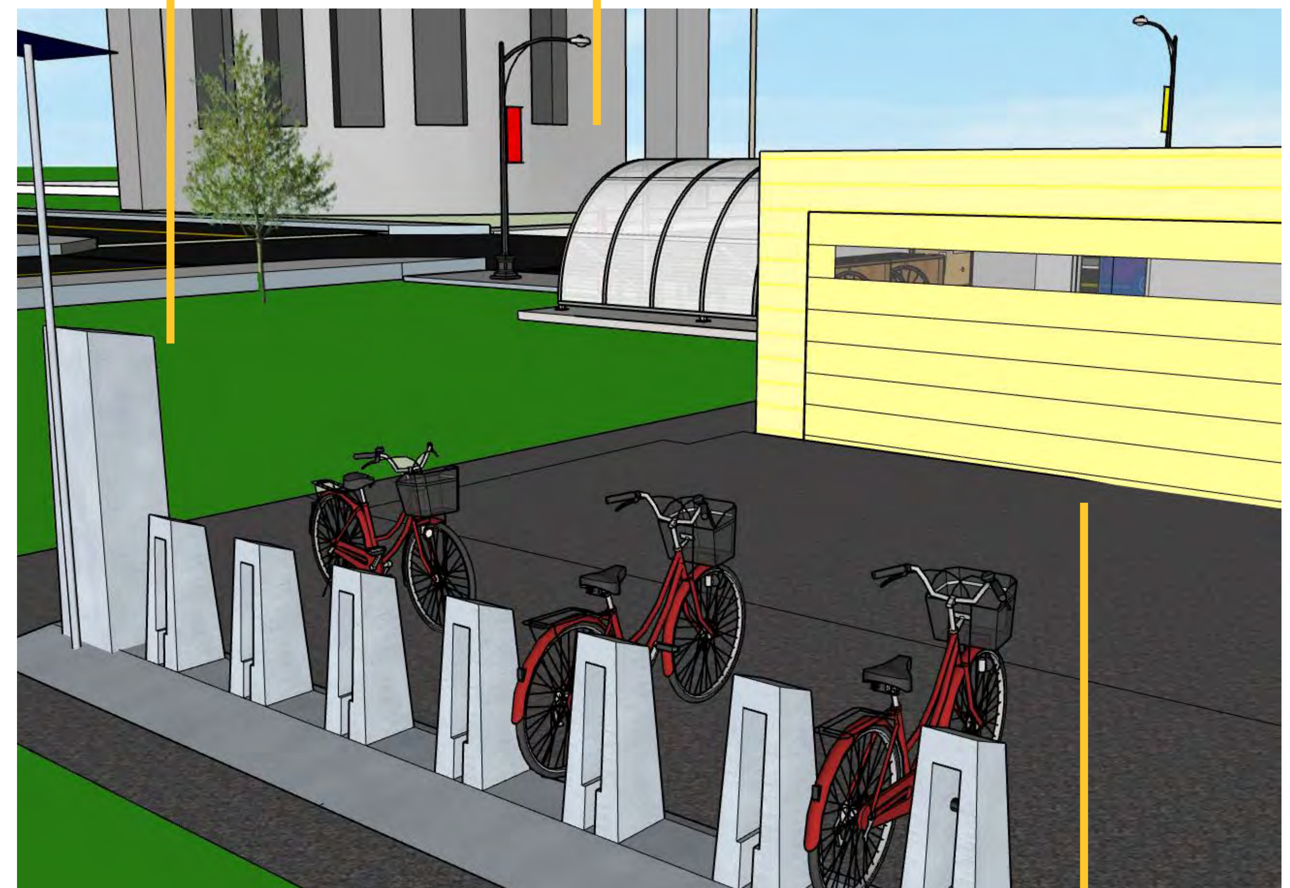


Illustration by Emma Cook

JEFFERSON AVENUE / BEST STREET



Rendering by Rey Medina

Rendering by Rey Medina

The top right corner features an e-bike charging station in the back of a potential community bicycle workshop or tool library at the intersection of Jefferson and Best. The rendering above shows this workshop with sheltered bicycle racks and seating from the front. The illustration below includes protected bike lanes that have corner refuges for the protection of riders.


Photos by Cynthia Wood

Illustration by Emma Cook

JEFFERSON AVENUE / E. UTICA STREET

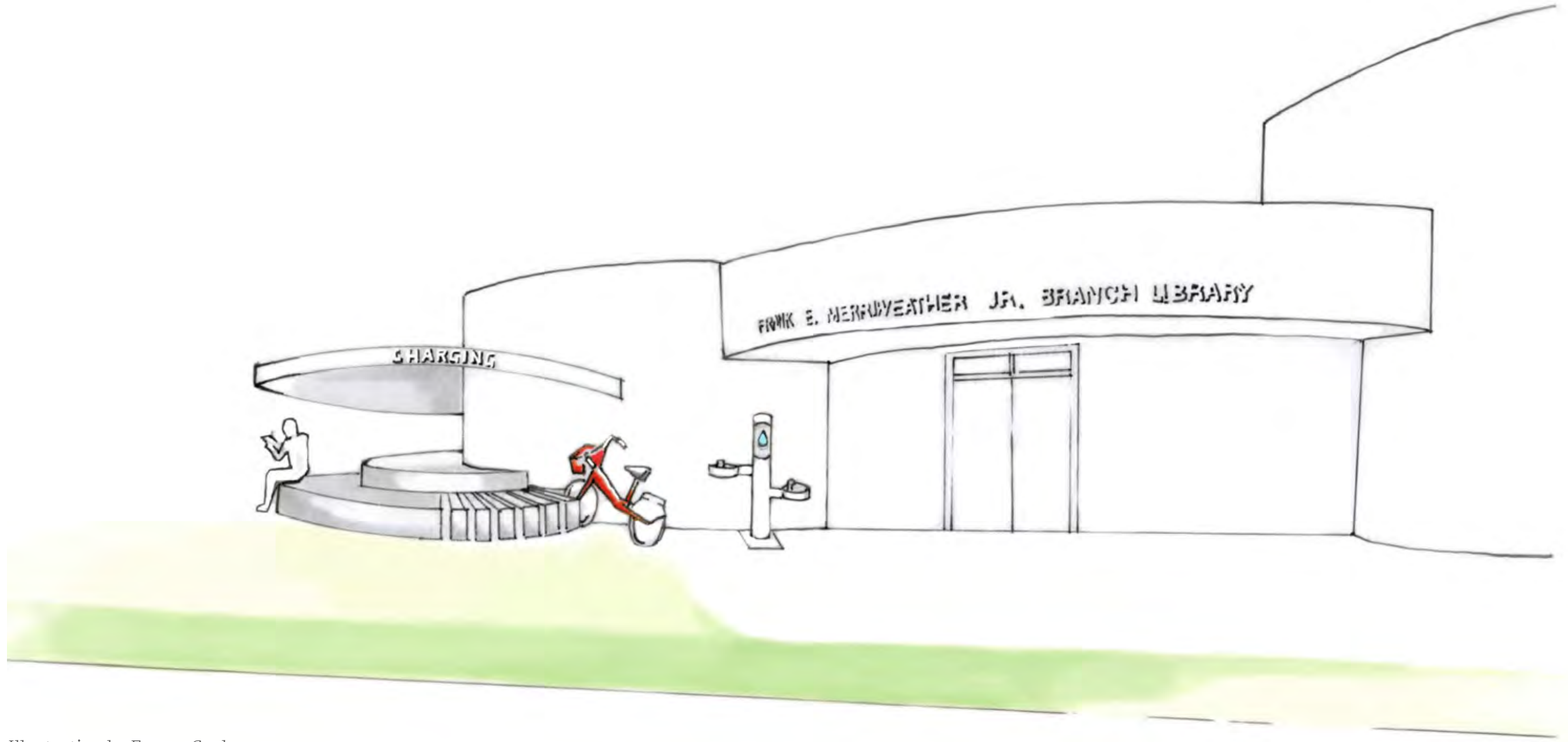
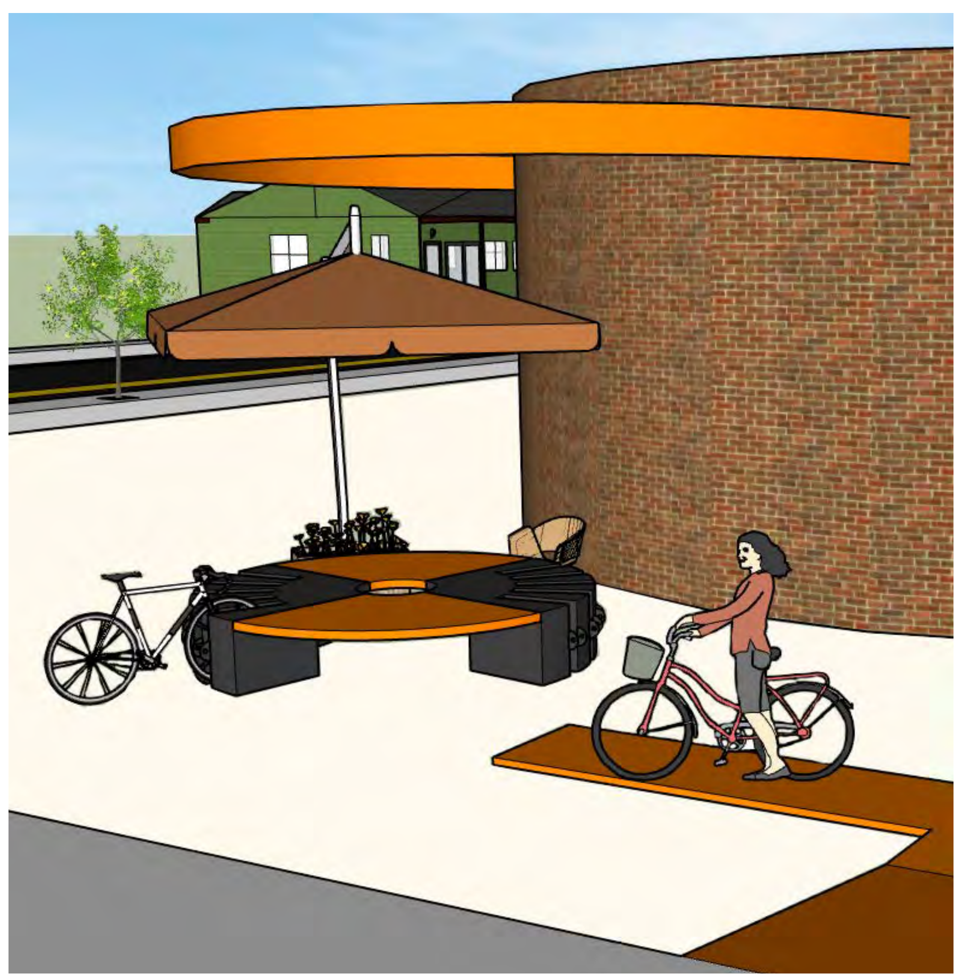


Illustration by Emma Cook

The Jefferson and East Utica intersection features two concept ideas for a potential cycling and pedestrian location along the Frank E. Merriweather Jr. Library. The above illustration features signage that serves as roofing, with a bike charging station merged with pedestrian seating. There is also a water bottle filling station and water fountain for cyclist and pedestrian usage. The rendering below is a similar concept to above that shows a space for signage at the top in orange. Also included is a charging/locking station for bikes that also functions as pedestrian seating.



Rendering by Rey Medina

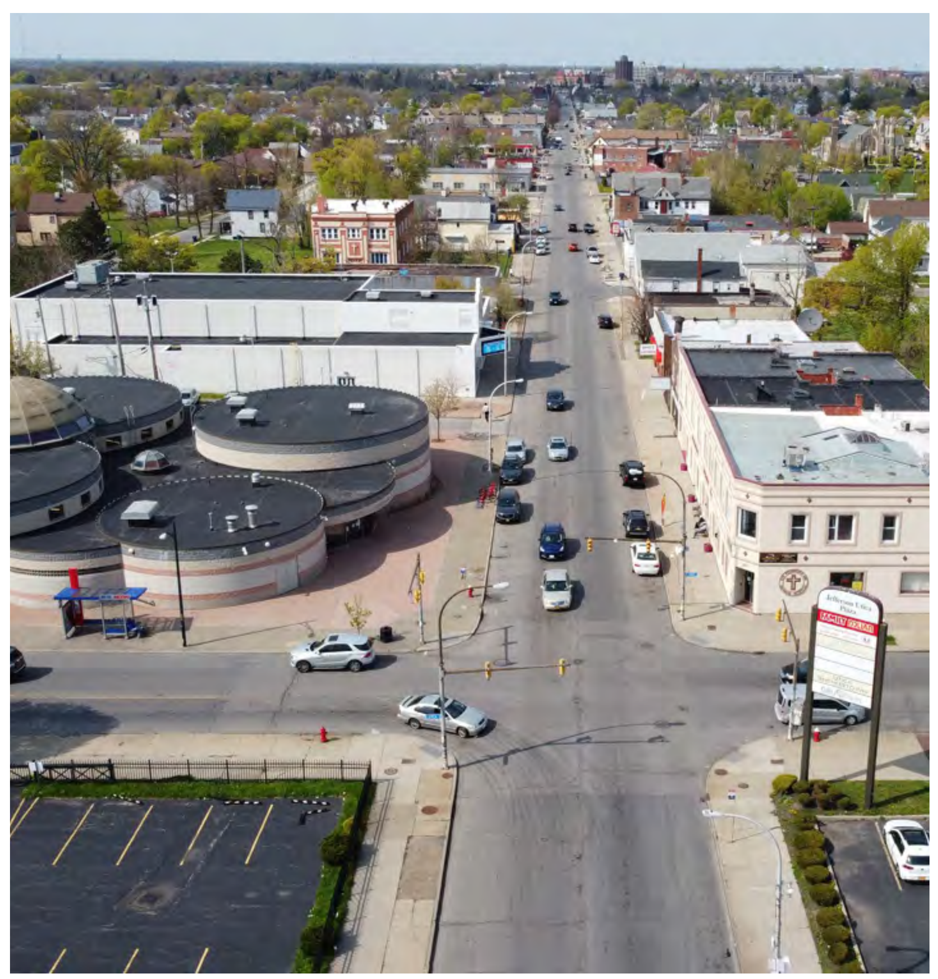


Photo by Cynthia Wood

MAIN STREET / FERRY STREET

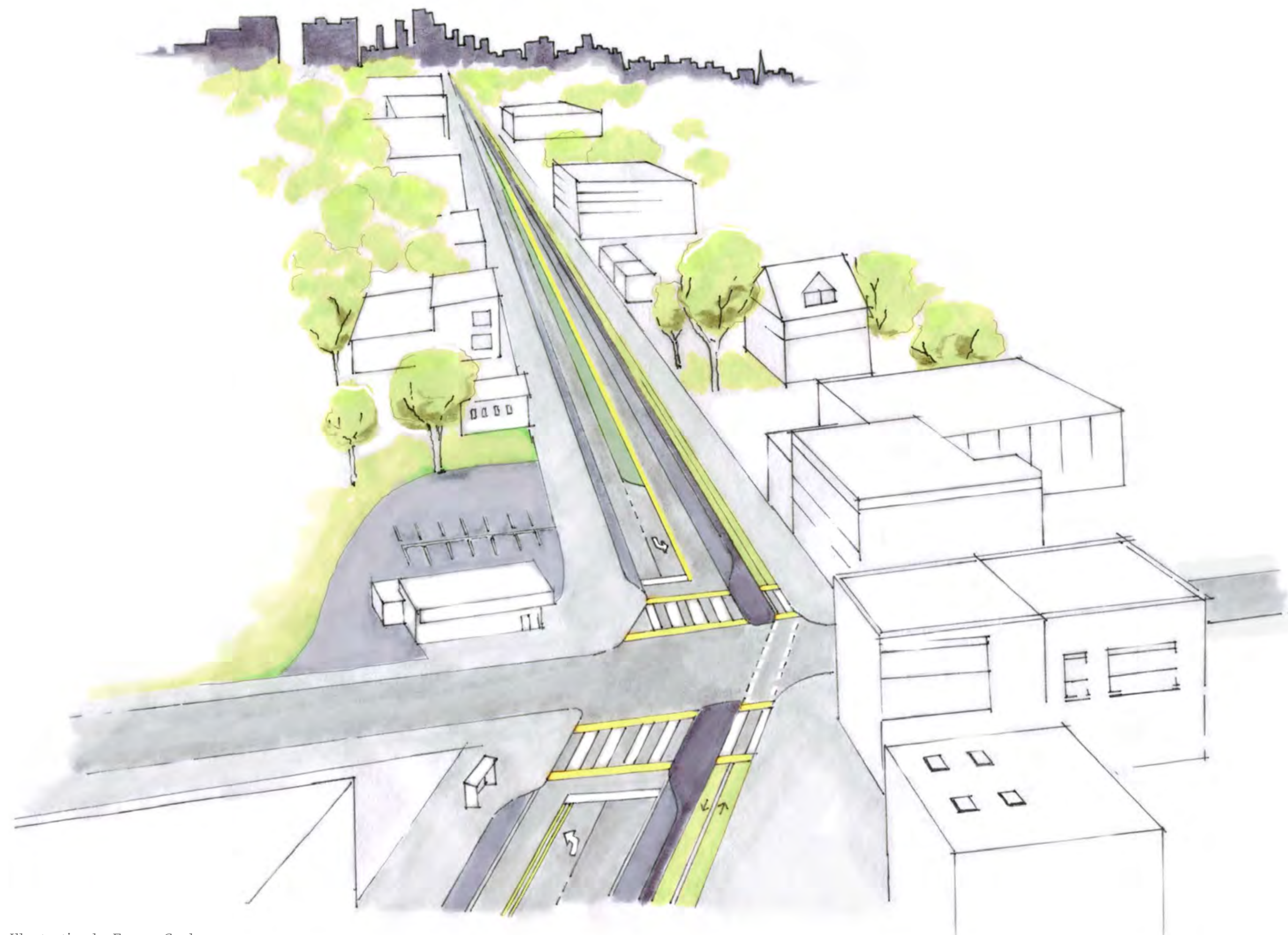
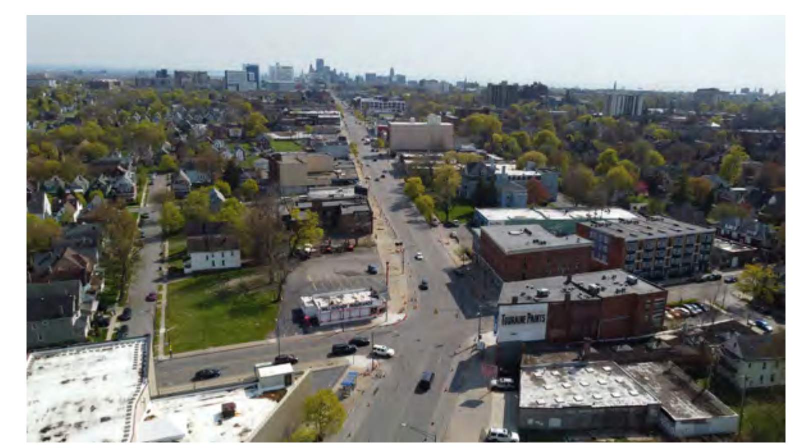
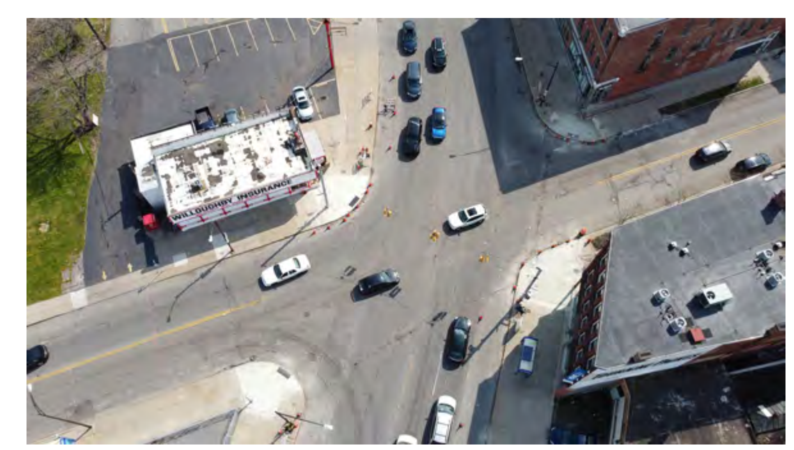


Illustration by Emma Cook

Main Street is the dividing line between East and West Buffalo. Thus this report sets forth design recommendations for this street, focusing on the Main and West Ferry intersection. Currently, this intersection is 60 ft. across, containing six vehicular traffic lanes. In addition, there is a 21 ft. wide sidewalk on the western side of the street and an 18 ft. wide sidewalk on the eastern side. The new design proposal rethinks the roadway to accommodate multiple transportation modes, reducing the number of traffic lanes to three. Additionally the proposal includes two nine-foot parking spaces on both sides of the roadway. The eastern section of the street includes a 10 ft. cycletrack, separated from the parking lane by a two foot buffer. Sidewalk dimensions remain the same, keeping the right of way to 99 ft. The design also includes traffic caution zones and added bump outs to reduce crosswalk distance and to create a pedestrian refuge.





Photos by Cynthia Wood

LINCOLN PARKWAY

Photo by Cynthia Wood

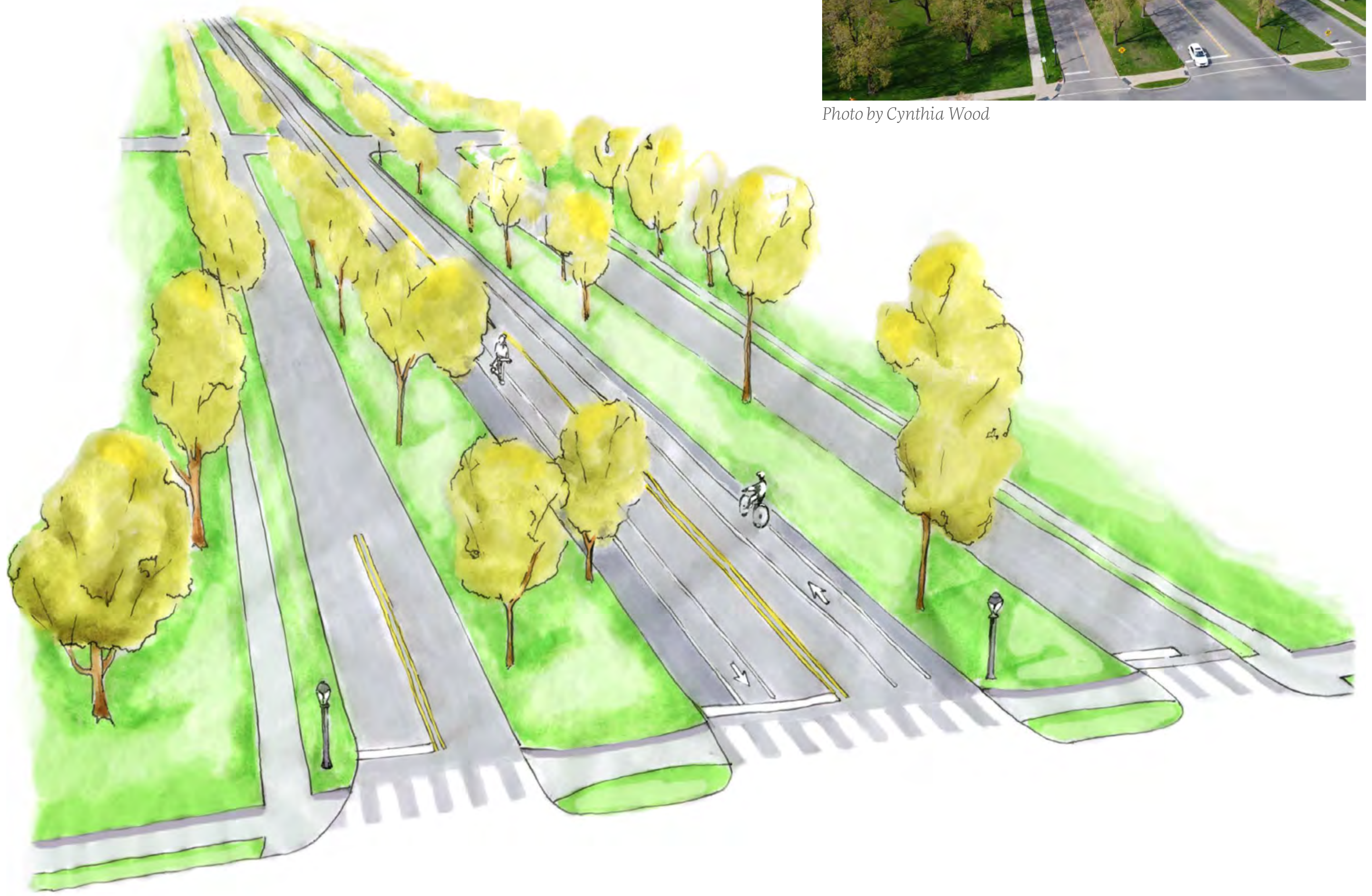


Illustration by Emma Cook

Lincoln Parkway is an important Olmsted-designed thoroughfare, running through West Buffalo's Elmwood Village. Currently, the center of the parkway has two 24 ft. wide travel lanes. The new proposal keeps a 48 ft. street width, consisting of two 10 ft. wide vehicular traffic lanes. Moving out from the center, the proposal calls for two six foot bicycles lanes, one northbound and one southbound. Next to the bike lanes, on both the North and South bound outer edges of the street, are two eight foot parking spaces. This proposal highlights how existing streets can easily be reworked to accommodate multi-modal transportation methods, including EMM.

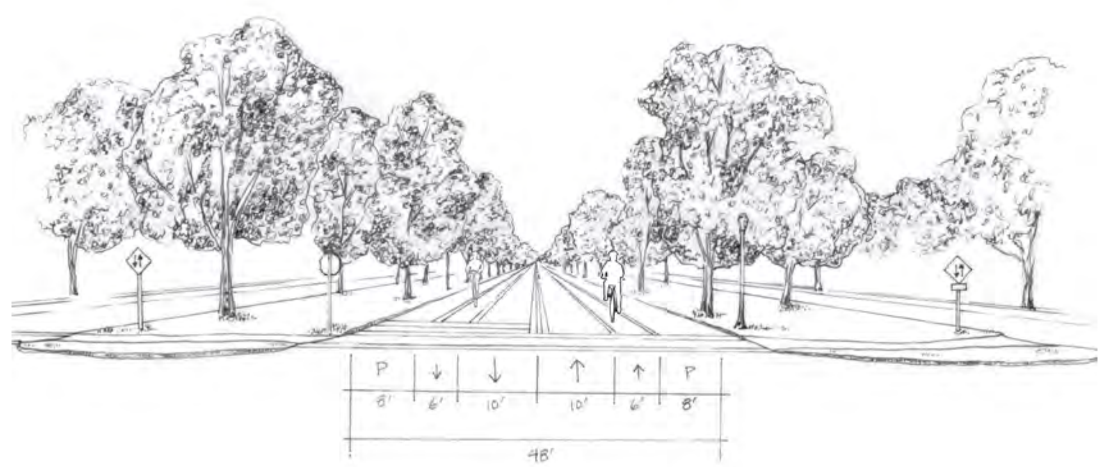


Illustration by Emma Cook

CONCLUSION

LEADING THE CHARGE: STEPS TOWARDS EMM AND MOBILITY JUSTICE

Photo by Anthony Bruna

This report utilized a mobility justice framework to treat EMM planning around issues ranging from uneven infrastructure quality, to discriminatory policing, to housing insecurity. EMM policies were studied alongside a deep consideration of Buffalo's historic and demographic context, especially between the city's East, West, and Far West Buffalo.

Nevertheless, this report contains limitations. Due to the time constraints of an academic semester community members were not consulted. This runs counter to the tenets of mobility justice which places the highest value on community engagement and a model that strives for bottom-up planning. As well, there was a failure to include policy recommendations that address the relationship between mobility and gender. Transportation researchers ought to examine EMM's correlation to gender-related problems such as the mobility patterns of single mothers, and exposure to street harassment. Researchers are also encouraged to examine other identities not explicitly addressed in this report, such as disabled individuals, refugees, and queer-identifying groups. Regardless of these limitations, this report lays groundwork to be built upon, believing in transportation planning that practices a holistic outlook. By addressing transportation's entanglement within multiple affairs, planners can develop recommendations and new understandings of cities that view urban problems as layered and wide-ranging.

The policy and design recommendations posed begin to recognize these multiple and intersecting factors. Initiatives like a Gentrification Impact Report highlight the tenuous relationship between property value and transportation access, understanding that the introduction of a novel technology like EMM may lead to increased property values and the displacement of established communities. The concerns and principles of mobility justice views housing stability as a significant factor to one's transportation capabilities. Stability also ties to matters of public safety. When considering the policing of EMM devices, recommendations consider the need for new understandings of traffic safety, advocating for diverse representation within traffic management positions, and realizing that the application of fines hold potential to disproportionately discipline and extract funds from vulnerable communities. A graduated fining system could remain sensitive to one's economic position and avoid the consequences of a tarnished disciplinary record that come with unpaid fees. Design recommendations assist in these initiatives, providing safe and green infrastructure solutions that include improved bicycle facilities and street dividers that clearly demarcate the traffic between vehicles and pedestrians. Quality infrastructure offers safer travel and reduces the likelihood of community members violating traffic laws. Accessible charging stations ensure a reliable infrastructure for EMM devices to be introduced into a city with less likelihood to stir controversy.

Overall, these suggestions address EMM policy through a wider social vision rather than a profit-oriented endeavor. Recommendations emphasize the value of community input to promote transportation planning as a co-produced, negotiated, and active process between experts and the people whose lives are directly impacted by professional decision-making. This is especially significant considering the emergence of newer transportation technologies that will continuously change the built environment's form. Therefore, what this report covers is the start to a much longer and needed conversation between transportation experts and community members. Adopting this model could offer planners insights that fully consider matters of race, class, and gender within the design of future transportation initiatives and promote a type of city-building that measures progress according to the insights and histories of communities.

Photos by Cynthia Wood

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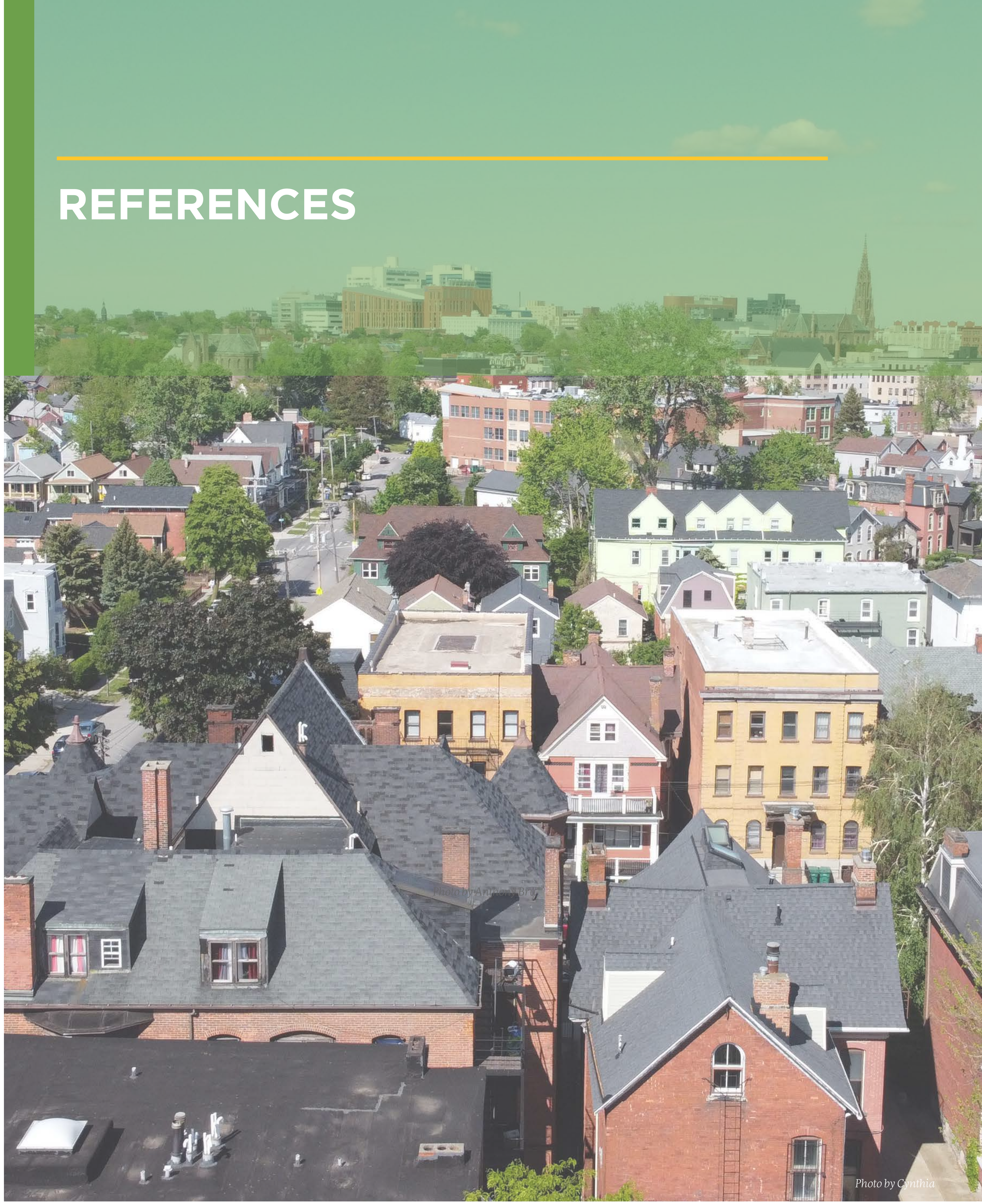

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APPENDIX

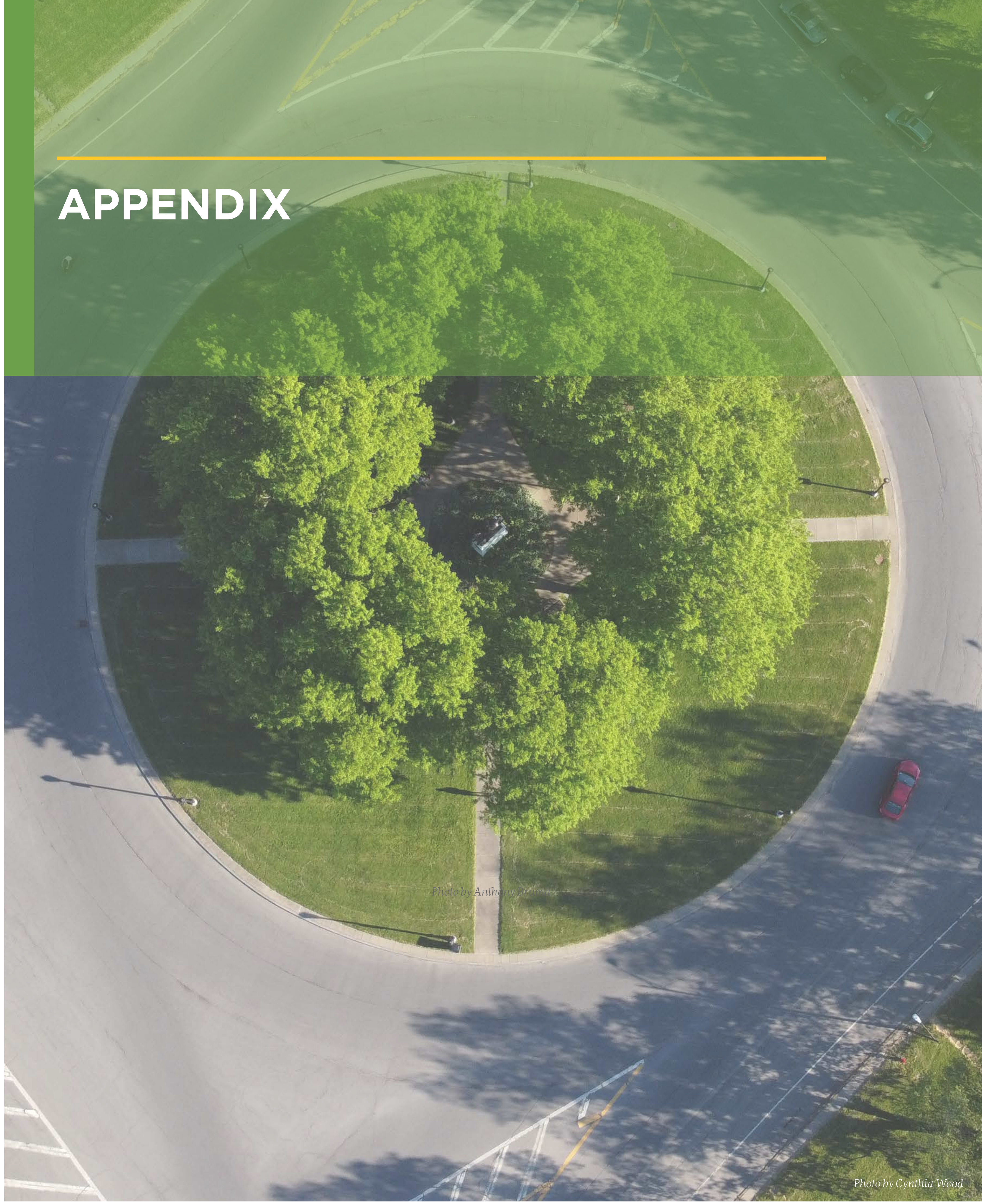
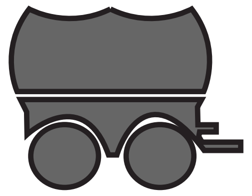


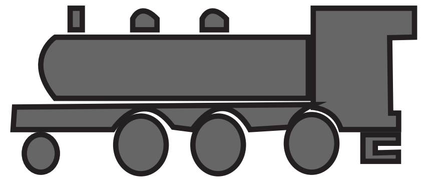
Photo by Cynthia Wood

APPENDIX 1

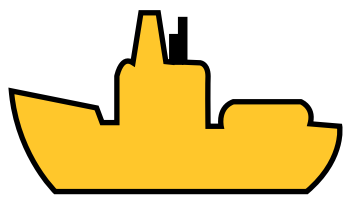
200 Years of Shifting Urban Conditions and Evolving Transportation in Buffalo, New York



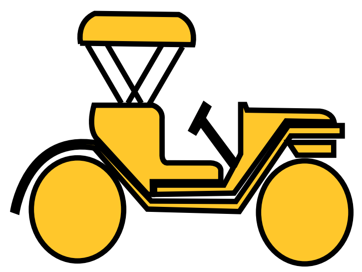
By the end of the 17th century, carriages had springs which absorbed the shock of ruts in the primitve roadway making traveling more comfortable for those who could afford it. By the beginning of the 18th century, coaches were used as a form of public city transportation often by the rich. Travel from Albany to WNY took two weeks by stagecoach.



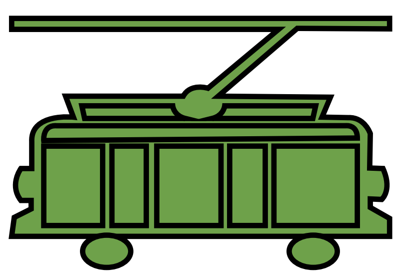
The first railroad construction in Western New York started as a part of the tract system from New York City across the state at the beginning of the twentieth century. From there, the City of Buffalo began installing rail lines across the city for commuters and commercial shipments alike. To decentralize the industrial development and link factories to the city, The Belt Line Railroad was constructed. Following the First World War and shortly after the Second World War, Buffalo stood as the second largest railroad hub in the United States, only second to Chicago.



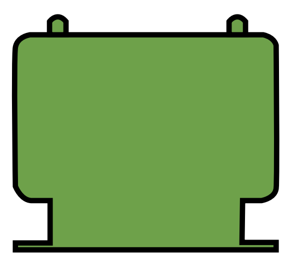
The first major transportation development occurred in 1825 with the construction of the Erie Canal. Referred to as the "Gateway to the West", the canal served as a crucial connection between New York City and the Great Lakes region. As the largest inland port in North America, the waterway supported the introduction of new cultures.



By 1902, there were 465 electric, steam and gas powered vehicles in the city in the newly developed street system. Many of these automobiles were constructed within the city itself, but Buffalo never became a major automobile manufacturing hub.



The official development of the streetcar was established in the 11th ward in 1860. It was also during this time that Calvert Vaux and Frederick Law Olmsted started to survey and establish a parkway system in Buffalo. The horse streetcar line was extended from Cold Spring to Delaware Park in 1879, followed by the Ferry Street and Forest Avenue lines in 1885 and 1888. These advancements opened transportation between East and West Buffalo in addition to spurring development of vacant land in the 11th Ward.



As population, and subsequently traffic increased, Buffalo began to look at ways to support the raising amounts of cars. The expressways were seen as methods of incentivising people to stay in the city as a way to solve the "traffic blight" issues "plaguing" the city, said by City Planning Director Russell Tryon in 1954. The Kensington and Scajaquada Expressways were proposed in 1946 and the Kensington was finally completed in 1971, amounting to an incredible 25 years long of deliberation and construction.

APPENDIX 2

Results from the Comparative Policy Analysis

Based on our analysis, certain city policies address our selected EMM principles better than others. Should the City of Buffalo choose to pursue the implementation of EMMs; the team recommends learning from how other municipalities have chosen to frame their EMM programs.

1. Connectivity and Infrastructure

Throughout the various policies and plans in the cities examined within the coding process, many designated portions of current infrastructure towards electric micro mobility. This included the existing bicycle lanes and urban trails, certain traffic lanes and even sidewalks. A few cities mentioned utilizing the data collected from micromoblity in the future in consideration of long-term planning, however none of the cities prepared a proactive approach to integrating other forms of transportation and new infrastructure with the implementation of micro mobility in the city.

In the City of Detroit, the use of electric micromobility is designated mostly to the places where bicycle lanes are currently present; followed by the rightmost lane of the roadway infrastructure. The device is required to follow the same traffic patterns as the other vehicles using the designated bicycle infrastructure. Otherwise, the electric scooter is to be used on the sidewalks with speed limits and secondary to pedestrian traffic. The City of Austin is taking advantage of using shared mobility hubs to expand EMM usage and make it more accessible for all residents. Shared mobility hubs are intended to be built alongside other forms of transportation to make EMM more accessible for city residents. While the goal is for residents to access mobility through the use of smartphones, Austin is also looking to develop methods for those who do not have access to one, and to make shared mobility hubs accessible for all of its residents. The City

also plans to include more infrastructure planning in their long term goals with expanding micro mobility.

2. Education and User Empowerment

Many of the researched cities included a section of user education, understanding the safety issues and consequences with the implementation of EMMs throughout the past five years. Some cities encouraged working in partnership with other organizations to increase awareness and others, like Seattle created public campaigns around the new form of transportation. The Cities of Detroit and Portland have created more explicit language in their policies to address user education and empowerment. Buffalo has the opportunity to cater to multiple groups through education in building strong partnerships and marketing to residents who speak other languages such as the large refugee population on the West Side. Potential partnerships here could be the International Institute of Buffalo, Journey's End, and Jericho Road; all organizations who cater specifically to the city's refugee and immigrant population.

The City of Detroit has developed and implemented a member education program since the distribution of electric micro mobility to distill safety information to users. Education includes technical specifications, best practices for operation and safe usage. The educational programs also cover requirements and restrictions in local, state and federal legislation in policy regarding age limitations, helmet use and operating restrictions. Additionally, the City deploys an interactive safety messaging system through a mobile platform to bridge interface with users.

Portland also addresses education and user empowerment through the Scooter Administrative Rule, which requires operators to have a city approved User Enforcement Plan explaining how the company communicates with its users. Using approved language, Portland's Bureau of Transportation requires all operators to educate users about EMM and how to safely ride the company's vehicles. In Portland, EMM resources and education are transparently promoted to increase the likelihood of improving user experiences and empowering residents. Similarly, the City of Austin has adopted shared mobility hubs which aim to educate and empower users through programs that teach residents how to ride and maintain EMMs.

3. Diversity and Inclusion

A fair amount of the cities studied addressed issues of equity and barriers to ridership in various policies, and the City of Baltimore even acknowledged the potential for EMMs to "reduce racial, generational, and geographical transportation disparities that affect the daily lives of Baltimore residents". Many of these policies were outlined after the implementation of EMMs, which positions the City of Buffalo uniquely, to pilot programs in historically underserved communities as well as cater to residents with varying degrees of physical ability. Interestingly, none of the cities mentioned gender disparities in ridership.

The City of Baltimore recognizes the importance EMMs could play in terms of reducing barriers to healthcare, jobs, healthy food, etc. for those with low access to transportation options and

ownership of a personal vehicle. In future transportation plans, the City seeks to use the new technology to address issues of equity through data assessment as permit requirements. All providers must offer non smart-phone and low income options for their riders. Additionally, the City seeks to create a smartphone application which can be used by visually impaired residents.

With the development of mobility hubs, Austin will create and adjust EMM services based on the needs of neighborhood residents. One of the goals mentioned in Austin's Strategic Mobility Plan is to increase the amount of shared mobility trips that originate and end in areas that are historically underserved. To make EMMs more accessible, operators are responsible for implementing and submitting a marketing and outreach plan, at their own cost, to promote the use of dockless mobility in neighborhoods currently underserved by dockless mobility options (currently defined as less than 25 EMM units per square mile). Plans must include offering an affordable option that does not require the user to access the service through the use of a smartphone and financial assistance for any customer with an income level at or below the federal poverty guidelines.

Similarly, Portland's Scooter Administrative Rule requires EMM operators to submit and have approved a user equity plan that offers discounted pricing for those with low income, smartphone free access, and the publishing of information in multiple languages. To address issues around EMM distribution, the City of Portland requires that by 8:00 a.m. operators must have at least 15% of their devices made available inside Eastern Neighborhoods which are geographically determined and attached to the City's Comprehensive Plan. The City of Detroit takes another approach which mandates that no less than 25% of an operator's vehicles must be deployed in neighborhoods outside of the downtown area in Grand Boulevard, by the Detroit River; which increases EMM access to communities beyond downtown and also alleviates the abundance of scooters found in pedestrian dense areas of the city.

4. Safety and Oversight

Safety is a high priority for every city attempting to make EMM's a standard method of transportation.Thinking about introducing EMMs in the City of Buffalo as a permanent transit solution requires consideration of many differing safety focuses. For example, the City of Seattle, Washington in the Seattle Emerging Mobility policy recognizes the importance of reallocating Right of Ways to promote pedestrian safety. Detroit, Michigan has several policies that tackle safety in different regards; their Avoidance of Public Nuisance ordinances suggests altering traffic speeds in certain areas as well as using GPS devices to keep track of the devices. Their devices are all equipped with front and rear lighting options for visibility in safety. Detroit highlights parking standards in the Avoidance of Obstruction policy and also shares an Additional Measures policy that recommends the EMM's operate on a 24/7 operating line.

Austin, Texas has created the Vision Zero Plan as part of the Austin Strategic Mobility Plan, which expresses interest in tackling investment on systemic risks to pedestrian safety. Austin also requires EMM licensees to provide a collision history report, which includes the amount of collisions, severity, location and time of crash. Denver's Mobility Action Plan highlights the vision zero plan (a plan with the goal of reaching zero cycling related deaths by the year 2030)

and Micromobility Action Report, highlighting equipment standards for all devices statewide. Lastly, City of Baltimore, Maryland in the 2019 Pilot Overview, Permit Applications and Rules and Regulations for interests in reducing environmental safety hazards as well as improving safety through vehicle design, maintenance and user education. The City requires all dockless vehicles to submit a safety portion of their permits which considers not only the vehicle user but all other transit users.

5. Impact and Assessment

The electric micromobility vehicles in the City of Detroit are scheduled for monthly maintenance checks to ensure the safety of the users. During these maintenance reviews, the vehicles are checked for various wear and damage in the wheels, handlebar covers, lights and reflectors as well as the kickstand and platform. The tires are checked for their pressure and whether the wheels are in alignment along with the spokes, hubs and axles. The brakes are checked for functionality and whether they require tightening, similarly to the handlebar which are also inspected for full range of motion. All the exterior surfaces must be clean and the vehicle is ride tested to ensure all the parts are working successfully.

Portland and Detroit have shared similar pursuits regarding equitable distribution assessment as stated in the third principle. The two cities have also outlined similar maintenance requirements for operators. At a more environmental level, Portland's Scooter Administrative Rule seeks to also include an environmental impact assessment alongside EMM deployment which aims to reduce climate pollution. This consists of quantifying the climate impacts during an EMMs life cycle while increasing the number of trips made using these low-carbon modes of transportation.

Austin sees EMM as a way to meet the mobility needs of residents in Austin and build a more sustainable living environment and reach a more equitable form of transportation. As Austin focuses on data sharing from other organizations and inputting requirements to accommodate and satisfy users to make it efficient through incorporating community surveys and input to determine where there is demand for EMM and user satisfaction.

6. Policing

Potentially is one of the most important policies while simultaneously the most under addressed policy. With more riders on the streets, there is now a larger margin for unjust policing for "riding while black." When implementing EMMs into cities, it will be essential for inequitable policing to be addressed. In all of the policies of our case cities, barely any had even semi-notable policies on how disproportionate policing is/will be addressed.

The city of Austin, Texas had the most approach with this. In Austin's Vision Zero Plan there is a recognition of racial profiling and targeting in underserved communities, as it looks to develop traffic enforcement practices to prevent these issues.This will be accomplished through community engagement efforts in underserved communities and safety investments in these communities as well. Second to Austin, The City of Baltimore began to work at this precedent by

setting up collaboration with the Police Department. Though not extensive, the city's Department of Transportation gave information pamphlets on proper ridership for the police to hand out to inform people on what is allowed and what is not. Positive feedback was found from this technique. This is good because it allows proactive rather than reactive monitoring, but is still not enough because it does not address what steps and actions will be taken if there are disproportionate burdens falling on some populations than others.

Other cities offer descriptions of punishments for the violation of codes. For example, if any of the codes in the City of Detroit's electric micromobility systems are violated, the punishment is a fee of no more than $500.00 or a sentence of up to 90 days of imprisonment. The violation classifies as a misdemeanor. The vehicles are determined to be in violation of the codes by local police enforcement and are punished on an individual basis. If the City of Detroit notices a large pattern of continual violations, the city can consider electric micromobility in violation of city code and extinguish the program altogether. The City of Detroit is responsible for removing an obstruction in traffic caused by electric micromobility after 24 hours of being reported. The City will retain the vehicle for 30 days after the removal, deciding how the item will re-enter the system or be disposed of accordingly.

7. Community Involvement

Unfortunately there are fewer policies that highlight the importance and need for community involvement in the planning of EMM's, but the policies we suggest do an excellent job of demonstrating the importance of including community. In Seattle, Washington the Seattle Emerging Mobility policy shows the cities expressed interest in working with community members to gather input on improving permit requirements as well as administering their next e-scooter pilot. In addition, this policy dedicates a great deal of effort explaining the benefit of including community stakeholders as a focus group for the planning process of EMM's. Furthermore, Baltimore, Maryland has the 2019 Pilot Overview which reviews their Department of Transportation's interest in establishing a resident board that focuses on the subject of mobility needs. It is their belief that in creating a Resident Mobility Advisors program the mobility needs of the community will be handled by experts within the community. Austin hopes to use shared mobility hubs as a method for increased community engagement. In an effort to improve their EMM implementation, the city of Austin has conducted surveys for community feedback that addresses how to make overall service better and to which areas service should be expanded to based on greatest need and interest.

For Buffalo to find great success and be a powerful pioneer for EMMs in small to mid sized cities, it will be pivotal for EMMs to become a full community effort. The more public knowledge and investment in the program, the better. In 2019, Baltimore claimed to have some of the highest riderships in the country. It is no coincidence that they also claimed themselves to have one of the most thoughtful implementation programs.

8. Innovation and Sustainability

When planning for the future of any project it is important to invest in sustainable actions that will guide forward thinking, as well as innovative ideas that will continue the growth of the plan. Embracing this approach will lead to long term success and the ability to adapt quickly to the changing times. The following policies set a good precedent that would benefit Buffalo to include when planning for the future of EMM's.

The Austin Strategic Mobility Plan for its recognition of the importance of creating urban trails with the goal of reducing car dependence (Austin, Texas). Denver's Micromobility Action Report strictly for its views on the importance of data sharing. Addressed in this report is the significance of data sharing, benefits of sharing user statistics and more on the benefits of data sharing in the process of planning for EMM's. Also from Denver we suggest looking at the Mobility Action Plan, which showcases the importance of increasing access to cleaner and healthier transportation choices.

9. Partnerships

Keeping a focus on local and non-local partnerships is a valuable part of implementing EMM. Having these partnerships allow for planners to implement strategies and fix existing problems in the most efficient manner possible. Without partners, simple tasks become far more difficult and take longer periods of time to implement. Seattle's Emerging Mobility plan offers in-depth guidance on how to carry out partnerships and collaborate with commercial business operations. In addition the plan highlights working with stakeholders and community members to gather input. Furthering the importance of having local partnerships to inform context, look to Denver's Micromobility Action Report. Baltimore's 2019 Pilot Overview and Permit Application informs more strategic actions such as targeted engineering, enforcement and education. While also listing partnerships that focus on serving at risk populations such as youth, immigrants and formerly incarcerated individuals. Austin partnered with the CDC and the Austin Police Department to collect data on EMM collisions and vehicle collisions in Austin to make it a safer form of transportation for users.

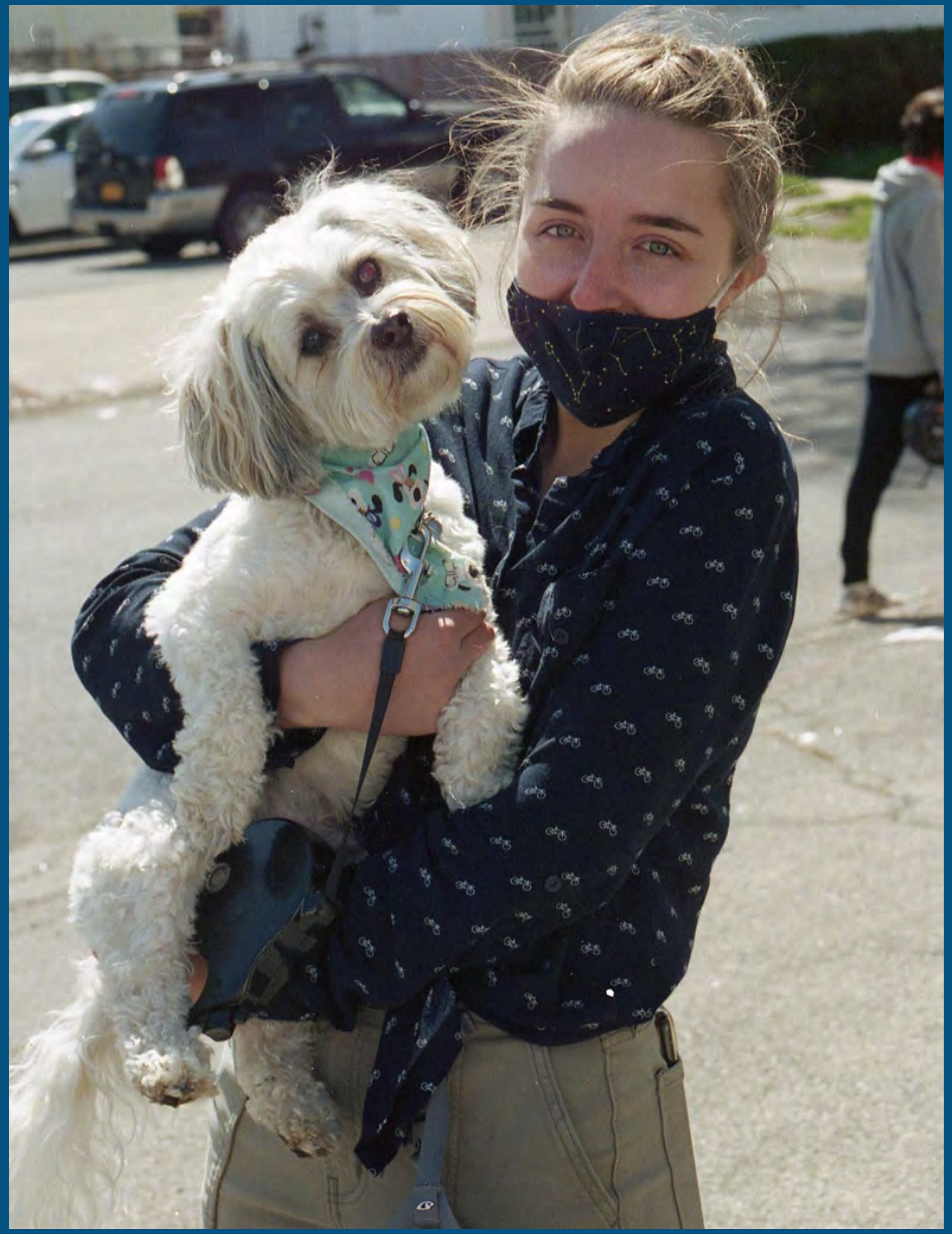


Photo by Cynthia Wood

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Appendix B. University at Buffalo Research Institute Greenhouse Gas Emissions Projections Methodology

Methods to Estimate Environmental Impacts of E-bikes and E-scooters in Upstate NY

Methods to Estimate Environmental Impacts of E-bikes and E-scooters in Upstate NY

University at Buffalo School of Architecture and Planning

University at Buffalo Regional Institute School of Architecture and Planning

Shared Mobility Inc.

New York State of Opportunity | NYSERDA

Prepared by: University at Buffalo Regional Institute

Prepared for: Shared Mobility, Inc. and New York State Research and Development Authority (NYSERDA)

9/30/2021

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1. INTRODUCTION

Electric bicycles (e-bikes) and e-scooters, or electric micromobility (EMM) devices are increasingly popular with sales expected to continue growing nationally and globally.[1] E-bikes, or pedal-assisted bikes, have electric motors that support pedaling and reduce user effort. E-scooters are propelled by an electric motor that uses throttle acceleration. EMM devices could provide a more convenient and relatively low-cost transportation option that has the potential to enhance transportation systems, reduce environmental impacts, and improve personal well-being.[2] Those who own these devices or use them in shared systems ("bike-shares" or "scooter-shares") may reduce automobile use by replacing vehicle trips with EMM, which could have notable impacts on greenhouse gas (GHG) emissions from transportation. The deployment of EMM devices in shared systems may increase usage of EMM and amplify these benefits by lowering the costs of EMM usage. However, as EMM technologies and shared mobility systems are evolving, the extent of these impacts is unclear.

This paper presents methods to estimate the regional environmental impacts of EMM, and related information on potential EMM usage useful to regional transportation modeling. The methods leverage publicly available resources, including surveys, government data, academic research, and the US Environmental Protection Agency's (EPA) Motor Vehicle Emissions Simulator (MOVES) software. The methods are meant to be applied and refined by transportation planners and engineers in metropolitan areas, particularly those working under municipal planning organizations (MPOs) in Upstate New York as EMM was legalized across New York State (NYS) in April, 2020.[3] Methods are demonstrated for the Buffalo Niagara metropolitan region. The results validate that a fairly straightforward process using EPA's MOVES software, surveys, and data analysis, can produce reasonable estimates of EMM impacts on GHG emissions. These methods provide a starting point for more robust approaches of estimating the transportation and environmental impacts of EMM as more is learned about EMM device usage.

The first section describes how to apply EPA MOVES3 software to model current annual regional GHG emissions of motor vehicles. An independent survey is then used to model the proportion of vehicle trips that may potentially be replaced by EMM. The EPA MOVES3 model is used again to estimate the resulting change in regional transportation GHG emissions due to EMM. Supplemental research and analyses are then used to account for the GHG emissions from EMM device charging and shared system operations. The paper also includes methods to estimate various data points that may help incorporate EMM in regional transportation demand forecasting (TDF) models used by MPOs. The document includes support tools and additional resources[4] that planners and analysts may use to repeat and expand these methods to estimate environmental impacts of EMM usage, particularly in Upstate NY.

[1] The Business Research Company: "Electric Bikes Global Market Report 2021: COVID-19 Growth And Change To 2030," April, 2021. Summary Retrieved July, 2021 at https://www.reportlinker.com/p06064487/Electric-Bikes-Global-Market-Report-COVID-19-Growth-And-Change-To.html?utm_source=GNW; World Economic Forum, "Electric bike sales grew by 145% in the US last year - here's why that matters," March, 2021. Retrieved July, 2021 at https://www.weforum.org/agenda/2021/03/electric-bicycles-sales-growth/

[2] MacArthur, John, Christopher Cherry, Michael Harpool and Daniel Scheppke. A North American Survey of Electric Bicycle Owners. NITC-RR-1041. Portland, OR: Transportation Research and Education Center (TREC), 2018.

[3] FY2021 Budget Article VII: Transportation, Economic Development and Environmental Conservation (S7508B/A9508B), Retrieved July 14, 2020 at assembly.state.ny.us/leg/?default_fld=%0D%0At&leg_video=&bn=S07508&term=2019&Summary=Y&Actions=Y&Text=Y

[4] Please refer to the additional resources available at this link - https://buffalo.box.com/s/7qkhl5rw7hjd2vfto94srz0cizdfydhu

2. LITERATURE REVIEW

Recent studies suggest that EMM devices may help regions and cities in climate change mitigation efforts,[5] but additional research is needed to help understand the extent to which EMM would replace other modes of travel in a wider variety of geographic contexts.[6,7] Models investigating the potential GHG reductions from mode shifts to EMM have been applied to cities and regions with a more robust bicycle infrastructure and relatively high rates of bicycling activity,[8] unlike Upstate NY.

The potential usage patterns and market potential for EMM have been studied by looking at EMM owners and shared systems European cities,[9] New Zealand,[10] Portland, Oregon,[11] and others. Surveys of current EMM owners reveal important insights, but the perspectives of this group, who are typically younger males, are not representative of all potential EMM shared system users.[12] Meanwhile, traditionally underserved communities, including individuals with lower incomes and people of color, experience access barriers to EMM shared systems which limit use.[13,14] Surveys of EMM users can help fill these research gaps and develop methods to project GHG impacts of EMM.

By estimating potential use of EMM in Upstate NY regions, this research will help address gaps related to the limited geographic diversity of related studies, adding useful insights from mid-sized, slow growth U.S. cities, like those in Upstate NY. The survey also fills a related research gap by looking at perceptions of e-bicycles and e-scooters for the same survey population and comparing potential usage and resulting GHG impacts of separate EMM devices.

The methods below adapt and expand upon an approach developed by McQueen, MacArthur, and Cherry (2020),[15] which built off of methods from Winslott-Hiselius and Svensonn (2017)[16] as well as

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[5] M. McQueen, J. MacArthur, and C. Cherry. "The E-Bike Potential: Estimating regional e-bike impacts on greenhouse gas emissions," Transportation Research Part D: Transport and Environment, Volume 87, Oct. 2020, 102482.

[6] T. Jones, L. Harms, E. Heinen. "Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility," Journal of Transport Geography, 53 (Supplement C) (2016), pp. 41-49.

[7] Castro et al, 2019.

[8] D. Bucher, R. Buffat, A. Froemelt, and M. Raubal. "Energy and greenhouse gas emission reduction potentials resulting from different commuter electric bicycle adoption scenarios in Switzerland," Renewable and Sustainable Energy Reviews, Volume 114, October 2019, 10: 9298, https://doi.org/10.1016/j.rser.2019.109298

[9] A. Castro, M. Gaupp-Berghausen, E. Dons, A. Standaert, M. Laeremans, A. Clark, E. Anaya-Boig, T. Cole-Hunter, I. AvilaPalencia, D. Rojas-Rueda, M. Nieuwenhuijsen, Regine Gerike, L. Int Panis, A. de Nazelle, C. Brand, E. Raser, S. Kahlmeier, and T. Götschi. 2019. Physical activity of electric bicycle users compared to conventional bicycle users and non-cyclists: Insights based on health and transport data from an online survey in seven European cities. Transportation Research Interdisciplinary Perspectives 1, (June 2019), 100017.

[10] Wild, Kirsty and Woodward, Alistair. Electric City: Report on the Electric City research programme: E-bikes and the future of cycling in New Zealand, 2018.

[11] MacArthur, J., Kobel, N., Dill, J., Mumuni, Z. Evaluation of an Electric Bike Pilot Project at Three Employment Campuses in Portland, Oregon. NITC-RR-564B. Portland, OR: Transportation Research and Education Center (TREC), 2017. http://dx.doi.org/10.15760/trec.158

[12] MacArthur, John, Christopher Cherry, Michael Harpool and Daniel Scheppke. A North American Survey of Electric Bicycle Owners. NITC-RR-1041. Portland, OR: Transportation Research and Education Center (TREC), 2018.

[13] J.A. Hirsch, I. Stewart, S. Ziegler, B. Richter, and S.J. Mooney. "Residents in Seattle, WA Report Differential Use of Free-Floating Bikeshare by Age, Gender, Race, and Location," Frontiers in Built Environment; Vol. 5 (2019). DOI= 10.3389/fbuil.2019.00017

[14] N. McNeil, J. Broach,and J. Dill. "Breaking Barriers to Bike Share: Lessons on Bike Share Equity," Institute of Transportation Engineers. ITE Journal; Washington Vol. 88, Iss. 2, (Feb 2018): 31-35.

[15] McQueen, MacArthur, and Cherry. 2020.

[16] Winslott Hiselius, L., & Svensson, Å. (2017). E-bike use in Sweden – CO2 effects due to modal change and municipal promotion strategies. Journal of Cleaner Production, 141, 818-824. https://doi.org/10.1016/j.jclepro.2016.09.141

Fyhri, Sundfør, and Weber (2016).[17] These researchers developed programming and spreadsheet tools to help other researchers and planners model GHG impacts of e-bike use by providing local data and estimates as inputs. These and other studies have quantified estimates of regional GHG impacts of EMM usage that can be used as comparisons in this study to better understand the potential benefits of EMM in Upstate NY regions and similar areas. This work seeks to build off of this work and further develop methods and support tools to be useful for regional transportation planners and MPOs.

3. METHODS

These methods involve a series of steps. First, the existing regional transportation emissions are estimated using US EPA'S MOVES3 software, which requires synthesizing various pieces of public data on the local transportation network. Next, estimates of the vehicle miles travelled (VMT) that would potentially be replaced by EMM are derived from survey methods, previous studies, and supplemental research. Then this estimate of VMT reduction via EMM is used to adjust the estimate of annual VMT needed for the MOVES3 model. The MOVES3 model is executed again applying this new estimate of VMT and used to calculate the resulting change in GHG emissions using supplemental research and tools. Reference tables, example data, and additional resources used to conduct these methods that are referenced throughout this document can be found in the resource folder at this link - https://buffalo.box.com/s/7qkhl5rw7hjd2vfto94srz0cizdfydhu

3.1 MODELING CURRENT VEHICLE EMISSIONS USING EPA MOVES3

Establishing practical methods to produce a sound baseline estimate of regional vehicle GHG emissions is the first step in estimating EMM's potential environmental impacts. The US Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator (MOVES) tool provides a tool to estimate motor vehicle emissions that can be tailored to individual counties and regions.

EPA's MOVES software is used in this study because it is a user-friendly, rigorous and proven model to estimate GHG emissions and can be tailored to different regions. MOVES estimates emissions from combustion as well as brake/tire wear and other vehicle processes that emit air pollutants. MOVES accounts for local factors that affect vehicle GHG emissions, such as traffic patterns, climate, and type of vehicle. The updated MOVES3, launched in 2020, utilizes recent local data on vehicles, travel behavior, emission rates, and fuel supply. It can be applied to various geographic scales, at the site, county, or national level, and various time spans, from hours of certain days of the week to annual totals. The software is freely available, with a wide array of resources for guidance and troubleshooting, including a tutorial to apply the model at the county scale which is used to conduct these methods.

3.1.1 Developing local inputs for EPA MOVES3 Tool

To estimate impacts at the regional level, MOVES3 needs to be run at the county scale and the county level results can be summed to estimate regional totals. EPA MOVES3 requires county-level data for most inputs. In some cases, the tool provides default county-level data that can be applied to the model. Other county-level inputs can be gathered from publicly available data. The methods are intended for use in Upstate New York regions and utilize data from the NYS Department of Motor Vehicles (DMV)[18]

[17] A. Fyhri, H.B. Sundfør, and C. Weber. (2016). "Effect of subvention program for e-bikes in Oslo on bicycle use, transport distribution and CO2 emissions," Institute of Transport Economics, Issue 1498.
[18] New York State Department of Motor Vehicles. Vehicle Registration Data. 2021. Accessed June 2021 at https://data.ny.gov/Transportation/Vehicle-Snowmobile-and-Boat-Registrations/w4pv-hbkt

and Department of Transportation (DOT)[19]. The US Bureau of Transportation Statistics' National Household Travel Survey (NHTS)[20] completed in 2017 also provides data on local travel patterns. Certain MOVES inputs allow national-level defaults to be substituted for county data, and other inputs are optional.

The section below describes the inputs and the sources used in this model to obtain these inputs for counties in NYS. Resources are provided to help users synthesize and format these data for input into the MOVES software. The analysis can be run at the county level by referring to guidebooks provided by EPA for further instruction and step-by-step guidelines to enter these inputs into the MOVES.

Vehicle Miles Travelled (VMT) by Vehicle Type

As different vehicle types have different emission rates, MOVES3 requires county-level data on vehicle miles traveled (VMT) categorized by vehicle type. These data can be entered as annual or daily totals, but must be entered by vehicle type, using either the Highway Performance Monitoring System (HPMS) or MOVES vehicle source type coding systems which are shown in Table 1 of the reference tables.

These data can be obtained from regional travel demand forecasting (TDF) models, or by using annual average daily traffic (AADT) data. The NYS DOT provides GIS data on AADT by vehicle type for major roads in the National Highway System (NHS). These data can be extracted by county using FIPS codes and converted to tabular data where it can be filtered to remove duplicate counts and only include combined full counts for each two-way road segment. The data provides the percent of traffic due to each vehicle type (passenger cars/trucks, motorcycles, buses, single- and combination-unit trucks).[21] These percentages are multiplied by the total AADT to obtain AADT estimates for each vehicle type. These average daily traffic counts by vehicle type are multiplied by the length of each road segment (in miles) to obtain the daily VMT estimates for every road segment using the equation below.[22] These values are then summed for the region and classified by HPMS source types to be properly formatted for input into MOVES3. Annual VMT for every vehicle type (*v*) is found by summing the product of the daily traffic (*AADT*) and length in miles (*L*) of each road segment (*i*), and the number of days in the year.

Equation 1: $$Annual\ VMT_V = \sum_{i=1}^{n} AADT_i * L_i * 365$$

Average Speed Distribution

As GHG emission rates vary by speed, and average speeds depend on local traffic, MOVES calls for county-level data on the average time vehicles spend travelling certain speeds. MOVES requires input data to be broken down for different types of roads and vehicles. Average speeds can also be entered variably by time of day and time of year. For this study, the average speed distribution was assumed to

[19] New York State Department of Transportation. Annual Average Daily Traffic, GIS Files. Accessed June 2021 at http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1282
[20] U.S. Department of Transportation, Bureau of Transportation Statistics, National Household Travel Survey. 2017. Accessed June, 2021 at https://nhts.ornl.gov/downloads
[21] The percentage traffic counts by vehicle type are not provided for all road segments. For these records, the percent distribution of AADT by vehicle type is assumed to be the same as the average of roadways of the same type. To calculate these averages, the records must first be categorized into MOVES roadway types with null values removed. Then an average value, weighted by length of road segment, can be calculated.
[22] U.S. Department of Transportation, Federal highway Administration. Traffic Data Computation Method Pocket Guide. Publication No. FHWA-PL-18-027 August 2018

be consistent for all hours of day. Another option would be to model different speeds for peak vs non-peak hours, rather than estimating for each hour of day, if data is available.

The MOVES model recommends using output data from TDF models used by MPOs. This data can provide estimates of average speed based on measured and modeled local travel patterns that could be categorized into necessary MOVES format. NYSDOT AADT data also provides estimates of the average speed of commercial trucks and passenger vehicles for NHS road segments. This information can be used with AADT values to measure the average speed for each vehicle type on all roadway segments.

The road types, expressed as NYSDOT functional class codes, are reclassified into MOVES road types using Table 2 in the reference tables. The NYSDOT AADT data provides an average speed based on modeled and measured traffic data for most road segments. Speeds are assumed to be consistent for all hours and days of the week. The vehicle hours traveled (*VHT*) for every vehicle type (V) and road type (R) is found by multiplying AADT by the length of each road segment (i) in miles (L) and then dividing by average speed (S) (see equation below).

Equation 2: $VHT_{V,R} = \frac{AADT_i * L_i}{S_i}$

AADT values for each vehicle type can be calculated using the percent of AADT attributed to each vehicle type in the NYS DOT AADT data (repeating methods described in Vehicle Type VMT). These AADT values for each vehicle type are entered into the equation above to find VHT for each MOVES vehicle type for every road segment. Each road segment is classified by average speed according to the speed bins used in MOVES. The total VHT for each road type and vehicle type is found and used to find the percentage of VHT in each average speed category for every road-vehicle type set. [23] This process yields the percent of time travelling in each speed bin by type of vehicle and road that can be entered into the MOVES3 CRM interface.

Meteorology

Emission rates of vehicles varies by temperature and humidity. MOVES provides default measures using ten-year averages of temperature and humidity by county. Users can output these data using the CRM tool and input it back into the system (see EPA's County Inventory Module tutorial in the resources).

Source Type Population

The NYS DMV makes vehicle registration data publicly available that can provide an estimate of the number of vehicles in a county. This data lists registrations by a vehicle typology that can be linked to the MOVES vehicle types by using Table 1 in the reference tables.[24] The data is first filtered to find active registrations issued in the last three years. This gives the input for MOVES source type population.

Age Distribution

The age of vehicles is a large determinant of emissions, as newer models are generally more efficient. NYS DMV Registration data provides the model year of vehicles and can be used to find the age distribution of vehicles for counties in NYS. MOVES has 31 separate age categories for each year from 0-

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[23] To expedite entering these values into the spreadsheet, a coding system and reference table with the average speed for each roadway/vehicle type combination using the associated MOVES codes can be used to fill in values for all time periods using spreadsheet software (such as a lookup function in Excel, which is provided as a resource.

[24] The resources include tables describing the body style and registration type codes used by the NYS DMV Registration data - https://buffalo.box.com/s/7qkhl5rw7hjd2vfto94srz0cizdfydhu

29 years and all cars 30 years or older. The number of cars with active registrations by model year is calculated and mapped to the MOVES age categories and entered into the MOVES CRM interface.

Road Type Distribution

Emission rates vary on different types of roads, so MOVES requires county-level VMT data by road type, which is to be entered separately for each vehicle type. VMT data by road and vehicle type may be obtained from TDF model outputs. The NYS DOT AADT data used to estimate VMT by vehicle type can also be used to estimate the percentage of VMT on each road type by vehicle type. The AADT data includes separate records for each street segment that can be extracted by county using FIPS codes and categorized by the MOVES roadway types using NYS DOT's functional class codes (see Table 2 in the reference tables). The VMT estimates by vehicle type (page 5) are summed for each road type and used to find the percentage of VMT by road type for each type of vehicle in the county of study.

Fuel

Different fuels used to power vehicles, from diesel, to gas, to electric, have different emissions rates. The type of fuels used depends on the mix of vehicles in the county, so MOVES requires local data on the mix of fuels used in the county of study. County data on fuel mix is a default output of MOVES that can be entered using the CRM interface (see EPA's County Inventory Module tutorial in the resources).

I/M Programs

Metropolitan regions are subject to evaluation through an inspection and maintenance (I/M) program administered by EPA to identify high-emitting vehicles in need of repairs to improve air quality. If a region has an active I/M program, related information should be entered into MOVES. The Buffalo Niagara region does not currently have an active I/M program so this option was skipped for this study.

Optional county-level data

The users also have the ability to provide detailed county-level data on vehicle starts, hoteling (or overnight idling of commercial trucks), and the fraction of highway miles that exist on on- and off-ramps. The national defaults are assumed for these inputs as the local data is often difficult to obtain.

Before executing the model, the MOVES run specifications (.mrs) file should be saved. This file can be reopened and used to re-run the model with a new estimate of VMT under an EMM replacement scenario. The model is run for an annual time period and the output emissions are broken down by vehicle type. After running the model, MOVES3 allows you to save outputs as ".TAB" files that can be opened in MS Excel. Examples of the run specifications and output files are provided in the resources. This process is repeated for all counties in a region separately and added together. The emissions can be used to find local emission rates by dividing the total emissions by distance travelled for each mode.

3.2 ESTIMATING VEHICLE MILES TRAVELLED REPLACED BY EMM

An estimate of the annual VMT replaced by EMM is the key input needed to estimate the GHG impacts of EMM. This requires estimating the number of individuals who are likely to use EMM devices, the extent of their VMT that would be replaced by EMM. The research team and SMI developed a survey for an e-bike shared system pilot program that can be used to estimate this information.[25] The survey data

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[25] The resource folder includes the SMI e-bike pilot program survey questionnaire, along with alternative methods to estimate these inputs using a more detailed survey questionnaire. (https://buffalo.box.com/s/7qkhl5rw7hjd2vfto94srz0cizdfydhu)

can be used with existing data on regional trip patterns to approximate the annual VMT replaced by EMM. This reduced VMT amount can be applied to the MOVES3 model in order to provide an estimate the impacts of EMM on GHG emissions.

3.2.1 The percentage of the population who are likely to use EMM

Survey questions asking “Would you use e-bikes or e-scooters in a shared system?” and “How much would you pay to buy an e-bike/scooter?” can be used to estimate the percentage of the regional population who may use EMM. Respondents who indicate they would participate in an E-bike share or E-scooter share, or would be willing to purchase a scooter for $2,000 or more, are assumed to be EMM users. Survey respondents are assumed to be representative of the vehicle driving population, so the percentage of respondents who would use an EMM device as indicated by their responses to these questions is taken as the share of the regional population that would use EMM. The average percentage of trips that would be replaced among this group, by mode, is then calculated using the methods below.

3.2.2 The share of trips replaced by EMM

The survey asks the percentage of overall trips that respondents would likely to take using EMM device separately (“What percentage of your typical trips would you be willing to take by e-bike?” and “What percentage… by e-scooter?”). These questions offer a simplified, but reasonable way of estimating the share of trips that could be replaced by EMM devices. This approach can also help increase survey responses by shortening the time to complete the survey compared to questions asking more detail on the prevailing trip types, modes, and distances that would be replaced by EMM. The average of the responses to each of these questions are used to model the proportion of trips replaced by each device which can be analyzed for further interpretation of the combined GHG impacts of EMM.

3.2.3 The distance of trips replaced by EMM

Previous surveys have shown EMM to be more commonly used for shorter distance trips. [26] Therefore the methods applied here assume that EMM replaces the trips of shortest distance. This helps produce a conservative estimate of EMM replacement of vehicle trips, rather than assuming EMM would replace longer distance trips that may be more likely to be taken by vehicles.

The average percentage of overall trips replaced by EMM calculated in the previous step is assumed to represent the shortest percentile of trips distributed by distance. The VMT replaced by EMM is measured as the aggregate distance of the shortest trips within this percentile of trips sorted by distance. For example, if survey respondents indicate that they would replace 50% of trips, it is assumed that the shortest 50% of trips would be replaced by EMM. The distance of trips within the shortest 50% of trips in the region can be estimated using the NHTS data.

Trips can be sorted by distance using data on local trip patterns from the National Household Transportation Survey (NHTS) completed by the US Department of Transportation’s (DOT) Bureau of transportation Statistics (BTS) in 2017. The US DOT NHTS asked respondents to provide the mode, time,

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[26] Wolf, A. and Seebauer, S. “Technology adoption of electric bicycles: A survey among early adopters” Transportation Research Part A 69 (2014) 196–21; Bundesamt für Umwelt, Wald und Landschaft (BUWAL), 2004. Electric two-wheelers: Effects on mobility behavior. Environmental Materials No. 173. Air, Bern; Lopez, Angel J., Paola Astegiano, Sidharta Gautama, Daniel Ochoa, Chris M.J. Tampère, and Carolien Beckx. 2017. "Unveiling E-Bike Potential for Commuting Trips from GPS Traces" ISPRS International Journal of Geo-Information 6, no. 7: 190. https://doi.org/10.3390/ijgi6070190

distance and other details on individual trips taken over multiple days in 2016. Microdata trip records that include geographic identifiers can be used to find the distribution of trips by distance for states and large metropolitan areas, including Buffalo and Rochester.

To estimate the VMT replaced by EMM, the NHTS survey is used to find the percentile distribution of all trips in the region by distance. The NHTS microdata records can be sorted by distance and used to find the cumulative count of all trips and trip miles within each percentile. A table can be produced to give the percentage of cumulative trip mileage within each tenth percentile of trip count (see the resources).

3.2.4 The mode of trips replaced by EMM

EMM devices have lower GHG emissions than passenger cars, but are not emissions free like walking or using a standard bicycle, so the mode of travel that EMM trips would replace is a critical parameter to model GHG impacts of EMM. Some surveys have found that EMM trips are more likely to replace trips taken by walking or regular bicycle than by vehicle. A 2018 survey of e-scooter pilot program participants in Portland found that 34% of e-scooter trips replaced car trips, but even more (42%) replaced walking or bicycle trips.[27] A similar survey of a shared system in Denver found that 32% of e-scooter trips replaced a vehicle trip, but 57% replaced a bicycle or walking trip.[28] Conversely, a 2018 survey of North American e-bike users showed that most (62%) of e-bike trips would have otherwise been made by automobile.[29]

As the emissions impacts of EMM greatly depend on the type of vehicles and trips being replaced, additional survey questions can be used to discern more details on the mode of trips that would be replaced by EMM. The SMI pilot program survey does not ask respondents for details on alternative travel modes, or the type of trips replaced by EMM, but alternative methods utilizing a longer form of the survey that provides details on the mode of trips replaced by EMM are provided in the resources.

The methods applied here assume that EMM will replace the primary mode of travel that respondents indicate on the SMI pilot program survey. Survey results can be segmented by primary mode (drivers, walk/bike, public transit) to estimate the percentage of trips replaced by EMM for each mode using the methods outlined in the previous sections.

3.2.5 Estimating annual miles travelled by vehicle type due to EMM replacing existing trips

The research team created an excel spreadsheet tool provided in the resources ("EMM Impacts on VMT and GHG Calculation") that can be used to calculate the reduced VMT for each MOVES vehicle type and the emissions induced by EMM devices. The sheet prompts users to enter: (1) the percentage of people who would use EMM by mode (section 3.2.1), (2) the percentage of trips replaced by EMM by mode (3.2.2), (3) the baseline VMT by vehicle type (section 3.1.1), (4) the total emissions by vehicle type from the MOVES3 model outputs (sections 3.1.1 and 3.2.6), (5) the emissions rate for EMM devices (section 3.3.2), and (6) the percent of regional trip miles traveled by walking or bicycling (3.3.1). The "EMM Impacts" tool uses these inputs to calculate a new VMT for each vehicle type using the equation below.

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[27] Portland Bureau of Transportation. 2018 E-Scooter Findings Report.

[28] Denver City Council. March 2019. "Electric Scooter Data and Survey Results" Accessed July 2021 at https://www.denvergov.org/content/denvergov/en/denver-city-council/council-members/at-large-2/news/2019/electric-scooter-data---survey-results-.html

[29] MacArthur, J., Harpool, M., Scheppke, D., Cherry, C., 2018. A North American Survey of Electric Bicycle Owners. Transportation Research and Education Center.

$$\textbf{\textit{Equation 3:}}\ M' = M - (M * (P * T * (1 - W))$$

Where *M'* is the new estimate of annual VMT for each vehicle type, *M* is the initial estimate of VMT used in the baseline scenario (section 3.1.1), *P* is the estimated percent of the population who use EMM (section 3.2.1), *T* is the percent of trip miles that EMM users would take by EMM (sections 3.2.2 and 3.2.3), and *W* is the percent of EMM trip miles that would replace walking or bicycle trips (section 3.3).

This equation is applied to respondents whose primary mode is driving a car, truck, or van, as EMM trips would reduce VMT based on the percentage of people and trips who would replace vehicle trips with EMM. For those who use public transportation as their primary mode, the trip miles replaced by EMM are not subtracted from the MOVES3 input, assuming the public bus routes and miles traveled would not be altered by EMM use. VMT for commercial trucks and motorcycles, which are not included as a primary mode option in the survey, are assumed to be unaltered by EMM usage patterns.

3.2.6 Running MOVES3 with an estimate of VMT under an EMM replacement scenario

The percentage of trips replaced by EMM along with the percentage of the population that would use EMM and the prevailing VMT for each vehicle type can be applied to Equation 3. This will yield annual VMT values by vehicle type under an EMM replacement scenario that can be used as MOVES3 inputs. The calculation can be performed using the "EMM Impacts" excel tool. With the VMT that would be replaced by EMM calculated, the EPA MOVES3 model can be run again with the reduced VMT to estimate the total vehicle GHG emissions under a scenario where EMM use replaces vehicles. The annual VMT by vehicle type is the only piece of data that will be altered to estimate the GHG impacts of EMM. Other model inputs, including the age of vehicles and speeds are assumed to be the same after replacing vehicle trips with EMM.

3.3 ESTIMATING CHANGE IN GHG EMISSIONS DUE TO EMM USE AND TRIP REPLACEMENT

The output of the second run of the MOVES3 software provides an estimate of annual GHG emissions from reduced vehicle travel due to EMM replacing vehicle trips. However, EMM usage would also induce GHG emissions, as EMM devices consume electricity for battery charging and shared system operations. EMM devices in shared systems may generate added emissions as additional vehicles are used to collect and distribute dockless EMM devices. Emissions resulting from new EMM travel that replaces each travel mode must be added to the model to calculate the net change in GHG emissions due to EMM.

3.3.1 Estimating the miles traveled by EMM due to EMM replacement of each mode of travel

Since vehicle drivers and public transit riders also walk or bike for a certain percentage of trips, these trips may also be substituted by EMM and also produce GHG emissions. The NHTS data is used to estimate the percentage of trips taken by walking or biking in the region (included in the resources). This percent of miles traveled by walking/bicycling is omitted from the estimate of reduced VMT due to EMM replacing vehicle trips (Equation 3). However, the emissions induced by this EMM use must be factored in the calculation of net GHG emissions. The VMT replaced by EMM are found by subtracting the estimate of reduced VMT under an EMM replacement scenario (Equation 3) from the baseline estimate of VMT by vehicle type (section 3.1.1).

For respondents who walk, bike or take transit as their primary mode, the estimated miles traveled by EMM is added to GHG emissions. To estimate the miles travelled by walking or bicycling in the region, the NHTS data is used to find the cumulative miles of walking and bicycling trips (included in the resources). This value can be applied to Equation 4 to estimate the GHG impacts of EMM trips replacing walking/bicycling trips. Where MT_E is the estimate of annual miles traveled by EMM, M_i is the initial estimate of miles travelled by walking/bicycling found from the NHTS data, P is the estimated percentage of the walking/bicycling population who would use EMM from survey responses, and T is the percentage of trip miles that EMM users would take by EMM from survey responses. Similarly, EMM miles traveled by public transportation riders is estimated using Equation 4, where M_i would be the existing miles traveled by public transportation used in the baseline model (section 3.1.1), and P and T are the percentage of people and trip miles that transit users replace using EMM, respectively.

Equation 4: $MT_E = M_i * P * T$

3.3.2 Estimating GHG emissions rates of EMM based on previous studies

GHG emissions from EMM are estimated by multiplying the emissions rates (CO_2-eq/mile) of EMM by the annual miles traveled by EMM, including the VMT replaced by EMM and the estimate of existing bicycle, walking and transit miles traveled that would be replaced by EMM. However, there are wide-ranging estimates of GHG emission rates for EMM, which can vary by device type, geographic region, and usage type (i.e., whether they are privately owned or used in a shared systems).

The emission rates per mile depend heavily on the lifespan of the e-bike and the type of battery (lead acid or lithium ion). As the price of lithium ion batteries is expected to decrease, sales of e-bikes powered by lithium batteries are projected to grow.[30] These batteries last longer and can be used for longer durations and distances, which would lower emission rates. The emissions rates of EMM varies by geographic region based on the mix of energy sources used in the electric grid. MacQueen, MacArthur and Cherry estimate the e-bike emission rates in Upstate NY to be 2.2 CO_2-eq/mile. [31]

The manner in which EMM devices are deployed in shared systems can substantially impact emission rates. A recent paper found that the GHG emission rates of e-scooters used in a dockless system were about half that of automobiles, or 202 CO2eq/mile.[32] This study limited the lifespan of EMM device to two years, and this relatively short lifespan increased emission rates. The study found that the manufacturing of EMM devices accounted for 50% of per mile emissions and 43% of emissions in the shared system came from the vehicle travel needed to pick up and distribute EMM devices to docking stations. Only 4.7% of e-scooter emissions were estimated to be from battery charging. The study suggests that efficient operations of shared systems could markedly reduce per mile emissions of shared EMM devices. For instance, using high efficiency vehicles to collect shared devices could reduce emission rates for shared EMM devices by 50%.[33] Other scenarios that could reduce EMM device emissions include, extending life spans of devices, using devices with removable batteries, limiting the distances needed to collect dockless devices, and lowering the frequency of EMM device collection.

[30] E-Bike Market by Class (Class-I, II & III), Battery (Li-Ion, Li-Ion Polymer, Lead Acid, Other), Motor (Mid, Hub), Mode (Throttle, Pedal Assist), Usage (Mountain/Trekking, City/Urban, Cargo), Speed (<25 & 25-45 kmph) and Region - Global Forecast to 2027. Dec 2020 | Report Code: AT 6958. Accessed Aug., 2021 at https://www.marketsandmarkets.com/Market-Reports/electric-bike-market-110827400.html

[31] McQueen, MacArthur, and Cherry. 2019. "The E-Bike Potential: Estimating the Effect of E-bikes On Person Miles Travelled and Greenhouse Gas Emissions." White Paper. Transportation Research and Education Center.

[32] Hollingsworth, J. Copeland, B. & Johnson, J. (2019). Are e-scooters polluters? The environmental impacts of shared dockless electric scooters. Environmental Research Letters. 14. 084031. 10.1088/1748-9326/ab2da8.

[33] *Ibid.*

Due to the wide discrepancies in estimates of EMM GHG emissions rates, the methods used here can be adjusted for different emissions rates of EMM. To produce more accurate estimates of EMM device emission rates, it would be helpful to collect precise data on the local energy supply, the life span of EMM devices, the battery type used, the energy consumed in manufacturing process and supply chain of EMM devices, the VMT needed to collect and distribute dockless devices, and the emissions rate of the vehicles used for shared device collection.

3.3.3 Estimating the GHG emissions due to EMM replacement

The GHG emission rates for EMM can be multiplied by the estimated miles traveled by EMM for each mode to approximate the GHG emissions induced by EMM replacing each mode of travel. These values can be added to the estimated vehicular GHG impacts of each mode under an EMM replacement to find the net vehicle emissions after EMM replacement. Subtracting this sum from the initial baseline estimate of annual GHG emissions of vehicles in the region provides an estimate of the GHG impacts of EMM. This process is summarized in the equation below.

Equation 5: $\Delta_e = e_i - e_n + e_e$

Where Δ_e is the change in emissions resulting from EMM replacement of vehicles, e_i is the initial baseline estimate of motor vehicle GHG emissions (output of step 1), e_n is the estimate of motor vehicle emissions under a potential EMM replacement scenario (output of step 3), and e_e is the estimate of GHG emissions induced by EMM devices.

3.4 DEMONSTRATION OF METHODS

The Buffalo Niagara metropolitan region, consisting of Erie and Niagara counties is used as a study area to demonstrate how to perform these methods. This area comprises SMI's service area for the EMM shared system pilot program associated with the survey. The methods outlined previously are applied to this study area and step-by-step results of the process are described below. This exercise is a demonstration of methods and not a formal academic study as survey responses are limited and preliminary. The resulting emission impacts of EMM should be interpreted with caution.

3.4.1 Modeling current vehicle emissions in Buffalo Niagara using EPA MOVES3

The county level scenario is run separately for both Erie and Niagara counties and the results are summed to yield a regional total. Using the methods described in section 3.1.1, the NYSDMV vehicle registration data is used to derive the age distribution and vehicle source type population and the AADT from the NYS DOT is used to find the VMT by vehicle type, average speed distribution, and the road type distribution. The MOVES3 defaults are used for fuel source and meteorology. The sources used for each MOVES3 input are summarized in Table 3 of the reference tables.

The outcome of these processes for both Erie and Niagara counties are used as inputs into the MOVES3 model and are included in the resources. The resulting estimate of baseline VMT emissions by vehicle type is shown below.

Figure 1: Baseline Annual VMT Estimates (calculated from NYSDOT AADT Data, 2019)

	Baseline Annual VMT		
Vehicle Type	**Erie County**	**Niagara County**	**Buffalo Niagara**
Motorcycles	44,337	15,134	59,470
Light Duty Vehicles	22,247,782	3,297,086	25,544,867
Buses	158,861	20,859	179,720
Single Unit Trucks	1,174,898	209,130	1,384,027
Combination Trucks	1,212,779	130,447	1,343,226
TOTAL	24,838,656	3,672,655	28,511,311

The MOVES3 Model is run using the baseline VMT values above and the input tables included in the resources. The output estimate of current annual GHG emissions for vehicles in Buffalo Niagara is below.

Figure 2: Baseline Annual Vehicle GHG Emissions (g CO_2-eq) (MOVES3 baseline model output)

	Baseline Annual Vehicular GHG Emissions (g CO_2-eq)		
Vehicle Type	**Erie County**	**Niagara County**	**Buffalo Niagara Region**
Motorcycles	160,557,578	58,455,889	219,013,467
Light Duty Vehicles	146,358,621,712	34,708,969,236	181,067,590,948
Buses	446,641,726	147,633,894	594,275,620
Single Unit Trucks	756,046,692	142,137,506	898,184,198
Combination Trucks	2,105,284,016	220,937,350	2,326,221,366
TOTAL	149,827,151,724	35,278,133,875	185,105,285,599

3.4.2 Estimating VMT replaced by EMM in Buffalo Niagara

The percentage of the population who are likely to use EMM and the share of trips of each mode that EMM users replace by EMM are required inputs to model the VMT replaced by EMM in Buffalo Niagara. These data points are estimated using the SMI pilot program survey responses according to the methods described in section 3.2. An analysis of survey responses to find these inputs is included in the resources.

The “EMM Impacts on VMT Calculator” tool can be used to estimate the percentage of trip miles replaced by EMM per mode based on the percentage of trips replaced by mode, as described in section 3.2.3. For example, survey respondents who drive a car as their primary travel mode indicated they would use EMM for 50.6% of trips, on average. Based on NHTS survey responses 50.6% of trips in the

Buffalo Niagara region are shorter than 3.1 miles, and trips of 3.1 miles or less account for about 8.7% of all trip miles. Therefore, it is assumed that 8.7% of EMM users' trip miles would be replaced by EMM. Modes unaffected by EMM travel, or excluded from the survey responses (i.e., commercial trucks and motorcycles) are ignored in the calculation. The resulting estimates of EMM usage based on the survey are shown in the table below.

Figure 3: Variables to Estimate EMM Trip Replacement by Mode from SMI E-bike Pilot Program Survey

	% Population Using EMM	**% Trips Replaced by EMM**	**% of Trip Miles Replaced by EMM**
Light Duty Vehicles	89%	50.6%	8.8%
Buses	100%	91%	45.8%
Walk/Bike	90%	61.36%	13.6%

n= 105

To estimate the VMT replaced by EMM for each vehicle type in Buffalo Niagara, the baseline VMT by vehicle type (section 3.1.1) is applied to Equation 3 using methods described in section 3.2.5. This process can be carried out by providing the required inputs in the EMM impacts calculation tool for each county in the region. The reduced estimates of VMT by vehicle type after EMM replacement are below.

Figure 4: Annual VMT Estimates after EMM Replacement (baseline VMT adjusted by SMI survey data)

	VMT After EMM Replacement		
Vehicle Type	**Erie County**	**Niagara County**	**Buffalo Niagara**
Motorcycles	44,337	15,134	59,470
Light Duty Vehicles	20,521,582	3,041,266	23,562,847
Buses	158,861	20,859	179.720
Single Unit Trucks	1,174,898	209,130	1,384,027
Combination Trucks	1,212,779	130,447	1,343,226
TOTAL	23,112,456	3,416,835	26,529,291

The MOVES3 model is then used to estimate the vehicle GHG emissions after EMM replacement by applying the estimates of reduced VMT from Figure 4. The run specifications used in the baseline model are opened and the VMT is adjusted to account for the estimate of VMT replaced by EMM. The MOVES3 model output of annual emissions by vehicle type under an EMM replacement scenario are below.

Figure 5: Annual Vehicle GHG Emissions After EMM Replacement (g CO_2-eq) (MOVES3 model output)

	Vehicular GHG Emissions After EMM Replacement (g CO_2-eq)		
Vehicle Type	**Erie County**	**Niagara County**	**Buffalo Niagara**
Motorcycles	160,557,578	58,455,889	219,013,467

Light Duty Vehicles	145,735,611,040	34,617,179,234	180,352,790,274
Buses	446,641,726	147,633,894	594,275,620
Single Unit Trucks	756,046,692	142,137,506	898,184,198
Combination Trucks	2,105,284,016	220,937,350	2,326,221,366
TOTAL	149,204,141,052	35,186,343,873	184,390,484,925

3.4.3 Estimating change in GHG emissions due to EMM use in Buffalo Niagara

Using the methods outlined in section 3.3.1, the GHG emissions induced by EMM are estimated by multiplying the GHG emission rates for EMM by the EMM trip miles that replace each travel mode. As the SMI pilot survey was used for an e-bike pilot program, the emission rate for e-bikes in the Upstate NY of 2.2 CO_2-eq/mi[34] estimated by McQueen, MacArthur, and Cherry is used as the EMM emission rate. This calculation can be carried out using the EMM Impacts tool (results below).

Figure 6: Estimated Annual Miles Traveled by EMM and GHG Emissions Induced by EMM (g CO_2-eq)

	Miles Traveled by EMM due to EMM Replacement			***GHG Emissions Induced by EMM (g CO_2-eq)***		
Vehicle Type	**Erie County**	**Niagara County**	**Buffalo Niagara**	**Erie County**	**Niagara County**	**Buffalo Niagara**
Light Duty Vehicles	1,726,200	255,820	1,982,020	3,821,807	566,386	4,388,192
Buses	86,836	11,402	98,238	192,255	25,244	217,499
Walk/Bike	26,722	3,960	30,682	59,162	8,768	67,930
TOTAL	1,839,758	271,182	2,110,940	4,073,224	600,397	4,673,621

With the estimate of GHG emissions under an EMM replacement scenario complete, the "EMM Impacts on VMT Calculator" can be used to estimate the net change in emissions due to EMM use. The new estimate of emissions by vehicle type can be entered into the tool and the tool will calculate the difference between the emissions outputs produced by the baseline MOVES3 model and the EMM replacement scenario. The overall regional results are shown in the table below.

[34] McQueen, MacArthur, and Cherry. 2019. "The E-Bike Potential: Estimating the Effect of E-bikes On Person Miles Travelled and Greenhouse Gas Emissions." White Paper. Transportation Research and Education Center.

Figure 7: Estimate of EMM Impacts on Annual GHG Emissions for Buffalo Niagara Region (g CO_2-eq)

Vehicle Type	***Baseline Annual Vehicle GHG Emissions***	**Annual Vehicle GHG Emissions After EMM Replacement**	***Annual GHG Emissions Induced by EMM***	***Net Annual Vehicle GHG Emissions After EMM Replacement***	***Net Change in Annual GHG Emissions After EMM Replacement***
Motorcycles	219,013,467	219,013,467	-	219,013,467	-
Light Duty Vehicles	181,067,590,948	180,352,790,274	4,388,192	180,357,178,466	-710,412,482
Buses	594,275,620	594,275,620	217,499	594,344,438	68,818
Single Unit Trucks	898,184,198	898,184,198	-	898,184,198	-
Combination Trucks	2,326,221,366	2,326,221,366		2,326,221,366	-
Walk/Bike			67,930	67,930	67,930
TOTAL	**185,105,285,599**	**180,700,452,105**	**4,673,621**	**184,395,158,546**	**-710,275,733**

The results of this demonstration suggest that EMM replacement of other modes of travel would result in a net reduction of 710,275,733 g CO_2-eq in annual GHG emissions in the Buffalo Niagara region. This equates to a 0.4% reduction from baseline annual GHG emissions. The model shows a decrease in annual GHG emissions from vehicles of 714,800,674 g CO_2-eq, it also estimates that 4,673,621 g CO_2-eq would be induced by EMM. This is largely the result of the estimated 89% of drivers replacing 8.8% of VMT with EMM. While the reduction from baseline emissions is relatively minor in percentage terms (-0.4%), this amount of GHG is equal to the annual emissions from 154 passenger vehicles, or from the electricity consumed by 129 homes.[35]

4. INCORPORATING EMM INTO REGIONAL TRANSPORTATION MODELS

As EMM could generate additional environmental impacts by altering traffic patterns and congestion, supplemental information on potential EMM device usage can be useful in regional transportation models. After consultation with planners at the Greater Buffalo Niagara Regional Transportation Council (GBNTRC), the MPO for Buffalo Niagara, we determined supplemental data points that may assist regional planners and transportation engineers in further efforts to model the possible impacts of EMM on transportation and the environment. This includes: the number of people in the region who use EMM devices, whether owned or in a shared system; the maximum distance someone would typically travel

[35] US EPA, Greenhouse Gas Equivalencies Calculator. Accessed August 2019 at https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

by EMM; the traffic analysis zones (TAZ's) where EMMs could be used; and the costs of owning and using EMM. A combination of survey methods, public data, and research can be used to estimate these key pieces of information. The section below proposes various methods to derive these inputs that may help incorporate EMM into regional travel demand models and forecasts.

4.1 THE NUMBER OF EMM DEVICES OWNED OR RENTED IN THE REGION

The number of e-bicycles and e-scooters in a region, or the size of the local EMM fleet, is a basic input needed to estimate EMM impacts on traffic patterns using MPO models. This includes EMM devices that can be rented in shared systems, as well as personally-owned EMM devices. A survey of the local population, utilizing questions similar to those outlined on page 8, can be used to estimate the percentage of people who are likely to use EMM. In lieu of surveys, the EMM fleet can be approximated using information from shared system providers and estimates of local consumer spending.

The number of devices in a shared system can be gathered from shared system operators. Shared system operators may provide open access to this information or can be contacted to find the number of EMM devices in a shared system. Otherwise, third-party platforms, such as bikesharemap.com, provide open access to shared system data and maps that may be used to estimate the number of EMM devices in a shared system.

Estimating the number of personally-owned EMM devices in a county or region is challenging as consumer data on household ownership of e-bikes and e-scooters is not available at the state or local level. However, estimates of the number of e-bicycles and e-scooters sold throughout the US each year have been made in a variety of industry reports and market projections.[36] These annual sales totals can be used to estimate the total number of EMM devices currently owned in the US. Based on these recent market reports, an estimated 1.4 million e-bikes were purchased in the U.S. from 2018 to 2020. This number gives an estimate of the total number of e-bikes owned in the U.S.

ESRI Consumer Spending Data, which aggregates credit card spending and demographic data to estimate current and future spending patterns for different types of consumer goods, includes estimates of spending on bicycles at the state, county, and tract level.[37] These estimates can be used apportion the national total number of EMM devices sold to states and counties based on the spending of bicycles. For example, if a county accounts for 1% of all bike spending in the US, it is assumed to account for 1% of all EMM devices in the US. The consumer spending data is downloaded and the percentage of bicycle spending the county accounts for is multiplied by the number of e-bikes owned in the U.S. (1.4 million) to give an estimate of the number of e-bikes in every county in New York State. This information is included in the resource tables (https://buffalo.box.com/s/7qkhl5rw7hjd2vfto94srz0cizdfydhu).

[36] Statista, "Estimated sales of electric bicycles in the United States between 2012 and 2016." Retrieved June 2021 at www.statista.com/statistics/326124/us-sales-of-electric-bicycles/; Juiced Bikes, "E-Bike Facts and Statistics 2020." May 18, 2020. Retrieved June 2021 at https://www.juicedbikes.com/blogs/news/e-bike-facts-and-statistics; Wahba, Phil. "E-Bike Sales Are Putting a Charge in the Fortunes of Bikemakers." July 20, 2019. Accessed June 2021 at https://fortune.com/longform/ebike-sales-on-the-rise/; Light Electric Vehicle Association, "Micro-mobility Market Report 2019 – 2020 Winter / Spring." Retrieved June 2021 at https://levassociation.com/micro-mobility-market-report-2019-2020-winter-spring/; Glusac, E. "Farther, Faster and No Sweat: Bike-Sharing and the E-Bike." March 2, 2021. Retrieved June 2021 at https://www.nytimes.com/2021/03/02/travel/ebikes-bike-sharing-us.html

[37] ESRI 2021 Consumer Spending Data was accessed June 2021 via the ArcGIS Business Analyst Web App at https://bao.arcgis.com/esriBAO (subscription required).

By using total estimated bicycle related spending as a proxy for EMM device purchases, this method assumes that EMM spending is geographically distributed the same as spending on bicycles. The method also assumes that all recently sold EMM devices are still in operation and that each device belongs to a unique owner. Furthermore, much of this market data predates the adoption of EMM in NYS. Even with these limitations, this method provides a reasonable approach to roughly estimate the number of EMM devices owned in a region.

The number of vehicles owned in a region could also be estimated using survey methods. There was a survey of North American e-bike owners that could be leveraged for information.[38] A survey tracking travel patterns of e-bike users is currently underway which will provide valuable details on EMM travel patterns and ownership.[39] Additional questions in the alternate version of the survey used for this study asking whether respondents own an EMM device, can help estimate the number of EMM owners in a region.

4.2 THE MAXIMUM TRIP DISTANCE TRAVELLED BY EMM

An estimate of the maximum distance the average EMM user would be willing to travel on an EMM device may be necessary to model EMM trip patterns in TDF models. The maximum likely distance of an EMM trip can be estimated through surveys or quantitative estimates from publicly available data leveraging work previously described in this document (section 3.1). This estimate can be used to estimate inter-neighborhood travel, or which TAZs can be accessed by EMM by each TAZ in the region.

The pilot program survey can be used to estimate the maximum distance someone would travel by EMM by using the methods to model the percentage of VMT replaced by EMM. This involves taking the average of the responses given to the question "What percentage of your overall trips would you use EMM for?" And then using NHTS survey data to create a histogram of trip distance, and find the average distance of the trips that are found to be potentially replaced by EMM.

For example, survey respondents who drive a car as their primary travel mode indicated they would use EMM for 50.6% of trips, on average. Based on NHTS survey responses 50.6% of trips in the Buffalo Niagara region are shorter than 3.1 miles. Therefore, 3.1 miles is assumed to be the maximum distance respondents would travel by e-bike and this is used as the threshold for the service area analysis. As the number of trips that could be replaced by e-bike was higher than that of e-scooter (43%), e-bicycles are used to determine a conservative estimate of maximum distance travelled by EMM.

Survey questions can also ask, "How far would you be willing to ride an e-bike/e-scooter to make a typical trip (one way)?" This was asked in a previous version of the survey. Based on a limited set of responses, respondents are most likely to be willing to ride an e-bike for 45 minutes or more to make a typical tip, and 32% of respondents would be willing to ride an e-scooter 15 min or less. Usage

[38] MacArthur, John, Christopher Cherry, Michael Harpool and Daniel Scheppke. A North American Survey of Electric Bicycle Owners. NITC-RR-1041. Portland, OR: Transportation Research and Education Center (TREC), 2018. https://doi.org/10.15760/trec.197;

[39] Cherry, C., Gao, W., MacArthur, J., Azad, M. Yang, R., McQueen, M. ME-Bike Study, 2021.

information from shared system operators would lead to more accurate estimates of trip distances and potential travel patterns of EMM. These could also be estimated based on previous research.[40, 41, 42]

4.3 TRAFFIC ANALYSIS ZONES AND ROADWAYS WHERE EMM ARE TRIPS POSSIBLE

Determining the areas within a region where EMM trips are possible is another essential input to incorporate EMM devices into MPO TDF and travel models. Location shared system data that might be used to delineate traffic analysis zones (TAZs) that contain shared system stops. Location information on shared device docking stations can be gathered from shared system operators. Many operators and third-party platforms provide open access to data on the location of stops and devices in their shared system, through online maps or other platforms, including bikesharemap.com and the US Bureau of Transportation Statistics Intermodal Passenger Connectivity Database. Otherwise, shared system operators can be contacted in attempts to gather information on the number of EMM devices in their system, potentially along with usage patterns. Surveys, interactive maps, or crowdsourced information can be used as alternatives to determine the locations of EMM devices in shared systems.

Knowing the specific roadways, or types of roadways, that could accommodate EMM traffic is another valuable input for travel models. EMM devices would not be permitted or able to travel on expressways or highways, but could potentially be used on any arterial or local surface road. They may also travel on bicycle trails and multi-use recreational trails and prefer roadways with bicycle infrastructure

More detailed preferences on bicycle infrastructure needed to accommodate EMM can be gathered using surveys. Alternative surveys may ask, “In what street settings do you feel comfortable using an e-bike?” and showed photographs of local examples of separated and unseparated bike lanes, sidewalks, “sharrows”, and unmarked roadways. The information gathered from this question can be used to further determine the types of roadways where EMM trips are more likely. The preliminary survey results can yield some insight.

This information can be aggregated by TAZ to estimate the likelihood and TAZ travel within and between zones. It can be combined with estimates of EMM device ownership and maximum time/distance travelling on the roadway into a GIS network analysis to determine potential travel patterns between TAZs (i.e., determining which other TAZs that could be accessed by EMM devices from each TAZ).

The neighborhoods or TAZs where EMM trips would be made can also be approximated based on where EMM device owners are likely to be reside. This information could be gathered through survey information, by asking respondents’ ZIP code of home address. The ESRI consumer spending data, which is provided at the census tract level, can also be used to approximate where EMM trips would be made based on where EMM device owners are likely to be located.

A Network Analysis in GIS can be used along with an estimate of the maximum distance one would travel by EMM to determine which TAZs are accessible by EMM devices. The population centroid of each TAZ, found through the Mean Population tool in GIS, is used as the home destinations of the

[40] Portland Bureau of Transportation. 2018 E-Scooter Findings Report.
[41] Denver City Council. March 2019. Electric Scooter Data and Survey Results. Accessed July 2021 at https://www.denvergov.org/content/denvergov/en/denver-city-council/council-members/at-large-2/news/2019/electric-scooter-data---survey-results-.html
[42] MacArthur, J., Harpool, M., Scheppke, D., Cherry, C., 2018. A North American Survey of Electric Bicycle Owners. Transportation Research and Education Center.

Service Area. The extent of the service area is the maximum time one would travel by EMM, estimated from survey data and NHTS data (section 4.2). The road network for the analysis excludes highways and expressways and includes multi-use recreational trails. This analysis generates a GIS shapefile delineating the area that could potentially be reached from the population-weighted center of each TAZ within the maximum distance someone would travel via EMM. The result of this analysis for the TAZs within the Buffalo Niagara region is included in the resources.

4.4 THE COST TO USE EMM

The costs of operating EMM devices, both owned and shared, is another important input to factor for EMM in travel demand modeling. For shared system devices, this information can be gathered from the shared system operators themselves, or through a survey of shared system users. In the case of transportation libraries, which offers devices free of charge or for a low-cost subscription, the cost to the user likely negligible. Shared system operators typically charge subscription fees which can be used to calculate total costs on an annual basis, or per mile costs can be calculated given estimates, or system usage information on distances traveled by system users.

The costs of owning an EMM device include both the costs of purchasing and maintaining devices. Estimates of the average and range of costs for new e-bikes and e-scooters can be gathered through market research. Prices of EMM devices fluctuate. As technologies improve and the costs of production decline, especially battery technology, the average retail price of new models is expected to decline in the future. There are also estimates of the average cost to maintain EMM devices, related to repairs, new tires, battery replacements, and charging costs. Survey information can also be used to estimate EMM costs. The SMI pilot program survey asks respondents' how much they'd be willing to spend to purchase a new e-bicycle or e-scooter. This could be used to estimate purchase costs of the local population. Additional survey questions of current EMM owners can ask how much respondents typically spend on maintenance and repairs for their EMM devices.

Additional research on maintenance/total costs of e-bike ownership. Research by bicycle volt showed the average annual cost of maintaining an electric bike to be $318 for the first four years, and $518 for the next six years. [43] This includes the costs of charging, battery replacement, repairs, and parts. The annual costs depend heavily on the usage and lifespan of the device and its key components – including the battery, tires, brakes, safety equipment, and other features and accessories users may purchase.

[43] Bicycle Volt. Electric Bike Maintenance Cost. Accessed June 2021 at https://bicyclevolt.com/electric-bike-maintenance-cost/

Appendix C. University at Buffalo Research Institute Greenhouse Gas Emissions Projections Results

Informing Electric Micromobility Policy through Demonstrations and Planning

Shared Mobility, Inc.

Informing Electric Micromobility Policy through Demonstrations & Planning

NYSERDA PON 3833

[Report]

Projecting Environmental Impacts of E-bikes and E-scooters in Upstate New York

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Electric micromobility (EMM) is a significant element in our clean transportation future. EMM refers to personal mobility devices, most commonly electric bikes (e-bikes) and electric scooters (e-scooters). EMM devices propel or assist riders using a small, onboard electric motor. EMM is typically used to replace short trips (under 3 miles) that would otherwise utilize automobiles or public transportation, significantly reducing greenhouse gas emissions. However, long-term data does not exist for New York State since the public use of electric micromobility devices was only recently made legal in April 2020.

This study seeks to evaluate the amount of carbon emissions EMM can prevent by applying survey data from demonstration events and existing regional and state transportation data. Shared Mobility Inc. (SMI), with support from the New York State Energy Research and Development Authority (NYSERDA), has sought to understand the environmental impact electric micromobility can have. EMM has the potential to offset carbon emissions by reducing the number of internal combustion engine vehicle (ICEV) trips, particularly short trips in urban areas, leading to the reduction in greenhouse gas (GHG) emissions from the state's transportation sector.

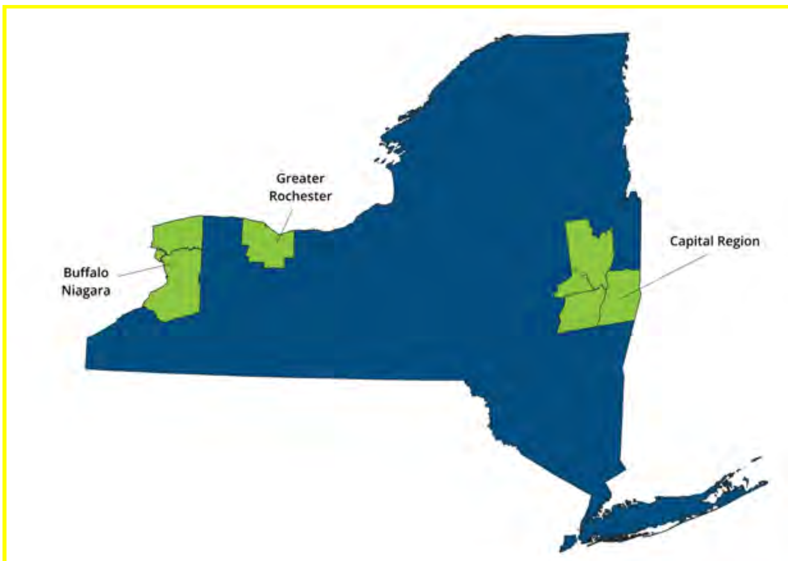
To best measure the impacts of EMM in Upstate New York, the University at Buffalo Regional Institute (UBRI) research team developed a methodology for this project. UBRI's methods document, Methods to Estimate Environmental Impacts of E-bikes and E-scooters in Upstate New York, provides a framework to obtain data sources and demonstrate the potential environmental impacts of **private or self-owned EMM device usage** in three metropolitan areas: Buffalo-Niagara, Greater Rochester, and the Capital Region.

Methodology

In June 2020, SMI began working with UBRI to develop a joint research and evaluation process that sought to use real-world feedback from potential EMM users to inform mode-shift projections. Since New York State made EMM legal only weeks before the project's kick-off, SMI and UBRI sought to understand the potential popularity of EMM devices. Additionally, the project aimed to understand the degree to which individuals would shift their travel mode to an EMM alternative if given the opportunity.

The study focused on the Buffalo-Niagara, the Capital Region, and Greater Rochester metropolitan areas, the three largest urban cores in Upstate New York. Each region was grouped based on the MPO's jurisdiction. As seen in image one, Buffalo-Niagara comprises Erie and Niagara. The Capital Region includes Albany, Schenectady, Rensselaer, and Saratoga counties. Monroe County is the focus of the Greater Rochester metropolitan area as it contains the core urban area.

Figure 1



UBRI's task in this project was to create a methodology that would be able to project total EMM usage and net-positive environmental impacts. SMI chose UBRI to develop this report because of its established reputation and expertise in research and regional work. The methodology is four subsections:

1. Modeling Current Vehicle Emissions Using EPA MOVES3
2. Estimating Vehicle Miles Traveled Replaced By EMM
3. Estimating Change in GHG Emissions Due to EMM use and Trip Replacement
4. Demonstration of Methods

The above sections provide a framework for using the MOVES3 software, input variables required for accurate results, variables to consider when estimating the trips being replaced, and how to calculate the change in emissions. UBRI points out valuable aspects for SMI to

consider in this methodology, such as trips that replace car trips versus trips that replace walking or other modes.
SMI and UBRI then developed short and long-form surveys to be administered at EMM demonstrations. The surveys were made to gather data to be used as inputs to MOVES3 for accurate local estimates. SMI and partners across Upstate New York hosted these demonstrations. Demonstrations ranged from small group meetings to large-scale public events. SMI held 45 demonstrations over 2020-2022. In 2020 there were 21 demonstrations, 22 demonstrations in 2021, and two demonstrations in 2022. A total of 690 surveys were administered at 45 demonstrations throughout the project term. The surveys were administered digitally via QR codes, with paper options available for non-smartphone users. SMI prioritized these surveys so the results would represent real lived experiences.

Each survey version attempted to glean different but related points of information. The surveys were then collected after each demonstration, organized into spreadsheets, and analyzed to be used as variable inputs. Both short and long-form surveys can be found in this report's appendices.

To apply the data generated from surveys, UBRI's methodology employs Motor Vehicle Emission Simulator (MOVES3), a transportation emissions simulation software developed by the US Environmental Protection Agency (EPA). This program was chosen for the project because it is the most accurate tool available to make estimates and provide detailed data on greenhouse gas (GHG) emissions.

MOVES3 runs a simulation and creates estimates using public traffic data, transportation data, and the following inputs:

- Vehicle Miles Traveled (VMT)
- Average travel speeds
- Road-Type Distribution (Highway vs. local)
- Source-Type Population (Breakdown of all automobile types)
- Age Distribution (Breakdown of vehicle ages)
- Meteorology (default)
- Fuel data (default)

The SMI team used survey data to make inputs representing EMM usage and applied them proportionately across our focus regions to represent lived experiences. Instructed by UBRI's methodology, county-level data was collected from the NYS Department of Motor Vehicles (DMV), the Department of Transportation (DOT), and the US Bureau of Transportation Statistics' National Household Travel Survey (NHTS). The county-level data was first synthesized into inputs and simulated using the MOVES3 software for regional baseline emission estimates. The synthesized inputs were then adjusted for EMM usage and rerun through the simulation. The baseline and EMM usage data were extracted and reduced for the absolute difference in vehicle emissions from the simulation. After taking the difference from vehicle emissions, the outcomes were adjusted for the trips that EMMs replaced that users would have otherwise taken by foot or traditional bicycles.

A full copy of UBRI's methods document can be found in this report's appendices.

Findings

Based on demonstration survey data and local inputs, the MOVES3 software calculates that EMM would save the Buffalo-Niagara region 17,715 metric tons of carbon emissions. The impact grows in Rochester with a calculated savings of 55,635 metric tons and 94,929 metric tons in the Capital Region. The sum total of reduced emissions is 168,279 metric tons for New York State.

The graphics below show the three focus regions of Buffalo, Rochester, and the Capital Region and their respective potential for emission reductions. The equivalencies of greenhouse gasses exhibit the significant impact that automobiles and their fuel sources have on emissions rates. This includes cars removed from the road, money saved in not purchasing gasoline, barrels of oil not consumed, and the amount of New York-Los Angeles flights not taken. Additionally, Table 5 shows the equivalent impact of the amount of trees grown. Survey responses support that a conservative adoption of EMM among the studied regions has considerable potential for reducing cars on public roads and economic savings of fuel not consumed.

Table 1

Cars Removed from the Road		
	GHG Emissions prevented by using EMM (metric tons)	**Equivalent Amount of Cars**
Buffalo Niagara	17,715	3,818
Greater Rochester	55,635	11,990
Capital Region	94,929	20,459
Total	168,279	36,267

As seen in Table 1, replacing short trips with EMM would be equivalent to removing 3,818 cars from the road in Buffalo alone. The effect increases in Rochester and the Capital Region.

Table 2

Amount Saved not Purchasing Gasoline		
	GHG Emissions prevented by using EMM (metric tons)	**Equivalent Amount of $ saved**
Buffalo Niagara	17,715	$8,691,119
Greater Rochester	55,635	$27,294,704
Capital Region	94,929	$82,558,394
Total	168,279	$118,544,217

Table 2 shows that over one year at $4 a gallon, EMM replaced ICEV trips has an estimated economic savings of $118.5 million from the reduction of gasoline purchased.

Table 3

Barrels of oil consumed		
	GHG Emissions prevented by using EMM (metric tons)	**Equivalent number of barrels of oil consumed**
Buffalo Niagara	17,715	41,198
Greater Rochester	55,635	129,383
Capital Region	94,929	220,765
Total	168,279	391,347

Table 4

Roundtrip Flights from NYC to LA		
	GHG Emissions prevented by using EMM (metric tons)	**Equivalent number of roundtrip flights (Airbus A320)**
Buffalo Niagara	17,715	26,520
Greater Rochester	55,635	83,286
Capital Region	93,929	142,109
Total	167,279	250,418

Combined, regions noted in Upstate New York could prevent consuming over 391,000 barrels of oil a year and would avoid the equivalent of more than 251,000 roundtrip cross-country flights of greenhouse gasses through the project adoption of EMM.

Table 5

Trees Grown		
	GHG Emissions prevented by using EMM (metric tons)	**Equivalent Amount of 10-year old urban-environment trees**
Buffalo Niagara	17,715	295,252
Greater Rochester	55,635	927,248
Capital Region	94,929	2,804,650
Total	168,279	4,027,150

Employing EMM in place of vehicles in the study's focus regions alone could prevent more than 370 million pounds of greenhouse gasses that car trips would otherwise emit. As seen in Table 5, these emission reductions would have the same impact as planting over 2.8 million trees in one year. Additionally, it would be equivalent to having 58,228 tons of waste recycled instead of landfilled or having 45.7 windmills run for one year.

Conclusion

Personal adoption and use of EMM have a great potential to impact our environment positively. Using EMM to replace short-distance trips under 3 miles can considerably impact GHG emissions that contribute to climate change. Electrified transportation use is on the rise across all sectors, and SMI, in partnership with UBRI, sought to understand the true potential of EMM to help shape a greener future in New York State.

Survey results from demonstration events held across Upstate New York indicate that EMM could help prevent the release of up to 168,279 metric tons of carbon annually in the Buffalo Niagara, Capital Region, and Greater Rochester metropolitan areas. Surveying focused on demonstration participants' daily travel patterns and, following a chance to try out EMM devices, asked them to envision how they could use EMM to replace existing automobile trips.

While these results are incredibly promising, there is more work to be done. This study focuses on the private adoption of EMM, but EMM could achieve further carbon savings through developing, deploying, and expanding shared EMM programs across New York State. Further research is needed to evaluate these impacts while work on shared EMM programming is underway in communities statewide.

As we stand at the crossroads of climate change, we must find ways to reduce the overall environmental impact of our transportation systems. EMM provides a significant pathway, amongst many, to help reduce transportation-related GHG emissions. Investing in these mobility solutions can secure a cleaner and greener future for all.

Appendix D. Complete List of Electric Micromobility Demonstration Activities

Event name	Date	Location
University at Buffalo School of Planning demonstration	6/23/20	Hayes Hall, University at Buffalo South Campus
Seneca One staff demonstration	7/1/20	Seneca One Tower, Buffalo
City of Buffalo Office of Strategic Planning demo	7/2/20	Eugene V Debs Hall, Buffalo
City of Rochester staff demonstration	7/24/20	Rochester City Hall, Rochester
U.B. Regional Institute staff demonstration	7/31/20	Hayes Hall, University at Buffalo South Campus
NYS Assemblymember Sean Ryan Buffalo office staff demonstration	8/5/20	Bidwell Parkway, Buffalo
Village of Williamsville demonstration	8/11/20	Williamsville Village Hall, Williamsville
GObike staff demonstration	8/14/20	Bidwell Parkway, Buffalo
City of Niagara Falls demo	8/26/20	Niagara Falls City Hall, Niagara Falls
City of Buffalo Department of Public Works staff demonstration	8/27/20	Cathedral Park, Buffalo
Village of Hamburg staff demonstration	9/3/20	Bidwell Parkway, Buffalo
GBNRTC staff demonstration	9/10/20	Niagara Square, Buffalo
City of Buffalo stakeholder demonstration	9/16/20	Cathedral Park, Buffalo
Niagara River Greenway Grand Island demo	9/19/20	West River Parkway, Grand Island
Downtown Buffalo EMM public demonstration	9/22/20	Cathedral Park, Buffalo
Youngstown Greenway stakeholder e-bike ride	9/24/20	Village Center, Youngstown
Village of Hamburg stakeholder demonstration	9/29/20	Hamburg Village Hall, Hamburg
Niagara Falls Greenway stakeholder e-bike ride	10/1/20	Aquarium of Niagara, Niagara Falls
Lewiston Greenway stakeholder e-bike ride	10/7/20	Academy Park, Lewiston
Capital Region stakeholder demonstration	10/16/20	CDTA Maintenance Facilities, Albany
"B3" local working group demonstration	10/22/20	Roosevelt Plaza, Buffalo
Buffalo United Front staff demonstration	3/19/21	Innovation Center, Buffalo
EMM info meeting with ICF staff	3/21/21	Virtual meeting
University at Buffalo Graduate Planning Studio demonstration	3/27/21	SMI E-Bike Storage Facility, Buffalo
Douglas Development staff demonstration	4/6/21	Seneca One Tower, Buffalo
North Country stakeholder EMM info session	4/6/21	Virtual meeting
Greater Binghamton stakeholder EMM info session	4/6/21	Virtual meeting
PUSH Buffalo staff demonstration	4/13/21	PUSH H.Q., Buffalo

Event name	Date	Location
Create a Healthier Niagara Falls staff and stakeholders demonstration	4/26/21	SMI E-Bike Storage Facility, Buffalo
Clementine Gold Group staff demonstration	4/27/21	SMI E-Bike Storage Facility, Buffalo
City of Newburgh EMM info session	5/4/21	Virtual meeting
BNMC Open Streets event	5/21/21	Washington Street, Buffalo Niagara Medical Campus
Scajaquada Corridor Stakeholder demo	6/2/21	Innovation Center, Buffalo
Grant Street Open-Streets EMM demonstration	7/10/21	Grant Street, Buffalo
Slow Roll Buffalo demonstration	7/12/21	Groove Lounge, Buffalo
City of Buffalo EMM Policy discussion	8/12/21	Virtual meeting
Region Central stakeholder demonstration	8/12/21	Delaware Park, Buffalo
SkyRide 2021 public demonstration	8/15/21	Outer Harbor, Buffalo
NYS Senator Tim Kennedy EMM staff demonstration	9/10/21	Sen. Kennedy Buffalo Office
BNMC Electrification rodeo	9/25/21	Innovation Center, Buffalo
Greater Binghamton Stakeholder demonstration	10/5/21	Otsiningo Park, Binghamton
North Country Stakeholder demonstra	10/6/21	Fairfield Inn, Canton
Forest Avenue Open Streets public demonstration	5/14/22	Forest Avenue, Buffalo
Electrify Buffalo 2022 EMM public demonstration	9/24/22	Innovation Center, Buffalo

Appendix E. Complete List of Electric Micromobility Demonstration Survey Results

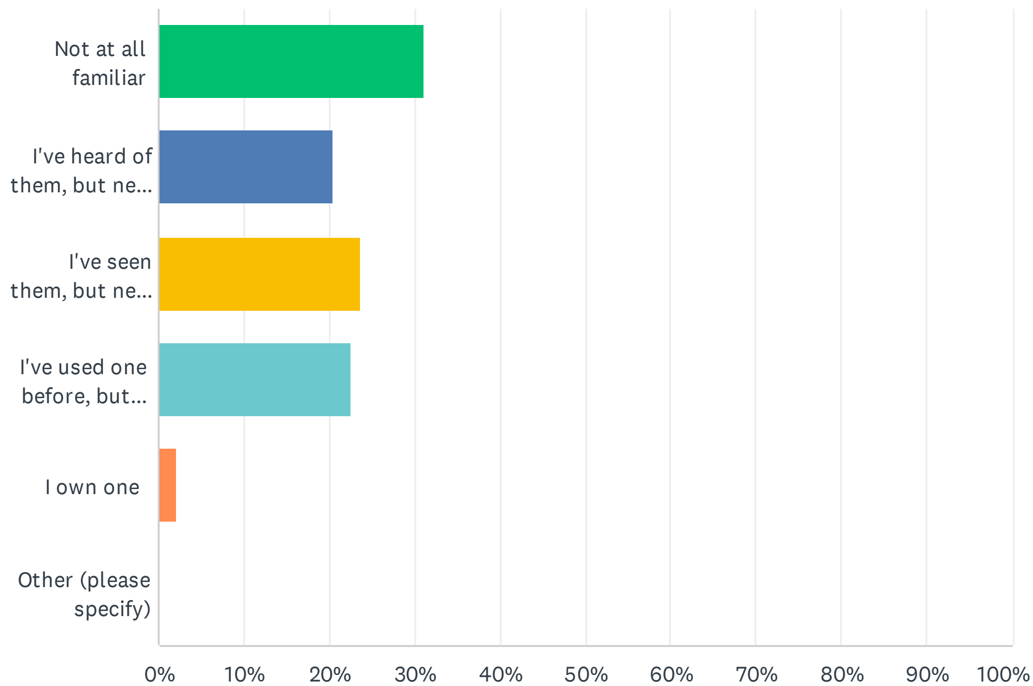
Appendix E

Complete List of Electric Micromobility Demonstration Survey Results

Shared Mobility Inc.

Q2 How familiar are you with e-bikes?

Answered: 93 Skipped: 1

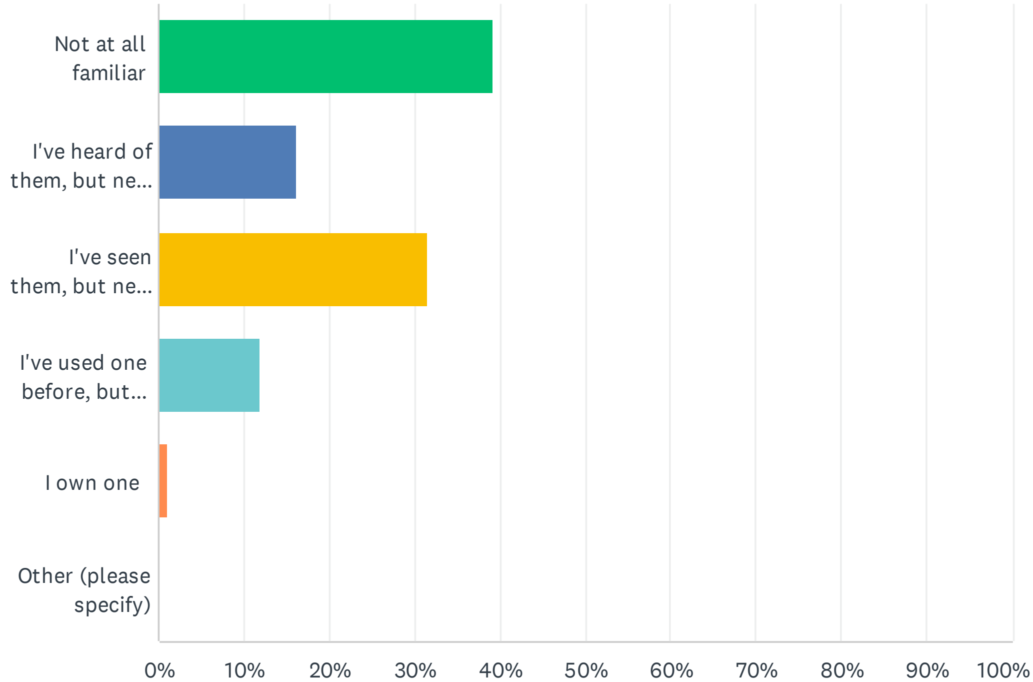


ANSWER CHOICES	RESPONSES	
Not at all familiar	31.18%	29
I've heard of them, but never seen or used one	20.43%	19
I've seen them, but never used one	23.66%	22
I've used one before, but don't own one	22.58%	21
I own one	2.15%	2
Other (please specify)	0.00%	0
TOTAL		93

#	OTHER (PLEASE SPECIFY)	DATE
	There are no responses.	

Q3 How familiar are you with e-scooters?

Answered: 92 Skipped: 2

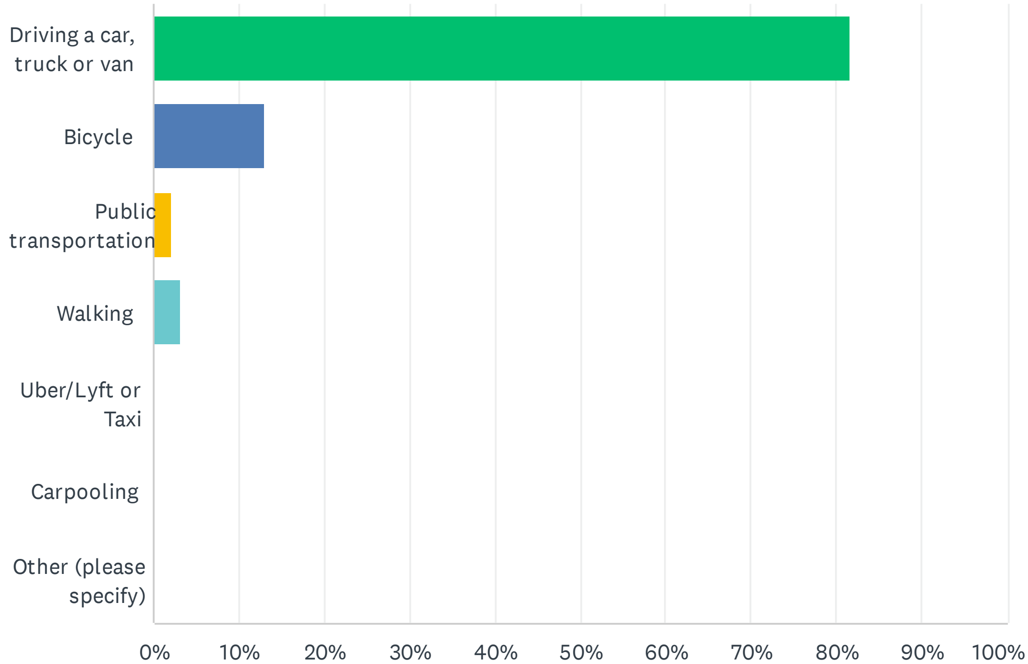


ANSWER CHOICES	RESPONSES	
Not at all familiar	39.13%	36
I've heard of them, but never seen or used one	16.30%	15
I've seen them, but never used one	31.52%	29
I've used one before, but don't own one	11.96%	11
I own one	1.09%	1
Other (please specify)	0.00%	0
TOTAL		92

#	OTHER (PLEASE SPECIFY)	DATE
	There are no responses.	

Q4 What is your primary mode of transportation?

Answered: 93 Skipped: 1

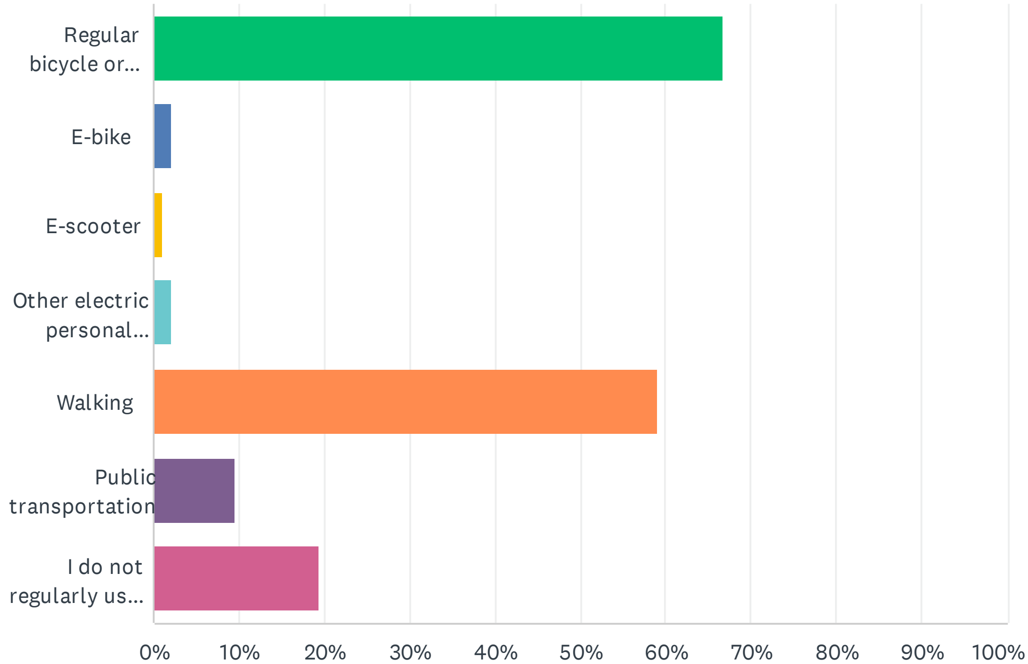


ANSWER CHOICES	RESPONSES	
Driving a car, truck or van	81.72%	76
Bicycle	12.90%	12
Public transportation	2.15%	2
Walking	3.23%	3
Uber/Lyft or Taxi	0.00%	0
Carpooling	0.00%	0
Other (please specify)	0.00%	0
TOTAL		93

#	OTHER (PLEASE SPECIFY)	DATE
	There are no responses.	

Q5 Do you regularly use any of the following forms of transportation?

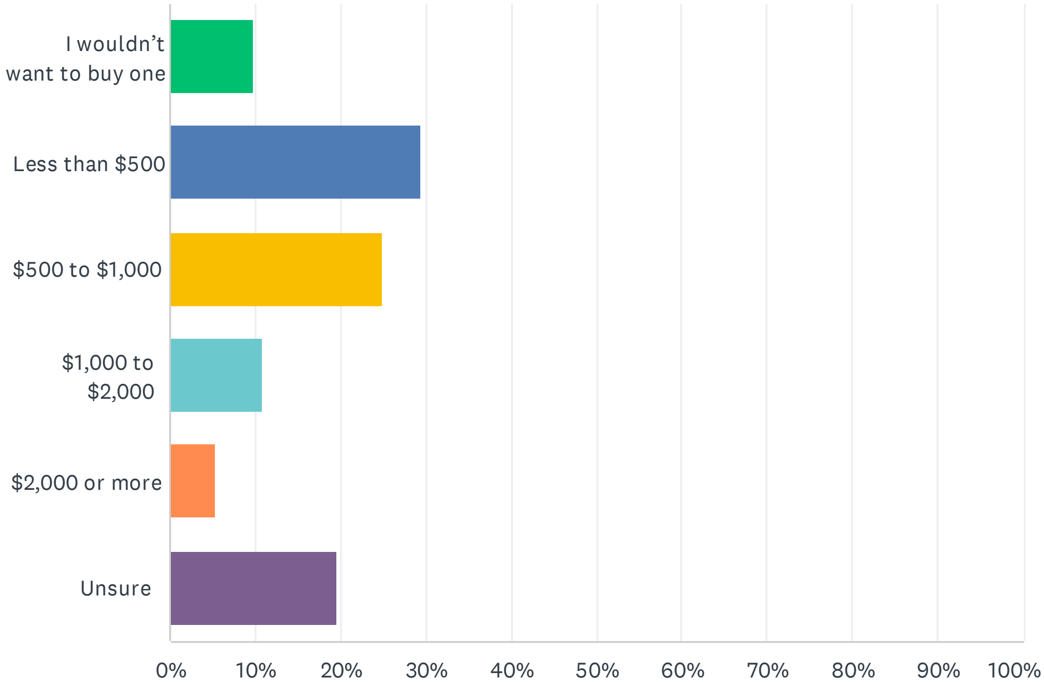
Answered: 93 Skipped: 1



ANSWER CHOICES	RESPONSES	
Regular bicycle or other non-motorized personal transportation devices	66.67%	62
E-bike	2.15%	2
E-scooter	1.08%	1
Other electric personal vehicles (e.g. Segway, OneWheel, electric skateboard, etc.)	2.15%	2
Walking	59.14%	55
Public transportation	9.68%	9
I do not regularly use any of these modes of transportation	19.35%	18
Total Respondents: 93		

Q6 How much would you pay to purchase an e-bike?

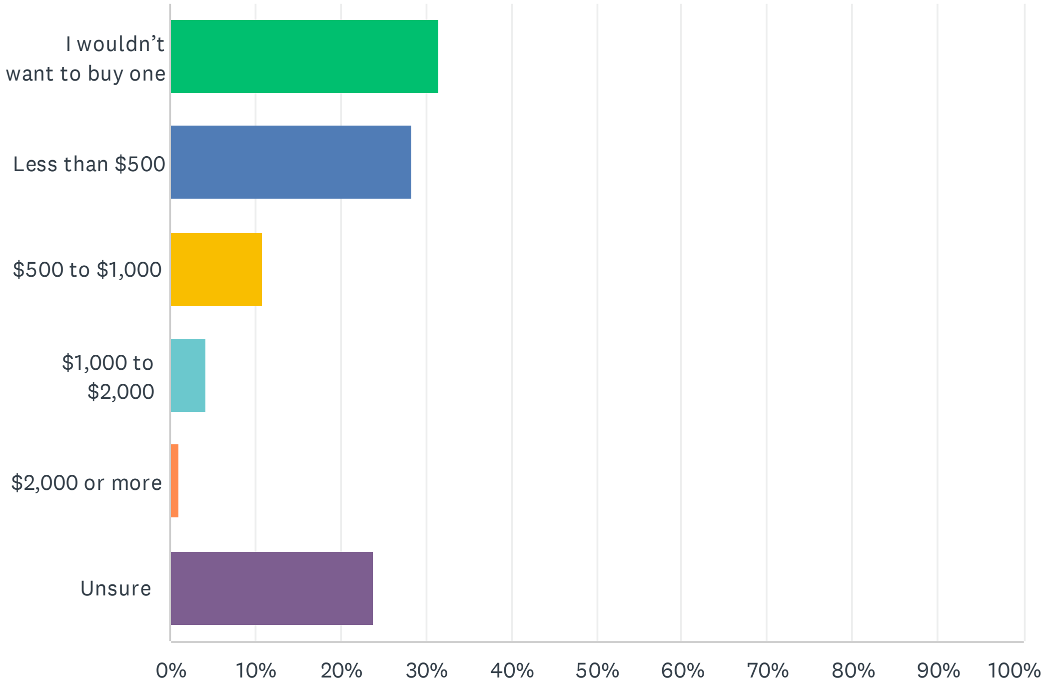
Answered: 92 Skipped: 2



ANSWER CHOICES	RESPONSES	
I wouldn't want to buy one	9.78%	9
Less than $500	29.35%	27
$500 to $1,000	25.00%	23
$1,000 to $2,000	10.87%	10
$2,000 or more	5.43%	5
Unsure	19.57%	18
TOTAL		92

Q7 How much would you pay to purchase an e-scooter?

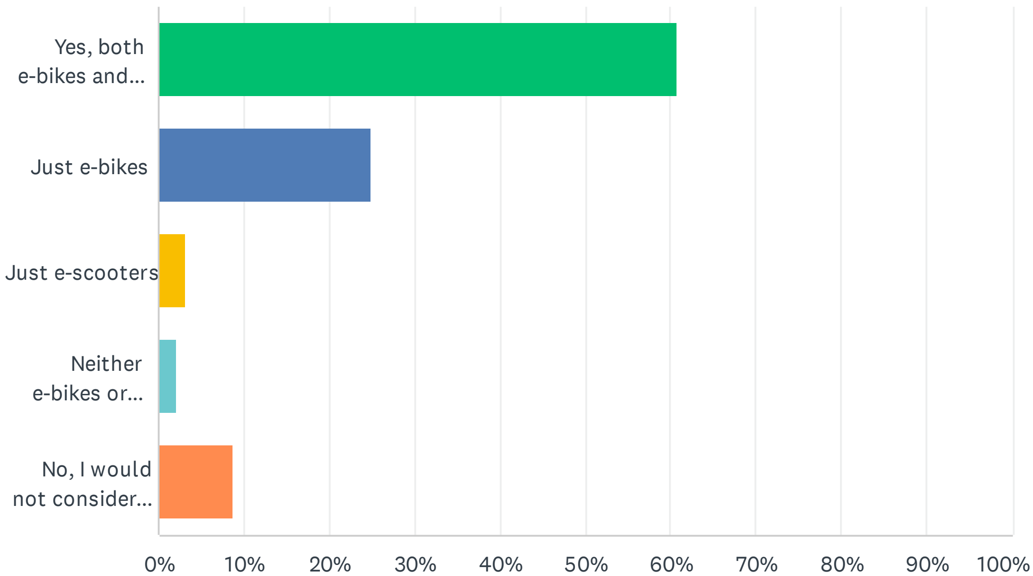
Answered: 92 Skipped: 2



ANSWER CHOICES	RESPONSES	
I wouldn't want to buy one	31.52%	29
Less than $500	28.26%	26
$500 to $1,000	10.87%	10
$1,000 to $2,000	4.35%	4
$2,000 or more	1.09%	1
Unsure	23.91%	22
TOTAL		92

Q8 Would you consider using an e-bike or e-scooter through a shared system or program?

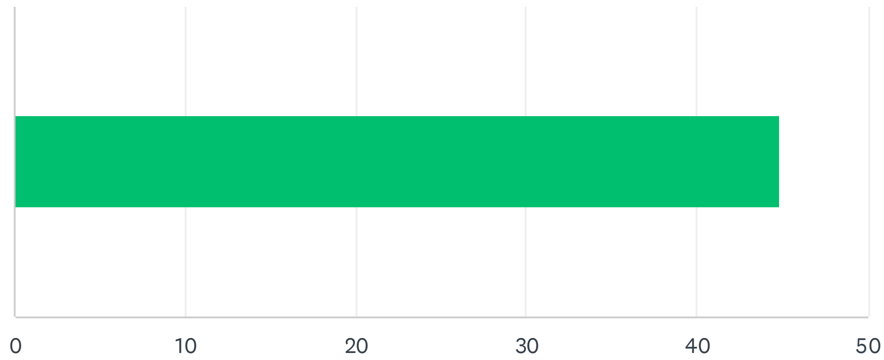
Answered: 92 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes, both e-bikes and e-scooters	60.87%	56
Just e-bikes	25.00%	23
Just e-scooters	3.26%	3
Neither e-bikes or e-scooters	2.17%	2
No, I would not consider using either in a shared system	8.70%	8
TOTAL		92

Q9 What percentage of your typical trips would you be willing to take by e-bike? (Assuming you own one or have free/affordable access to one)

Answered: 91   Skipped: 3



ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	45	4,082	91
Total Respondents: 91			

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11	6	9/25/2021 12:47 PM
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18	50	8/15/2021 10:48 AM
19	50	8/15/2021 10:47 AM

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87	15	5/21/2021 9:19 AM
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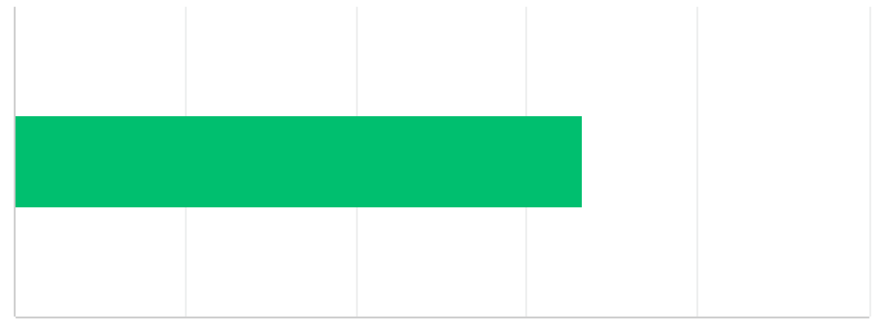
91	80	4/27/2021 7:16 PM

Q10 What percentage of your typical trips would you be willing to take by e-scooter? (Assuming you own one or have free/affordable access to one)

Answered: 85   Skipped: 9



ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
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Total Respondents: 85			

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16	20	8/15/2021 10:51 AM
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19	14	8/15/2021 10:47 AM

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27	13	8/15/2021 10:17 AM
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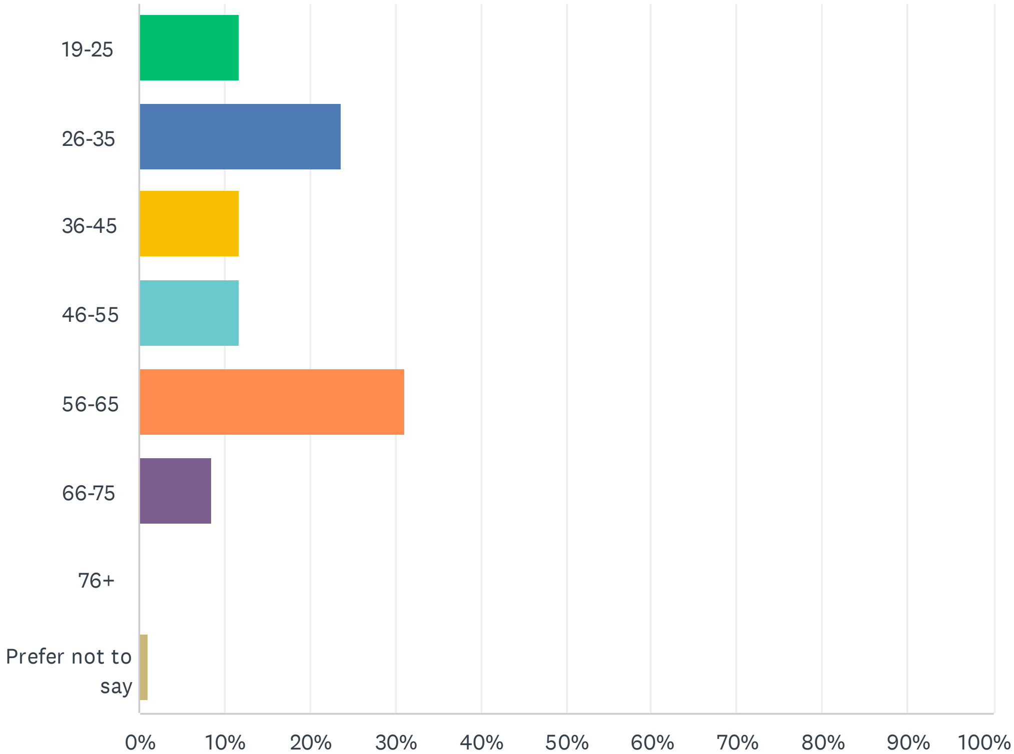
44	4	7/10/2021 11:56 AM
45	77	7/10/2021 11:53 AM
46	31	7/10/2021 11:51 AM
47	70	7/10/2021 11:50 AM
48	39	7/10/2021 11:25 AM
49	66	7/10/2021 11:16 AM
50	53	7/10/2021 11:15 AM
51	24	6/26/2021 1:49 PM
52	100	6/26/2021 12:34 PM
53	18	6/26/2021 12:19 PM
54	21	6/26/2021 12:15 PM
55	52	6/26/2021 11:38 AM
56	100	6/19/2021 12:40 PM
57	33	6/19/2021 11:52 AM

58	63	6/19/2021 11:52 AM
59	55	6/19/2021 11:33 AM
60	50	6/19/2021 10:37 AM
61	50	6/19/2021 10:24 AM
62	0	6/19/2021 10:21 AM
63	100	6/19/2021 10:20 AM
64	73	6/19/2021 10:20 AM
65	63	6/12/2021 12:12 PM
66	10	5/21/2021 12:11 PM
67	35	5/21/2021 12:02 PM
68	50	5/21/2021 11:09 AM
69	30	5/21/2021 10:42 AM
70	18	5/21/2021 10:36 AM
71	25	5/21/2021 10:33 AM
72	0	5/21/2021 10:28 AM
73	33	5/21/2021 10:21 AM
74	38	5/21/2021 10:21 AM
75	60	5/21/2021 9:49 AM
76	27	5/21/2021 9:39 AM
77	21	5/21/2021 9:32 AM
78	49	5/21/2021 9:29 AM
79	14	5/21/2021 9:28 AM
80	40	5/21/2021 9:27 AM
81	9	5/21/2021 9:19 AM
82	10	5/21/2021 9:19 AM
83	32	4/27/2021 7:23 PM
84	51	4/27/2021 7:16 PM
85	50	4/27/2021 7:16 PM

Q11 How old are you?

Answered: 93 Skipped: 1



ANSWER CHOICES	RESPONSES	
19-25	11.83%	11
26-35	23.66%	22
36-45	11.83%	11
46-55	11.83%	11
56-65	31.18%	29
66-75	8.60%	8
76+	0.00%	0
Prefer not to say	1.08%	1
TOTAL		93

Q12 What ZIP Code do you live in?

Answered: 93 Skipped: 1

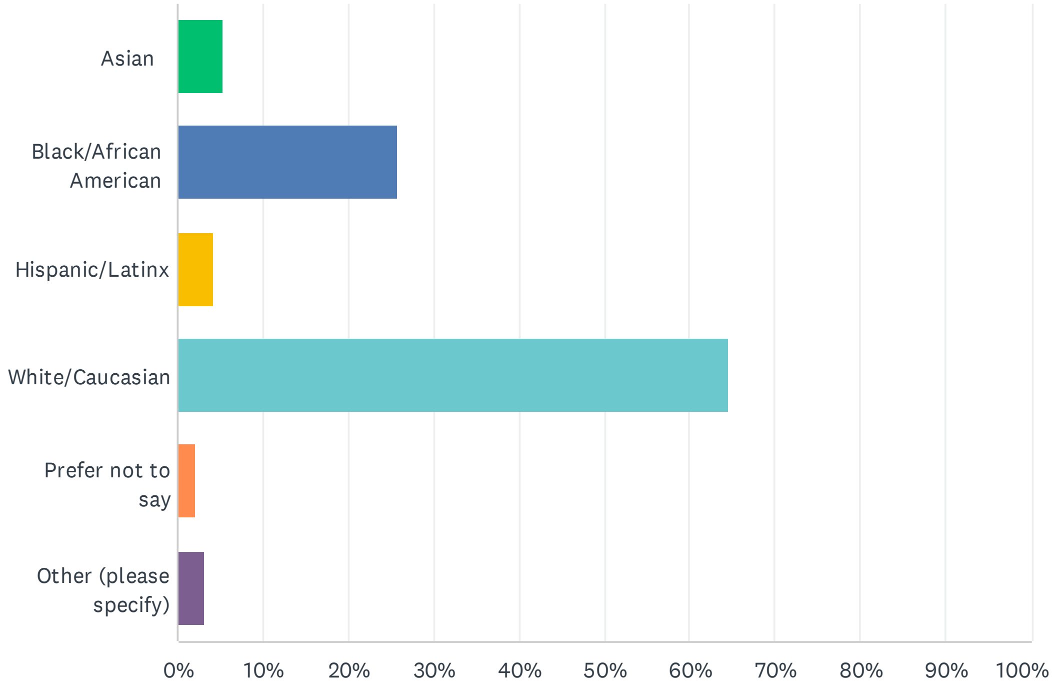
#	RESPONSES	DATE
1	14217	9/25/2021 2:05 PM
2	14224	9/25/2021 1:59 PM
3	14222	9/25/2021 1:47 PM
4	14224	9/25/2021 1:45 PM
5	14214	9/25/2021 1:44 PM
6	14325	9/25/2021 1:39 PM
7	14072	9/25/2021 1:28 PM
8	14031	9/25/2021 1:24 PM
9	14031	9/25/2021 1:23 PM
10	14228	9/25/2021 1:19 PM
11	14226	9/25/2021 12:48 PM
12	14221	9/25/2021 12:48 PM
13	14221	9/25/2021 12:37 PM
14	14051	9/25/2021 12:18 PM
15	14223	9/25/2021 12:13 PM
16	14226	9/25/2021 11:52 AM
17	14225	8/15/2021 10:53 AM
18	14225	8/15/2021 10:51 AM
19	17050	8/15/2021 10:48 AM
20	14075	8/15/2021 10:48 AM
21	17050	8/15/2021 10:48 AM
22	14216	8/15/2021 10:39 AM
23	14213	8/15/2021 10:38 AM
24	14075	8/15/2021 10:36 AM
25	14213	8/15/2021 10:32 AM
26	13202	8/15/2021 10:22 AM
27	14224	8/15/2021 10:21 AM
28	14202	8/15/2021 10:19 AM
29	14221	8/15/2021 10:18 AM
30	14202	8/15/2021 10:10 AM
31	14043	8/15/2021 10:10 AM
32	14204	8/15/2021 9:53 AM
33	14057	8/15/2021 9:48 AM

34	14086	8/15/2021 9:47 AM
35	14216	8/15/2021 9:32 AM
36	14222	8/15/2021 8:57 AM
37	14301	7/28/2021 10:46 PM
38	14301	7/27/2021 7:12 PM
39	14305	7/27/2021 7:07 PM
40	14086	7/10/2021 1:00 PM
41	14006	7/10/2021 12:56 PM
42	14209	7/10/2021 12:52 PM
43	14086	7/10/2021 12:44 PM
44	14222	7/10/2021 12:39 PM
45	14209	7/10/2021 12:37 PM
46	14150	7/10/2021 12:03 PM
47	14113	7/10/2021 11:58 AM
48	14213	7/10/2021 11:57 AM
49	14213	7/10/2021 11:54 AM
50	14086	7/10/2021 11:53 AM
51	14086	7/10/2021 11:52 AM
52	14213	7/10/2021 11:51 AM
53	14024	7/10/2021 11:25 AM
54	14043	7/10/2021 11:17 AM
55	14043	7/10/2021 11:16 AM
56	14213	6/26/2021 1:49 PM
57	14208	6/26/2021 12:35 PM
58	14226	6/26/2021 12:19 PM
59	14222	6/26/2021 12:16 PM
60	14211	6/26/2021 11:39 AM
61	14305	6/19/2021 12:41 PM
62	14304	6/19/2021 12:04 PM
63	14305	6/19/2021 11:54 AM
64	14301	6/19/2021 11:34 AM
65	14305	6/19/2021 10:38 AM
66	14301	6/19/2021 10:26 AM
67	14305	6/19/2021 10:21 AM
68	14303	6/19/2021 10:21 AM
69	14304	6/19/2021 10:21 AM
70	14215	6/12/2021 12:15 PM
71	142122	6/12/2021 12:13 PM

72	14220	5/21/2021 12:11 PM
73	14317	5/21/2021 12:03 PM
74	14206	5/21/2021 11:09 AM
75	14215	5/21/2021 10:43 AM
76	14213	5/21/2021 10:37 AM
77	14201	5/21/2021 10:33 AM
78	14222	5/21/2021 10:28 AM
79	14214	5/21/2021 10:21 AM
80	14226	5/21/2021 10:21 AM
81	14214	5/21/2021 9:49 AM
82	14211	5/21/2021 9:40 AM
83	14214	5/21/2021 9:32 AM
84	14225	5/21/2021 9:29 AM
85	14223	5/21/2021 9:29 AM
86	14215	5/21/2021 9:28 AM
87	14213	5/21/2021 9:21 AM
88	14213	5/21/2021 9:20 AM
89	14216	4/27/2021 7:23 PM
90	14215	4/27/2021 7:22 PM
91	14209	4/27/2021 7:17 PM
92	14215	4/27/2021 7:17 PM
93	test	4/2/2021 2:28 PM

Q13 How do you identify your race/ethnicity?

Answered: 93 Skipped: 1

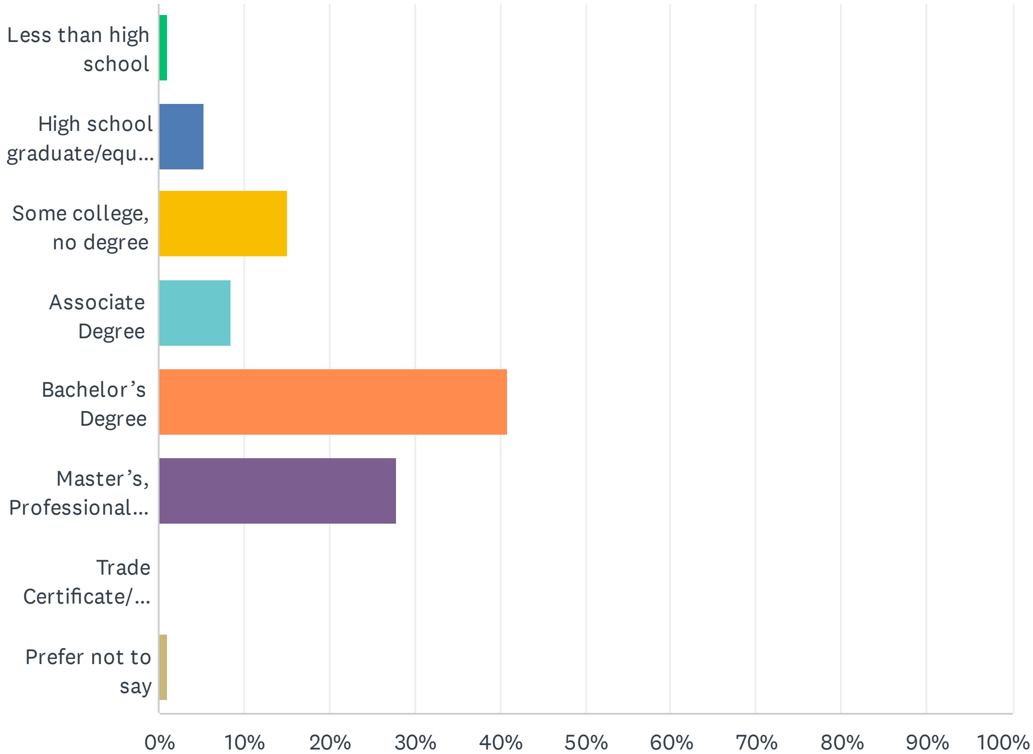


ANSWER CHOICES	RESPONSES	
Asian	5.38%	5
Black/African American	25.81%	24
Hispanic/Latinx	4.30%	4
White/Caucasian	64.52%	60
Prefer not to say	2.15%	2
Other (please specify)	3.23%	3
Total Respondents: 93		

#	OTHER (PLEASE SPECIFY)	DATE
1	seneca Indian	7/10/2021 12:56 PM
2	Multiple	6/19/2021 10:21 AM
3	White	5/21/2021 10:33 AM

Q14 What is your highest level of education?

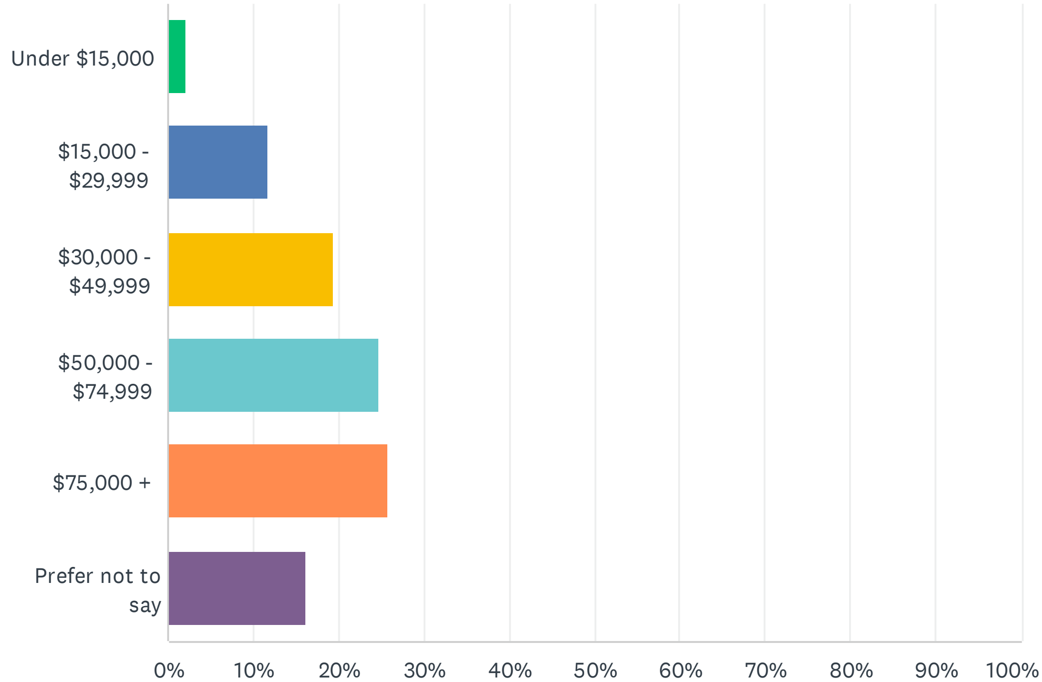
Answered: 93 Skipped: 1



ANSWER CHOICES	RESPONSES	
Less than high school	1.08%	1
High school graduate/equivalent	5.38%	5
Some college, no degree	15.05%	14
Associate Degree	8.60%	8
Bachelor's Degree	40.86%	38
Master's, Professional or Doctoral degree	27.96%	26
Trade Certificate/Apprenticeship	0.00%	0
Prefer not to say	1.08%	1
TOTAL		93

Q15 What is your annual household income?

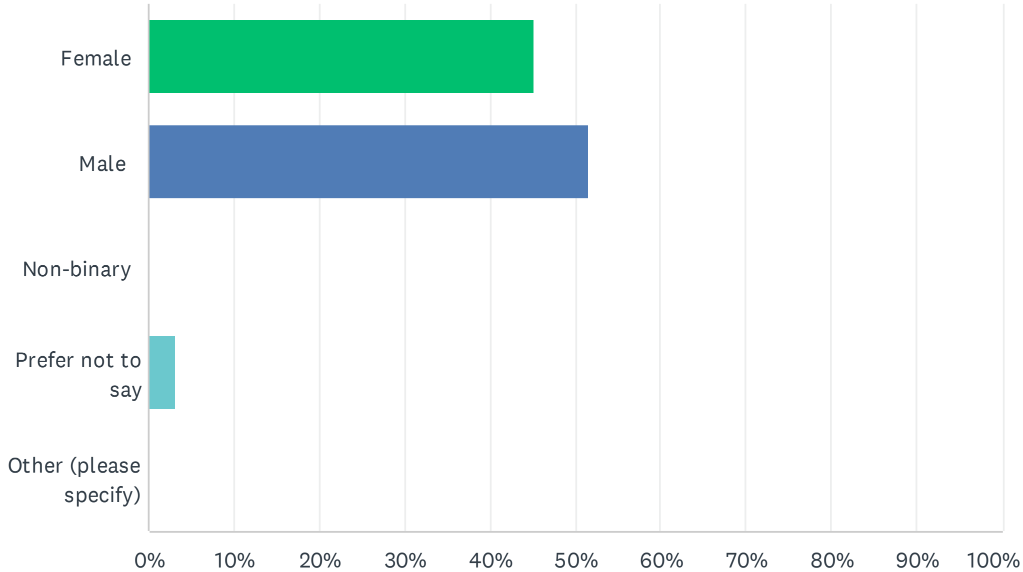
Answered: 93 Skipped: 1



ANSWER CHOICES	RESPONSES	
Under $15,000	2.15%	2
$15,000 - $29,999	11.83%	11
$30,000 - $49,999	19.35%	18
$50,000 - $74,999	24.73%	23
$75,000 +	25.81%	24
Prefer not to say	16.13%	15
TOTAL		93

Q16 How do you identify your gender?

Answered: 93 Skipped: 1

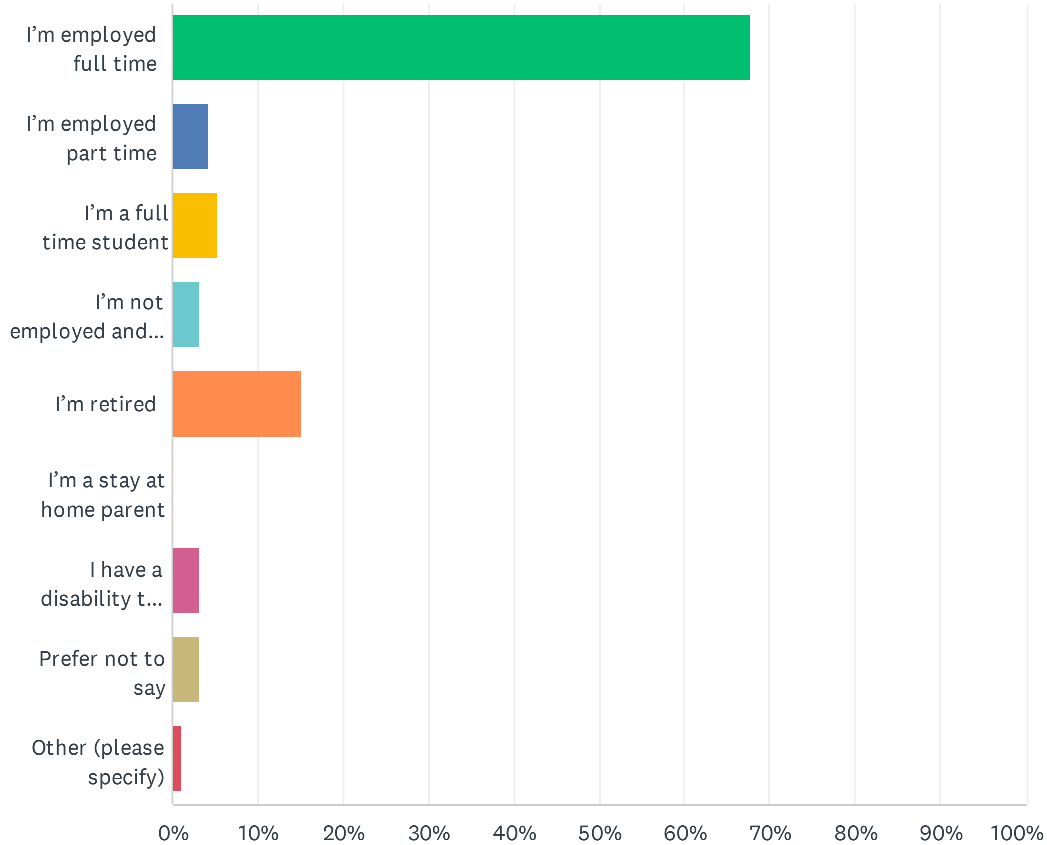


ANSWER CHOICES	RESPONSES	
Female	45.16%	42
Male	51.61%	48
Non-binary	0.00%	0
Prefer not to say	3.23%	3
Other (please specify)	0.00%	0
TOTAL		93

#	OTHER (PLEASE SPECIFY)	DATE
	There are no responses.	

Q17 Are you currently employed?

Answered: 93 Skipped: 1

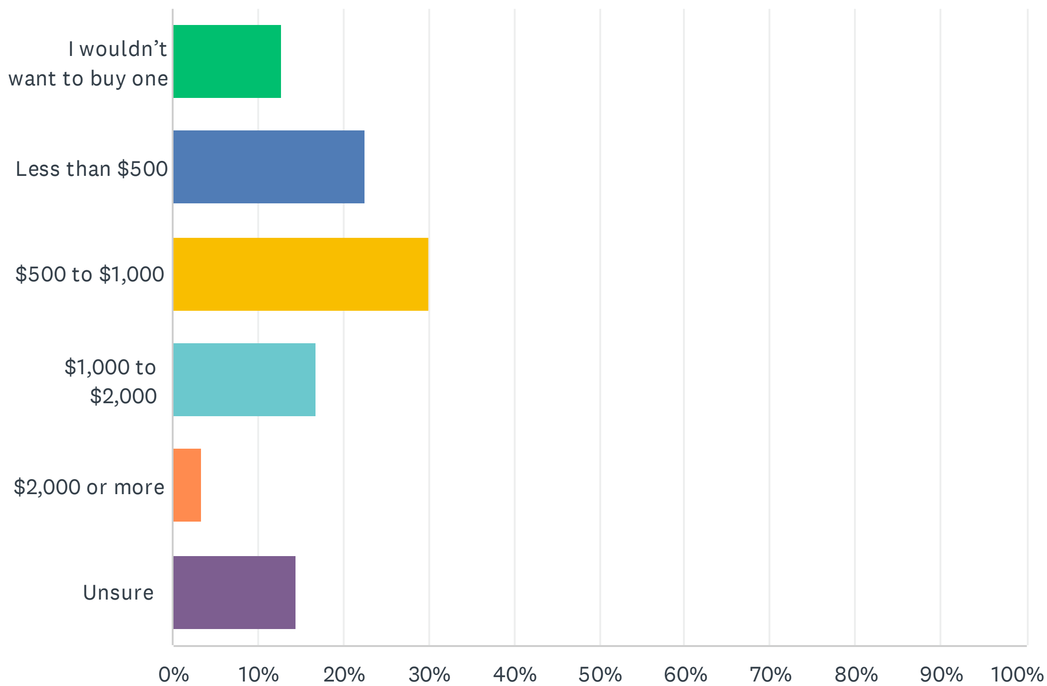


ANSWER CHOICES	RESPONSES	
I'm employed full time	67.74%	63
I'm employed part time	4.30%	4
I'm a full time student	5.38%	5
I'm not employed and looking for work	3.23%	3
I'm retired	15.05%	14
I'm a stay at home parent	0.00%	0
I have a disability that prevents me from working	3.23%	3
Prefer not to say	3.23%	3
Other (please specify)	1.08%	1
Total Respondents: 93		

#	OTHER (PLEASE SPECIFY)	DATE
1	n/a	7/10/2021 11:53 AM

Q2 How much would you pay to purchase an e-bike?

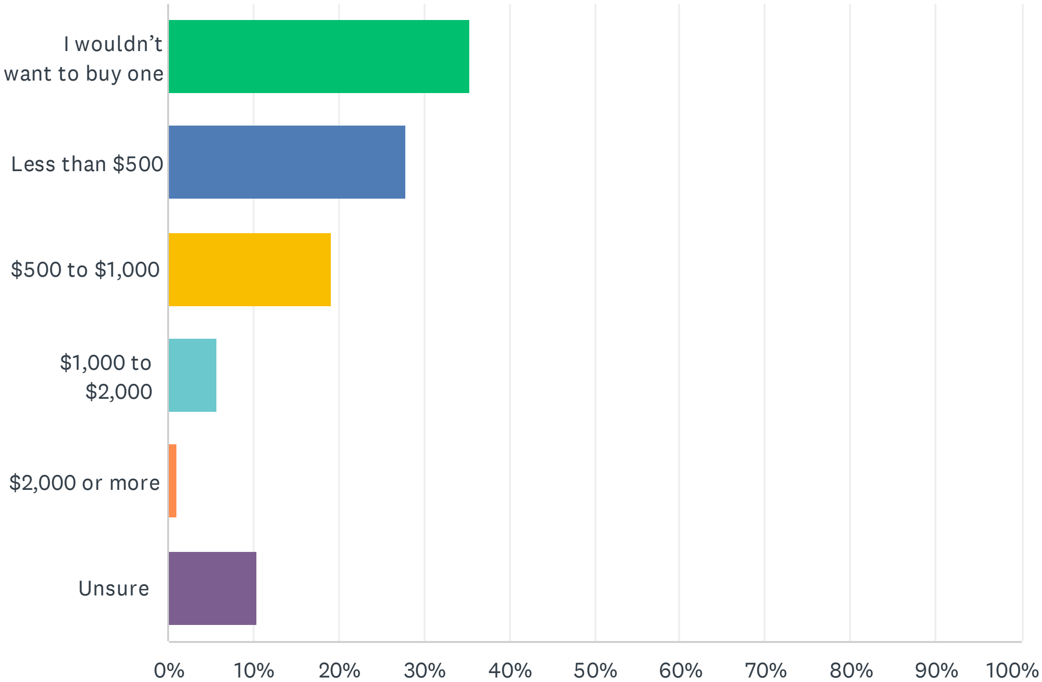
Answered: 173 Skipped: 14



ANSWER CHOICES	RESPONSES	
I wouldn't want to buy one	12.72%	22
Less than $500	22.54%	39
$500 to $1,000	30.06%	52
$1,000 to $2,000	16.76%	29
$2,000 or more	3.47%	6
Unsure	14.45%	25
TOTAL		173

Q3 How much would you pay to purchase an e-scooter?

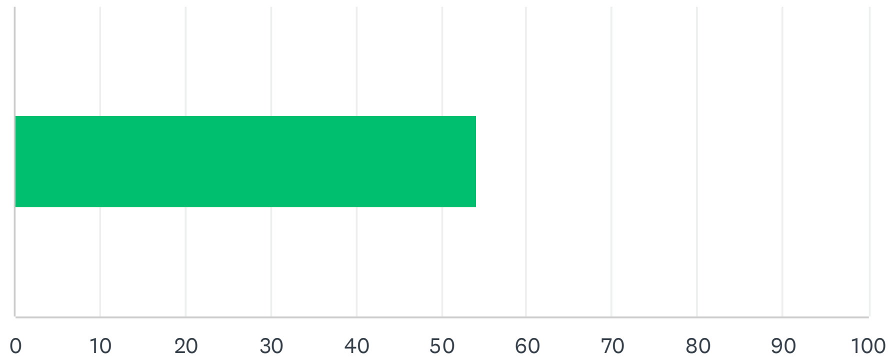
Answered: 172   Skipped: 15



ANSWER CHOICES	RESPONSES	
I wouldn't want to buy one	35.47%	61
Less than $500	27.91%	48
$500 to $1,000	19.19%	33
$1,000 to $2,000	5.81%	10
$2,000 or more	1.16%	2
Unsure	10.47%	18
TOTAL		172

Q4 What percentage of your typical trips would you be willing to take by e-bike? (Assuming you own one or have free/affordable access to one)

Answered: 171 Skipped: 16



ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	54	9,272	171
Total Respondents: 171			

#		DATE
1	98	11/22/2022 9:17 AM
2	100	7/20/2022 11:10 PM
3	30	11/8/2021 3:49 PM
4	5	11/7/2021 3:36 PM
5	91	10/19/2021 12:50 PM
6	15	10/19/2021 8:55 AM
7	76	10/16/2021 10:36 AM
8	65	10/15/2021 9:52 PM
9	44	10/15/2021 9:15 PM
10	38	10/15/2021 7:06 PM
11	60	10/15/2021 6:24 PM
12	66	10/15/2021 4:26 PM
13	25	10/15/2021 1:14 PM
14	26	10/15/2021 12:26 PM
15	91	10/15/2021 11:48 AM
16	100	10/15/2021 8:24 AM
17	20	10/14/2021 1:07 PM
18	50	10/14/2021 9:01 AM
19	66	10/13/2021 11:30 PM

20	50	10/13/2021 6:18 PM
21	34	10/13/2021 5:14 PM
22	63	10/13/2021 3:39 PM
23	30	10/11/2021 7:13 PM
24	96	10/8/2021 6:16 PM
25	80	10/8/2021 2:59 PM
26	83	10/8/2021 1:30 PM
27	90	10/8/2021 1:24 PM
28	39	10/8/2021 12:58 PM
29	80	10/8/2021 12:23 PM
30	80	10/8/2021 12:11 PM
31	74	10/8/2021 10:57 AM
32	83	10/8/2021 10:38 AM
33	90	10/8/2021 10:33 AM
34	100	10/8/2021 10:31 AM
35	100	10/8/2021 10:26 AM
36	100	10/8/2021 10:14 AM
37	50	10/4/2021 11:33 AM
38	20	9/25/2021 2:03 PM
39	100	9/25/2021 2:01 PM
40	50	9/25/2021 1:53 PM
41	75	9/25/2021 1:32 PM
42	14	9/25/2021 1:28 PM
43	27	9/25/2021 1:28 PM
44	35	9/25/2021 1:24 PM
45	10	9/25/2021 1:00 PM
46	50	9/25/2021 1:00 PM
47	13	9/25/2021 12:43 PM
48	8	9/25/2021 12:22 PM
49	27	9/25/2021 12:19 PM
50	44	9/25/2021 12:18 PM
51	62	9/25/2021 11:57 AM
52	100	9/21/2021 10:30 AM
53	50	9/20/2021 8:50 AM
54	75	9/17/2021 4:23 PM
55	68	9/16/2021 11:37 AM
56	80	9/16/2021 10:28 AM
57	15	9/15/2021 3:26 PM

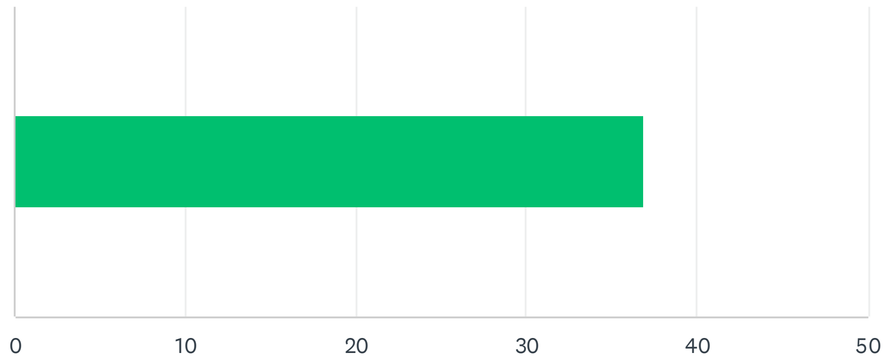
58	30	9/15/2021 2:22 PM
59	100	9/15/2021 2:21 PM
60	85	9/15/2021 2:08 PM
61	46	9/15/2021 2:02 PM
62	37	9/15/2021 2:01 PM
63	25	9/15/2021 1:57 PM
64	25	9/15/2021 1:57 PM
65	90	9/13/2021 11:03 AM
66	50	9/11/2021 12:34 PM
67	31	8/27/2021 2:21 PM
68	68	8/27/2021 2:05 PM
69	50	8/27/2021 11:41 AM
70	100	8/27/2021 9:58 AM
71	64	8/23/2021 8:48 PM
72	83	8/23/2021 7:24 PM
73	81	8/23/2021 7:12 PM
74	70	8/23/2021 3:58 PM
75	52	8/23/2021 3:40 PM
76	50	8/20/2021 2:27 PM
77	85	8/19/2021 3:59 PM
78	18	8/19/2021 10:16 AM
79	50	8/19/2021 9:38 AM
80	70	8/18/2021 2:49 PM
81	15	8/15/2021 10:42 PM
82	50	8/15/2021 11:03 AM
83	16	8/15/2021 11:02 AM
84	25	8/15/2021 11:02 AM
85	50	8/15/2021 11:01 AM
86	51	8/15/2021 11:00 AM
87	50	8/15/2021 10:55 AM
88	54	8/15/2021 10:50 AM
89	24	8/15/2021 10:48 AM
90	50	8/15/2021 10:41 AM
91	41	8/15/2021 10:40 AM
92	0	8/15/2021 10:27 AM
93	35	8/15/2021 10:27 AM
94	100	8/15/2021 10:16 AM
95	12	8/15/2021 10:01 AM

96	48	8/15/2021 10:00 AM
97	14	8/15/2021 9:51 AM
98	54	8/15/2021 9:39 AM
99	44	8/15/2021 9:24 AM
100	70	8/14/2021 3:42 PM
101	50	8/14/2021 12:17 PM
102	35	8/11/2021 6:29 PM
103	60	8/10/2021 5:43 PM
104	57	8/10/2021 5:13 PM
105	10	8/9/2021 1:47 PM
106	50	8/5/2021 8:19 PM
107	18	8/5/2021 6:41 PM
108	35	8/5/2021 6:35 PM
109	47	8/5/2021 9:06 AM
110	49	8/4/2021 6:49 PM
111	71	8/4/2021 6:33 PM
112	81	8/4/2021 1:59 PM
113	60	8/4/2021 1:38 PM
114	65	8/4/2021 1:34 PM
115	50	8/2/2021 11:22 AM
116	20	7/30/2021 5:03 PM
117	70	7/29/2021 9:39 AM
118	25	7/28/2021 10:47 PM
119	24	7/27/2021 7:13 PM
120	80	7/27/2021 7:08 PM
121	60	7/26/2021 8:43 AM
122	67	7/23/2021 3:14 PM
123	30	7/23/2021 9:23 AM
124	40	7/22/2021 11:11 AM
125	85	7/19/2021 10:03 PM
126	75	7/16/2021 8:55 AM
127	30	7/14/2021 6:47 PM
128	40	7/13/2021 10:14 AM
129	64	7/10/2021 1:06 PM
130	91	7/10/2021 1:00 PM
131	31	7/10/2021 12:55 PM
132	79	7/10/2021 12:51 PM
133	14	7/10/2021 12:50 PM

134	70	7/10/2021 12:40 PM
135	18	7/10/2021 12:08 PM
136	24	7/10/2021 12:06 PM
137	100	7/10/2021 12:05 PM
138	45	7/10/2021 12:02 PM
139	11	7/10/2021 12:00 PM
140	35	7/10/2021 12:00 PM
141	71	7/10/2021 11:59 AM
142	25	7/10/2021 11:28 AM
143	54	7/10/2021 11:23 AM
144	51	7/10/2021 11:23 AM
145	80	7/8/2021 2:40 PM
146	81	7/8/2021 12:07 AM
147	75	6/26/2021 2:48 PM
148	100	6/26/2021 12:49 PM
149	51	6/26/2021 12:24 PM
150	50	6/26/2021 11:53 AM
151	100	6/19/2021 12:42 PM
152	75	6/19/2021 12:29 PM
153	100	6/19/2021 10:40 AM
154	51	6/12/2021 12:57 PM
155	30	5/21/2021 12:21 PM
156	13	5/21/2021 10:46 AM
157	31	5/21/2021 10:38 AM
158	30	5/21/2021 10:35 AM
159	29	5/21/2021 10:35 AM
160	61	5/21/2021 9:59 AM
161	42	5/21/2021 9:56 AM
162	51	5/21/2021 9:47 AM
163	100	5/21/2021 9:45 AM
164	66	5/21/2021 9:42 AM
165	38	5/21/2021 9:36 AM
166	20	5/21/2021 9:36 AM
167	21	5/21/2021 9:29 AM
168	100	4/27/2021 7:30 PM
169	69	4/27/2021 7:29 PM
170	90	4/27/2021 7:24 PM
171	77	4/27/2021 7:23 PM

Q5 What percentage of your typical trips would you be willing to take by e-scooter? (Assuming you own one or have free/affordable access to one)

Answered: 158   Skipped: 29



ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	37	5,835	158
Total Respondents: 158			

#		DATE
1	0	11/22/2022 9:17 AM
2	100	7/20/2022 11:10 PM
3	20	11/8/2021 3:49 PM
4	0	11/7/2021 3:36 PM
5	50	10/19/2021 12:50 PM
6	5	10/19/2021 8:55 AM
7	5	10/16/2021 10:36 AM
8	50	10/15/2021 9:52 PM
9	4	10/15/2021 9:15 PM
10	40	10/15/2021 7:06 PM
11	85	10/15/2021 6:24 PM
12	72	10/15/2021 4:26 PM
13	10	10/15/2021 1:14 PM
14	4	10/15/2021 12:26 PM
15	16	10/15/2021 11:48 AM
16	100	10/15/2021 8:24 AM
17	0	10/14/2021 1:07 PM
18	24	10/14/2021 9:01 AM
19	76	10/13/2021 11:30 PM

20	58	10/13/2021 6:18 PM
21	16	10/13/2021 5:14 PM
22	44	10/13/2021 3:39 PM
23	12	10/11/2021 7:13 PM
24	81	10/8/2021 6:16 PM
25	50	10/8/2021 2:59 PM
26	60	10/8/2021 1:30 PM
27	25	10/8/2021 1:24 PM
28	0	10/8/2021 12:58 PM
29	20	10/8/2021 12:23 PM
30	1	10/8/2021 10:57 AM
31	5	10/8/2021 10:38 AM
32	56	10/8/2021 10:33 AM
33	100	10/8/2021 10:31 AM
34	51	10/8/2021 10:26 AM
35	100	10/8/2021 10:14 AM
36	25	10/4/2021 11:33 AM
37	22	9/25/2021 2:03 PM
38	96	9/25/2021 2:01 PM
39	58	9/25/2021 1:53 PM
40	25	9/25/2021 1:49 PM
41	61	9/25/2021 1:32 PM
42	0	9/25/2021 1:28 PM
43	15	9/25/2021 1:28 PM
44	30	9/25/2021 1:24 PM
45	14	9/25/2021 1:00 PM
46	7	9/25/2021 12:22 PM
47	30	9/25/2021 12:19 PM
48	60	9/25/2021 12:18 PM
49	57	9/25/2021 11:57 AM
50	10	9/21/2021 10:30 AM
51	50	9/20/2021 8:50 AM
52	45	9/16/2021 11:37 AM
53	4	9/16/2021 11:20 AM
54	50	9/16/2021 10:28 AM
55	8	9/15/2021 2:22 PM
56	100	9/15/2021 2:21 PM
57	50	9/15/2021 2:08 PM

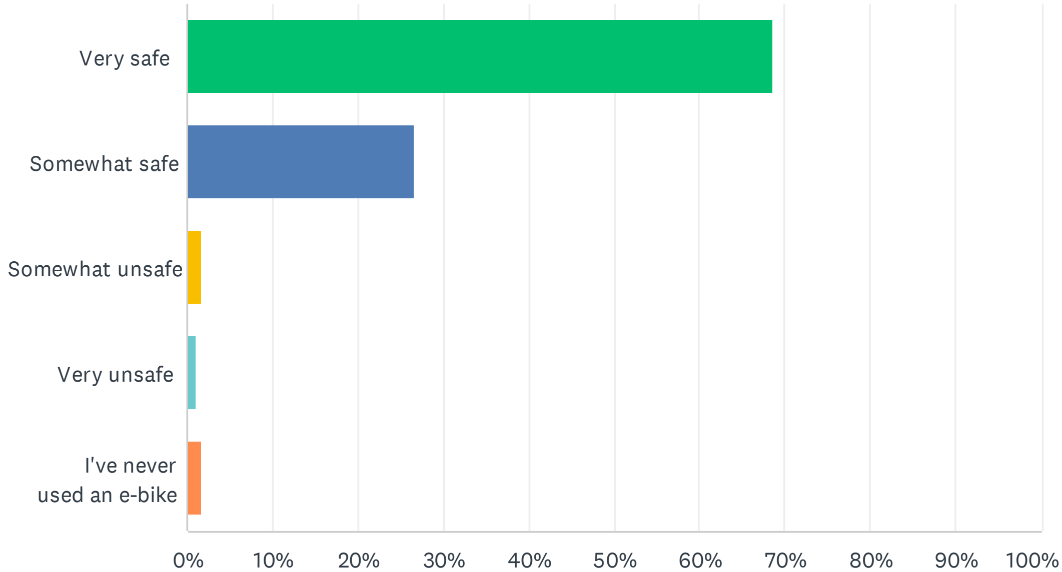
58	30	9/15/2021 2:02 PM
59	5	9/15/2021 2:01 PM
60	25	9/15/2021 1:57 PM
61	25	9/15/2021 1:57 PM
62	90	9/13/2021 11:03 AM
63	35	9/11/2021 12:34 PM
64	16	8/27/2021 2:05 PM
65	50	8/27/2021 11:41 AM
66	41	8/27/2021 9:58 AM
67	27	8/23/2021 8:48 PM
68	87	8/23/2021 7:24 PM
69	10	8/23/2021 7:12 PM
70	15	8/23/2021 3:58 PM
71	1	8/23/2021 3:40 PM
72	15	8/20/2021 2:27 PM
73	80	8/19/2021 3:59 PM
74	16	8/19/2021 10:16 AM
75	20	8/19/2021 9:38 AM
76	10	8/18/2021 2:49 PM
77	5	8/15/2021 10:42 PM
78	40	8/15/2021 11:03 AM
79	17	8/15/2021 11:02 AM
80	25	8/15/2021 11:02 AM
81	11	8/15/2021 11:01 AM
82	26	8/15/2021 11:00 AM
83	20	8/15/2021 10:55 AM
84	54	8/15/2021 10:50 AM
85	19	8/15/2021 10:48 AM
86	10	8/15/2021 10:41 AM
87	23	8/15/2021 10:40 AM
88	17	8/15/2021 10:27 AM
89	20	8/15/2021 10:27 AM
90	62	8/15/2021 10:16 AM
91	24	8/15/2021 10:01 AM
92	14	8/15/2021 9:51 AM
93	0	8/15/2021 9:24 AM
94	100	8/14/2021 3:42 PM
95	0	8/14/2021 12:17 PM

96	33	8/10/2021 5:43 PM
97	33	8/10/2021 5:13 PM
98	60	8/5/2021 8:19 PM
99	16	8/5/2021 6:41 PM
100	0	8/5/2021 6:35 PM
101	5	8/5/2021 9:06 AM
102	57	8/4/2021 6:33 PM
103	44	8/4/2021 1:59 PM
104	56	8/4/2021 1:38 PM
105	60	8/4/2021 1:34 PM
106	20	8/2/2021 11:22 AM
107	10	7/30/2021 5:03 PM
108	30	7/29/2021 9:39 AM
109	25	7/28/2021 10:47 PM
110	5	7/27/2021 7:13 PM
111	81	7/27/2021 7:08 PM
112	40	7/26/2021 8:43 AM
113	76	7/23/2021 3:14 PM
114	5	7/23/2021 9:23 AM
115	75	7/22/2021 11:11 AM
116	95	7/19/2021 10:03 PM
117	0	7/16/2021 8:55 AM
118	0	7/14/2021 6:47 PM
119	1	7/13/2021 10:14 AM
120	67	7/10/2021 1:06 PM
121	89	7/10/2021 1:00 PM
122	26	7/10/2021 12:55 PM
123	9	7/10/2021 12:51 PM
124	39	7/10/2021 12:40 PM
125	7	7/10/2021 12:08 PM
126	100	7/10/2021 12:05 PM
127	14	7/10/2021 12:02 PM
128	23	7/10/2021 12:00 PM
129	87	7/10/2021 11:59 AM
130	35	7/10/2021 11:28 AM
131	77	7/10/2021 11:23 AM
132	54	7/10/2021 11:23 AM
133	15	7/8/2021 2:40 PM

134	85	7/8/2021 12:07 AM
135	16	6/26/2021 2:48 PM
136	100	6/26/2021 12:49 PM
137	24	6/26/2021 12:24 PM
138	0	6/26/2021 11:53 AM
139	100	6/19/2021 12:42 PM
140	73	6/19/2021 12:29 PM
141	100	6/19/2021 10:40 AM
142	7	5/21/2021 12:21 PM
143	11	5/21/2021 10:46 AM
144	12	5/21/2021 10:38 AM
145	80	5/21/2021 10:35 AM
146	66	5/21/2021 10:35 AM
147	40	5/21/2021 9:59 AM
148	37	5/21/2021 9:56 AM
149	20	5/21/2021 9:47 AM
150	0	5/21/2021 9:45 AM
151	24	5/21/2021 9:42 AM
152	40	5/21/2021 9:36 AM
153	10	5/21/2021 9:36 AM
154	13	5/21/2021 9:29 AM
155	100	4/27/2021 7:30 PM
156	40	4/27/2021 7:29 PM
157	51	4/27/2021 7:24 PM
158	75	4/27/2021 7:23 PM

Q6 How safe do you feel riding an e-bike, in general?

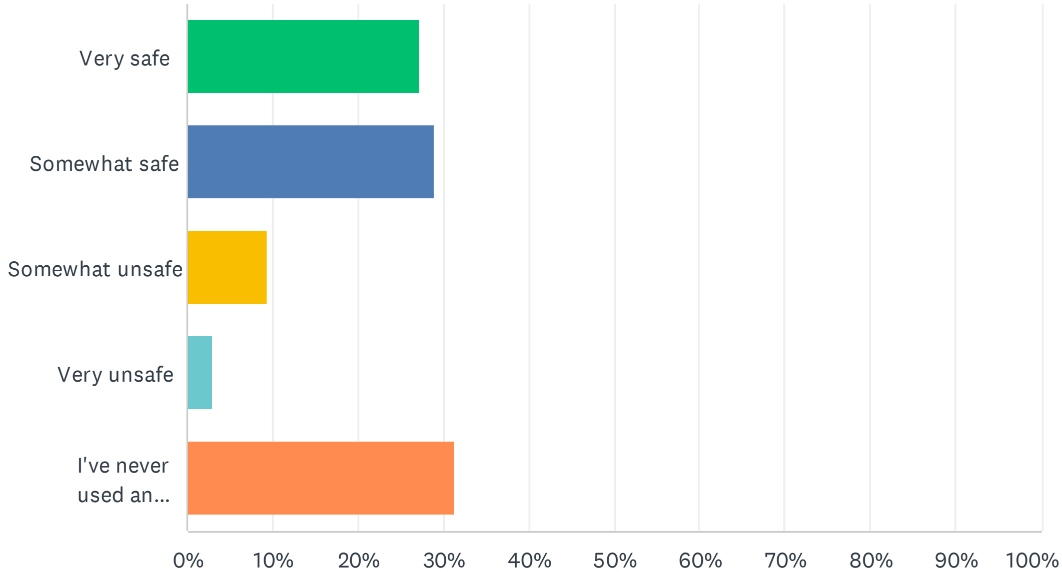
Answered: 172 Skipped: 15



ANSWER CHOICES	RESPONSES	
Very safe	68.60%	118
Somewhat safe	26.74%	46
Somewhat unsafe	1.74%	3
Very unsafe	1.16%	2
I've never used an e-bike	1.74%	3
TOTAL		172

Q7 How safe do you feel riding an e-scooter, in general?

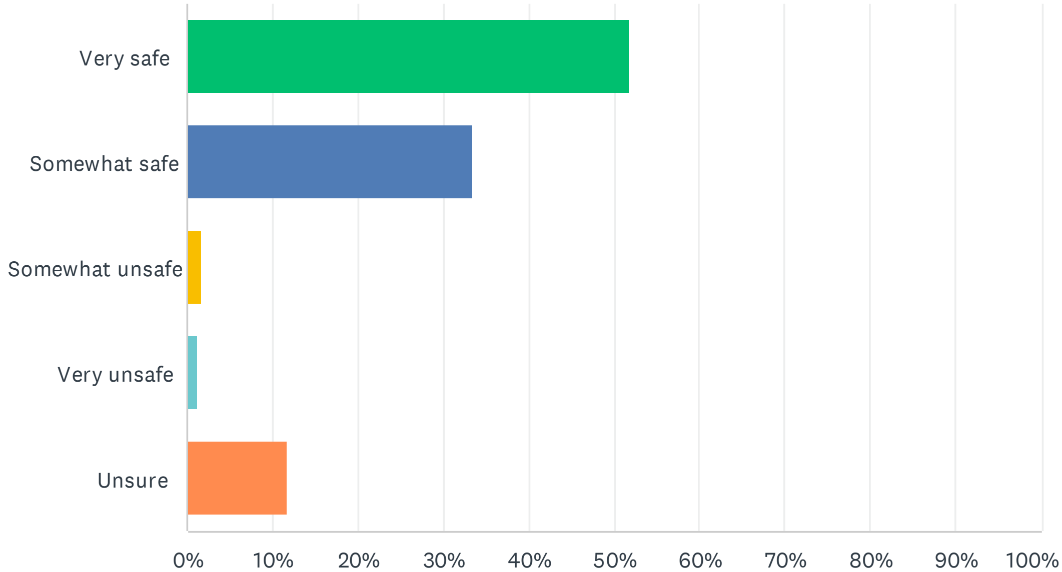
Answered: 172 Skipped: 15



ANSWER CHOICES	RESPONSES	
Very safe	27.33%	47
Somewhat safe	29.07%	50
Somewhat unsafe	9.30%	16
Very unsafe	2.91%	5
I've never used an e-scooter	31.40%	54
TOTAL		172

Q8 In your opinion, how safe are shared EMM systems?

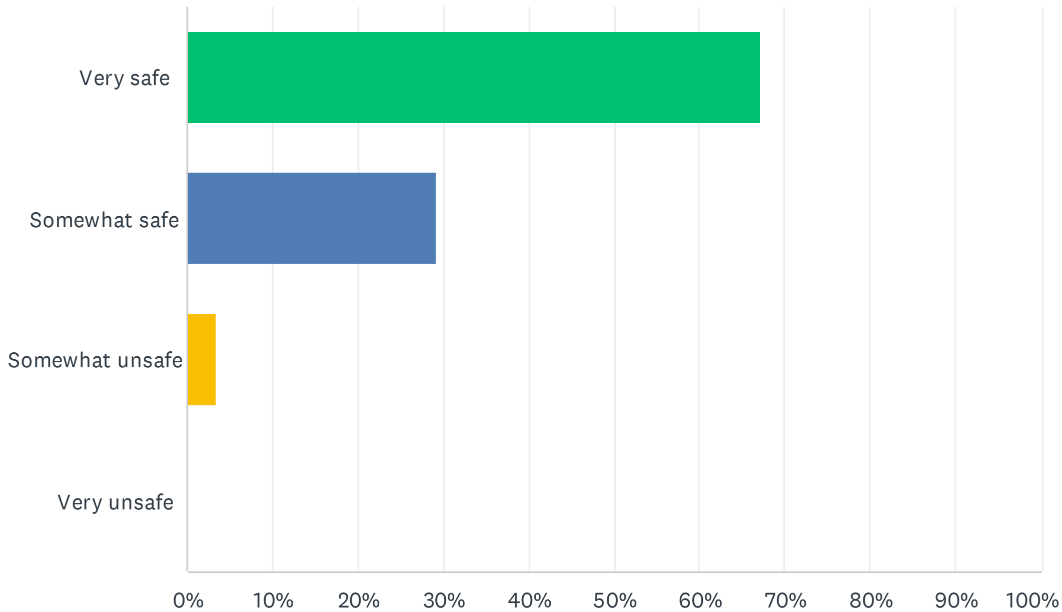
Answered: 170 Skipped: 17



ANSWER CHOICES	RESPONSES	
Very safe	51.76%	88
Somewhat safe	33.53%	57
Somewhat unsafe	1.76%	3
Very unsafe	1.18%	2
Unsure	11.76%	20
TOTAL		170

Q9 In your neighborhood, how safe would you feel riding an e-scooter or e-bike?

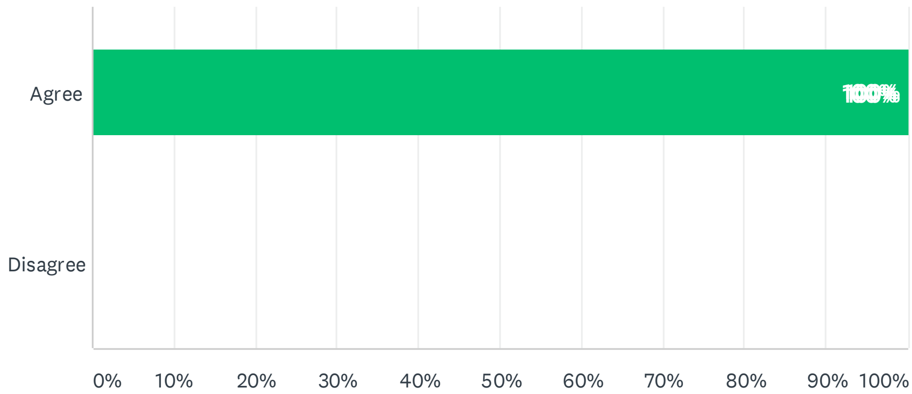
Answered: 171   Skipped: 16



ANSWER CHOICES	RESPONSES	
Very safe	67.25%	115
Somewhat safe	29.24%	50
Somewhat unsafe	3.51%	6
Very unsafe	0.00%	0
TOTAL		171

Q1 By selecting "I agree" below, you acknowledge that you have read and understood the consent form, that you are 18 years old or older, and that you agree to participate in the survey.

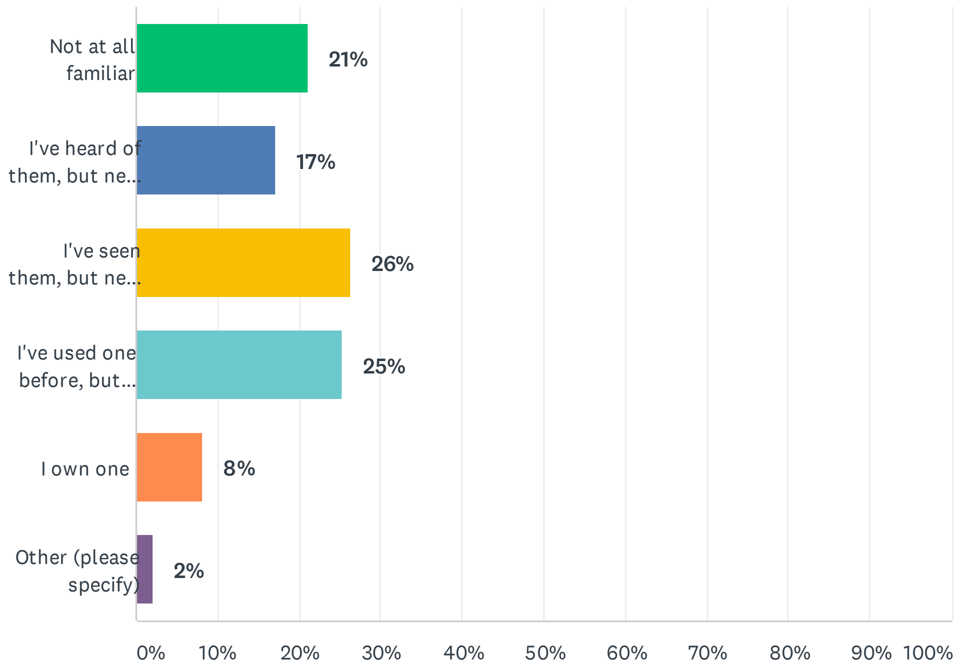
Answered: 103   Skipped: 0



ANSWER CHOICES	RESPONSES	
Agree	100%	103
Disagree	0%	0
TOTAL		103

Q2 How familiar are you with e-bikes?

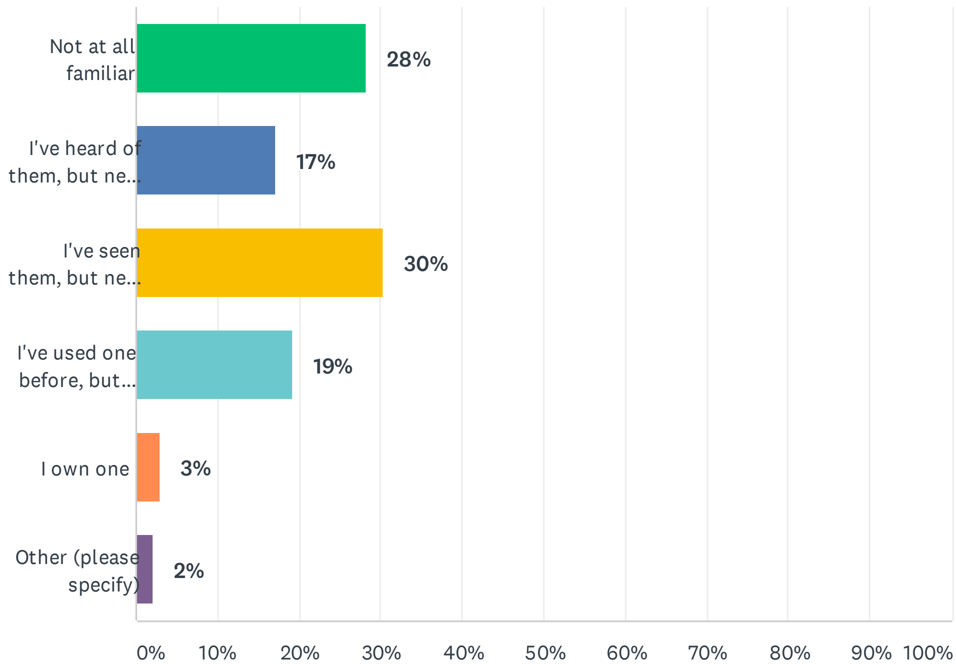
Answered: 99 Skipped: 4



ANSWER CHOICES	RESPONSES	
Not at all familiar	21%	21
I've heard of them, but never seen or used one	17%	17
I've seen them, but never used one	26%	26
I've used one before, but don't own one	25%	25
I own one	8%	8
Other (please specify)	2%	2
TOTAL		99

Q3 How familiar are you with e-scooters?

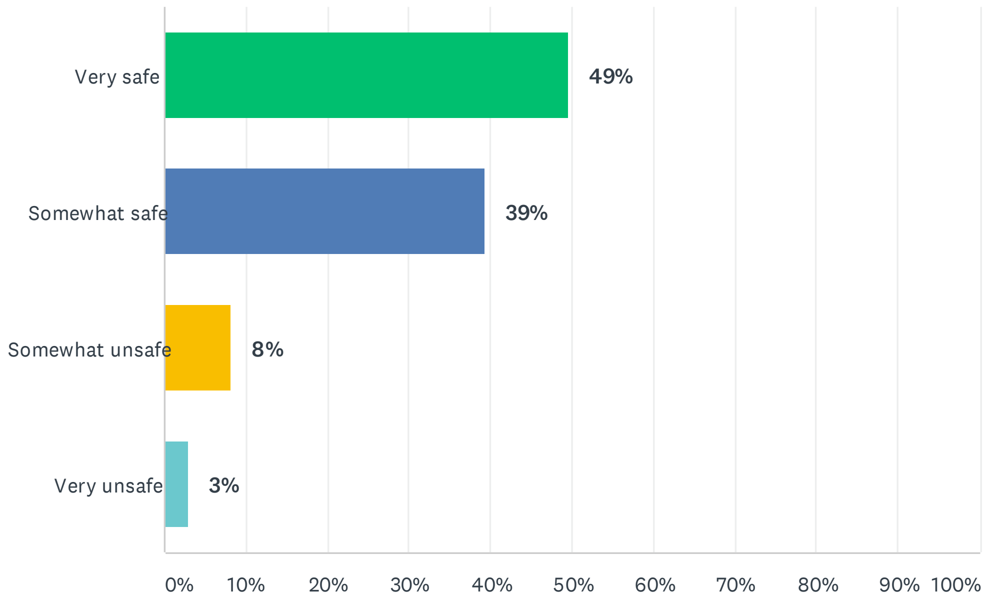
Answered: 99 Skipped: 4



ANSWER CHOICES	RESPONSES	
Not at all familiar	28%	28
I've heard of them, but never seen or used one	17%	17
I've seen them, but never used one	30%	30
I've used one before, but don't own one	19%	19
I own one	3%	3
Other (please specify)	2%	2
TOTAL		99

Q4 How safe do you feel when you're riding a bicycle, in general?

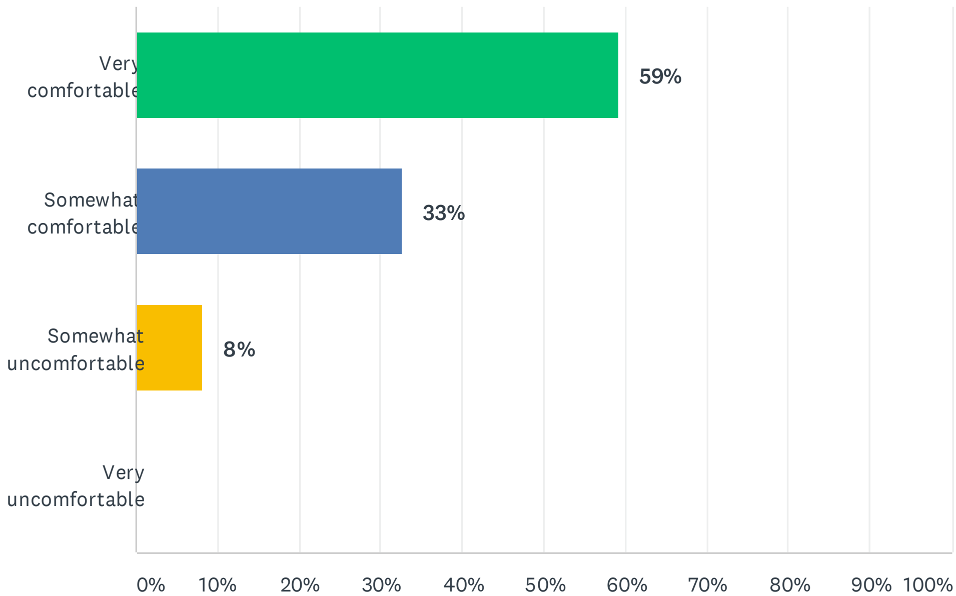
Answered: 99 Skipped: 4



ANSWER CHOICES	RESPONSES	
Very safe	49%	49
Somewhat safe	39%	39
Somewhat unsafe	8%	8
Very unsafe	3%	3
TOTAL		99

Q5 How comfortable do you feel riding a bicycle in your neighborhood?

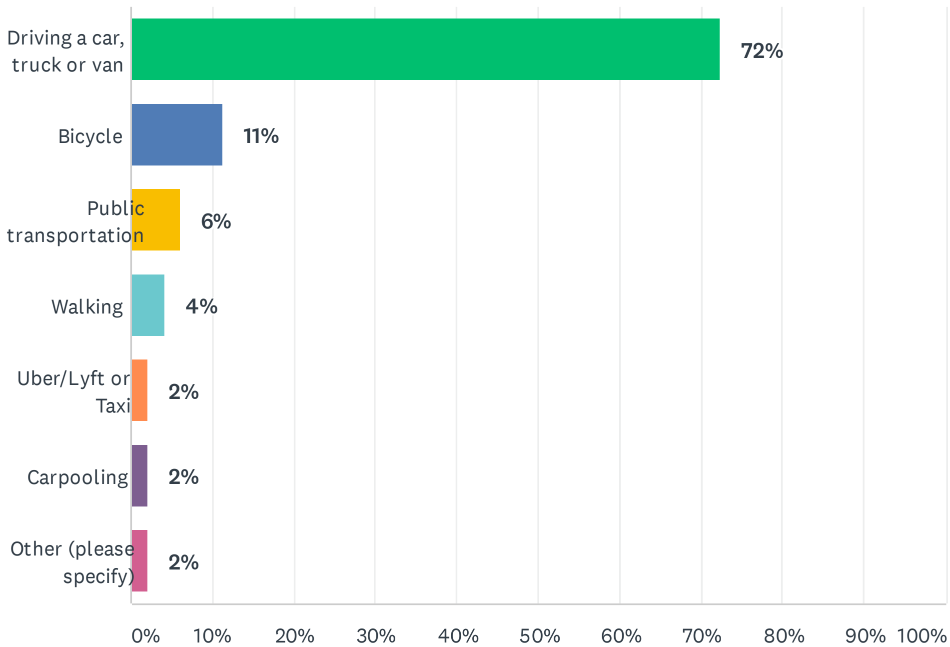
Answered: 98 Skipped: 5



ANSWER CHOICES	RESPONSES	
Very comfortable	59%	58
Somewhat comfortable	33%	32
Somewhat uncomfortable	8%	8
Very uncomfortable	0%	0
TOTAL		98

Q6 What is your primary mode of transportation?

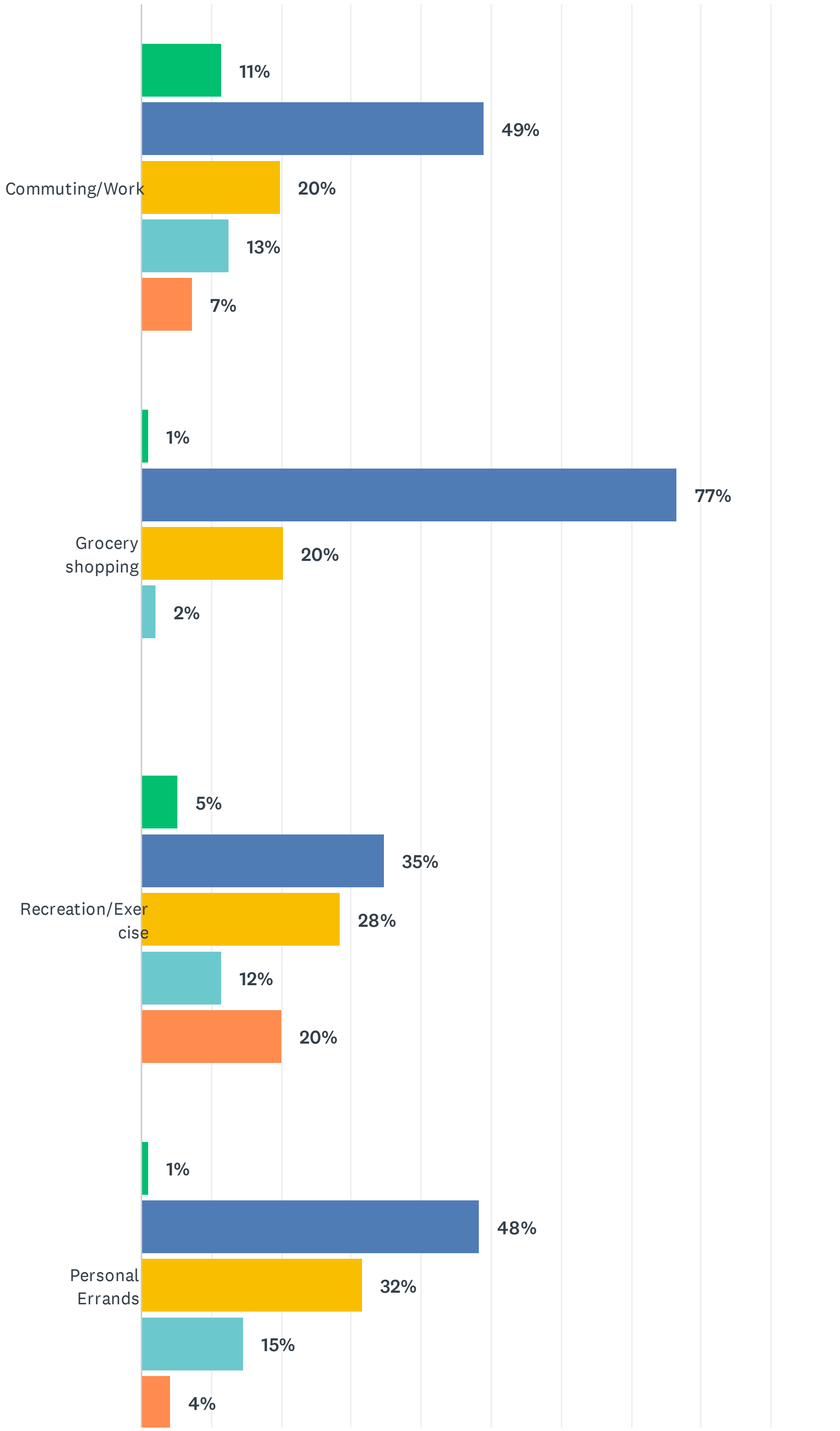
Answered: 98 Skipped: 5

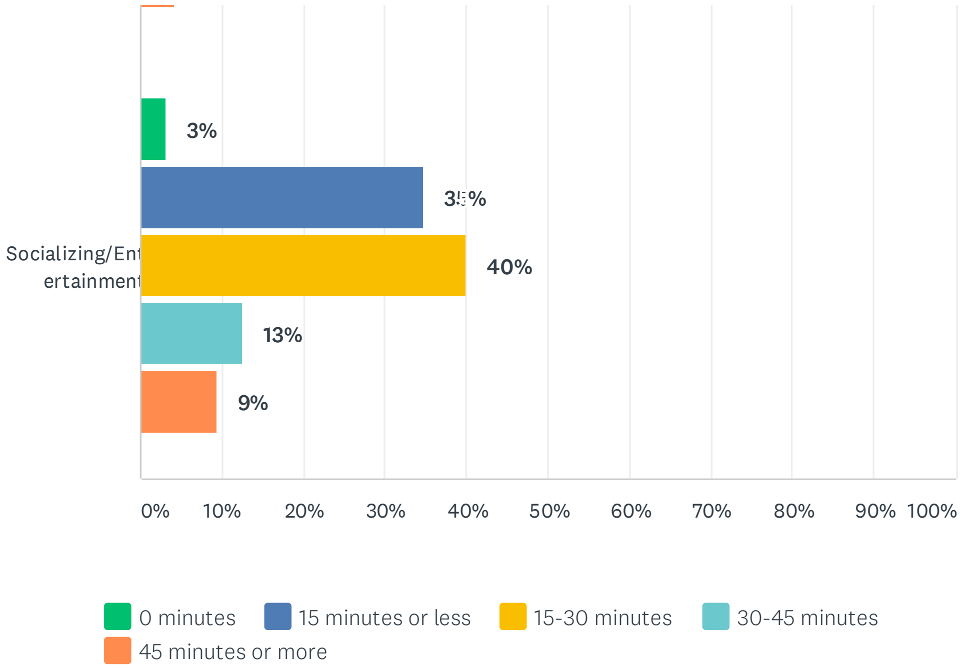


ANSWER CHOICES	RESPONSES	
Driving a car, truck or van	72%	71
Bicycle	11%	11
Public transportation	6%	6
Walking	4%	4
Uber/Lyft or Taxi	2%	2
Carpooling	2%	2
Other (please specify)	2%	2
TOTAL		98

Q7 On average, how much time do you spend traveling (one-way) for the following trip types?

Answered: 97 Skipped: 6

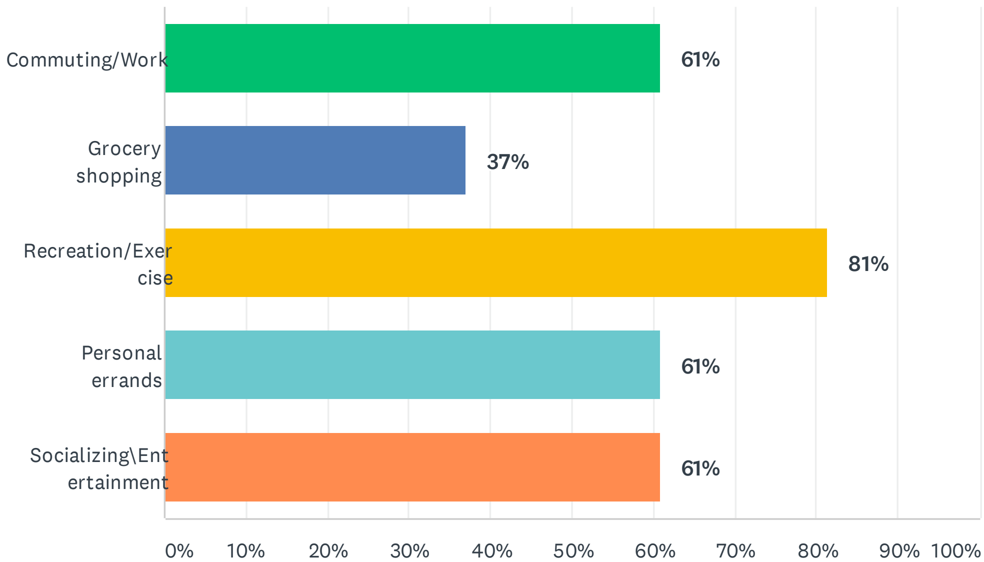




	0 MINUTES	15 MINUTES OR LESS	15-30 MINUTES	30-45 MINUTES	45 MINUTES OR MORE	TOTAL
Commuting/Work	11% 11	49% 47	20% 19	13% 12	7% 7	96
Grocery shopping	1% 1	77% 72	20% 19	2% 2	0% 0	94
Recreation/Exercise	5% 5	35% 33	28% 27	12% 11	20% 19	95
Personal Errands	1% 1	48% 46	32% 30	15% 14	4% 4	95
Socializing/Entertainment	3% 3	35% 33	40% 38	13% 12	9% 9	95

Q8 For which of the following trips would you consider using a bicycle?

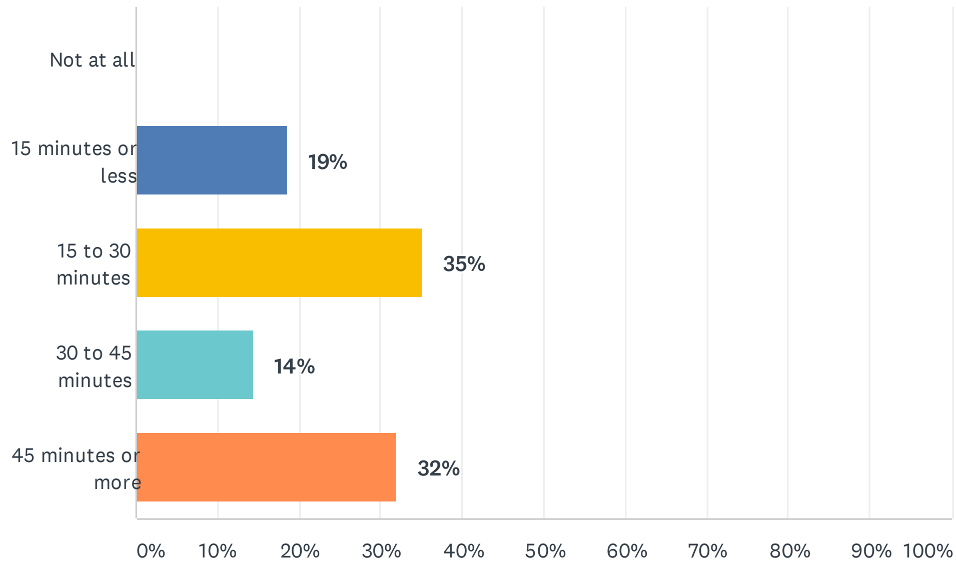
Answered: 97 Skipped: 6



ANSWER CHOICES	RESPONSES	
Commuting/Work	61%	59
Grocery shopping	37%	36
Recreation/Exercise	81%	79
Personal errands	61%	59
Socializing\Entertainment	61%	59
Total Respondents: 97		

Q9 How far would you be willing to ride a bicycle to make a typical trip?

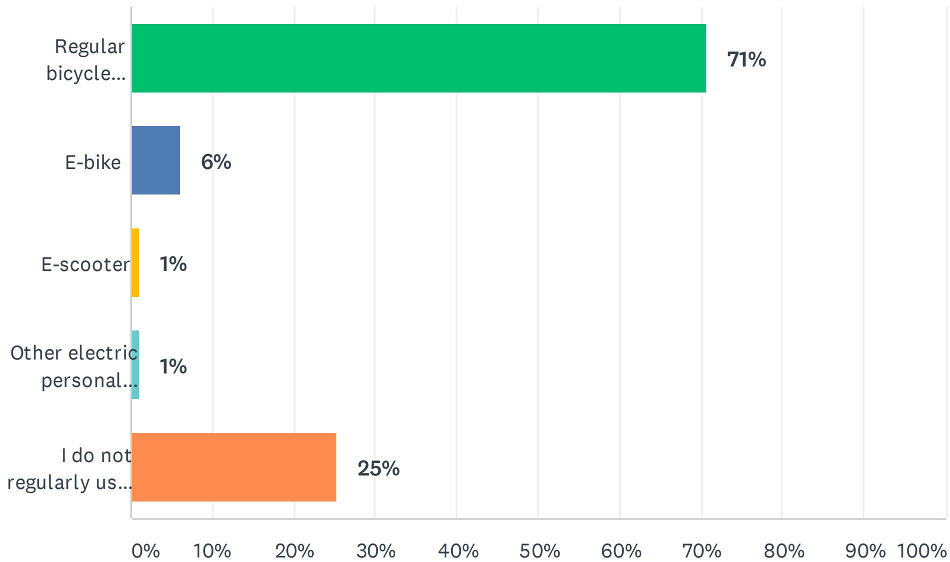
Answered: 97 Skipped: 6



ANSWER CHOICES	RESPONSES	
Not at all	0%	0
15 minutes or less	19%	18
15 to 30 minutes	35%	34
30 to 45 minutes	14%	14
45 minutes or more	32%	31
TOTAL		97

Q10 Do you regularly use any of the following forms of transportation?

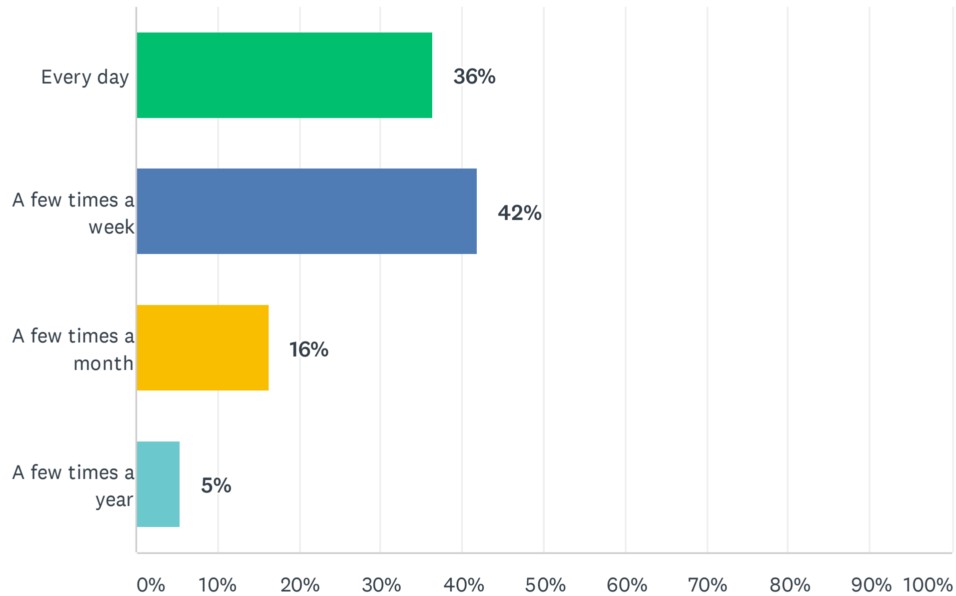
Answered: 99 Skipped: 4



ANSWER CHOICES	RESPONSES	
Regular bicycle (non-motorized)	71%	70
E-bike	6%	6
E-scooter	1%	1
Other electric personal vehicles (e.g. Segway, OneWheel, electric skateboard, etc.)	1%	1
I do not regularly use any of these modes of transportation	25%	25
Total Respondents: 99		

Q11 How often do you use these modes of transportation?

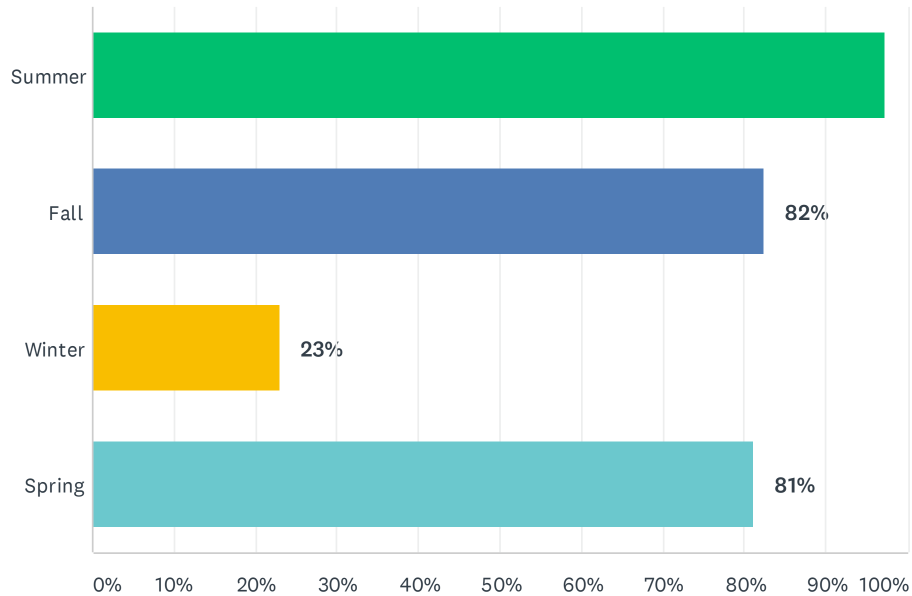
Answered: 74   Skipped: 29



ANSWER CHOICES	RESPONSES	
Every day	36%	27
A few times a week	42%	31
A few times a month	16%	12
A few times a year	5%	4
TOTAL		74

Q12 In what seasons do you use these modes of transportation?

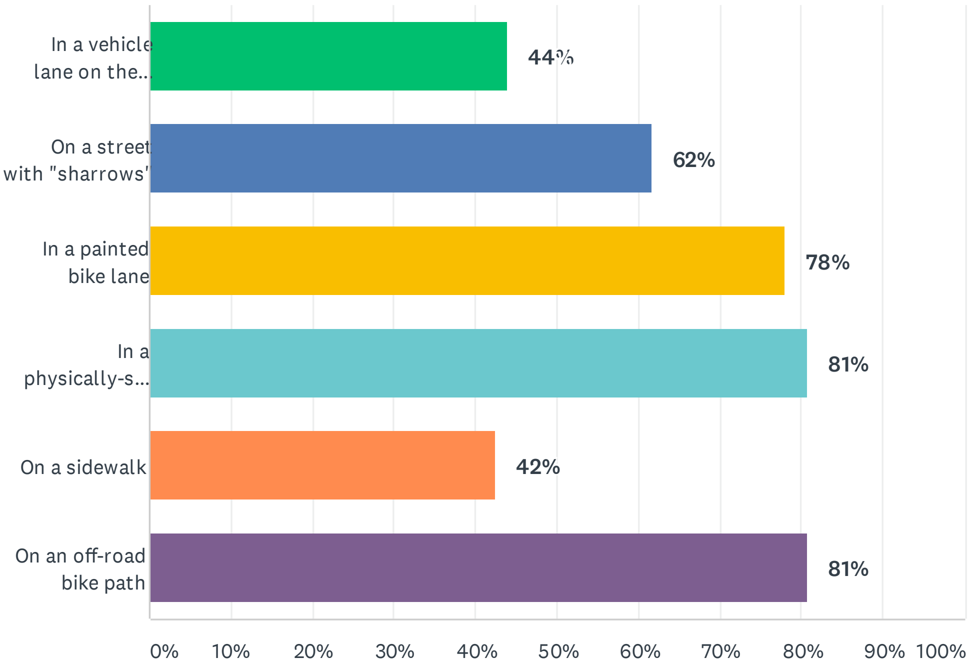
Answered: 74 Skipped: 29



ANSWER CHOICES	RESPONSES	
Summer	97%	72
Fall	82%	61
Winter	23%	17
Spring	81%	60
Total Respondents: 74		

Q13 In what street settings do you feel comfortable using these modes of transportation?

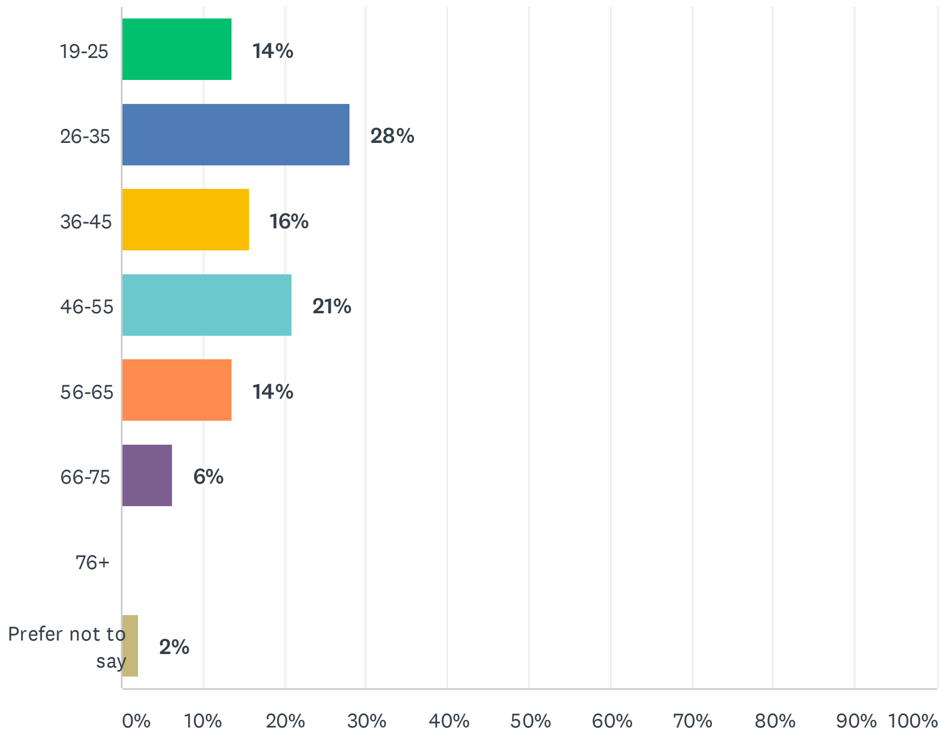
Answered: 73 Skipped: 30



In a vehicle lane on the street	44%	32
On a street with "sharrows"	62%	45
In a painted bike lane	78%	57
In a physically-separated bike lane	81%	59
On a sidewalk	42%	31
On an off-road bike path	81%	59
Total Respondents: 73		

Q14 How old are you?

Answered: 96 Skipped: 7



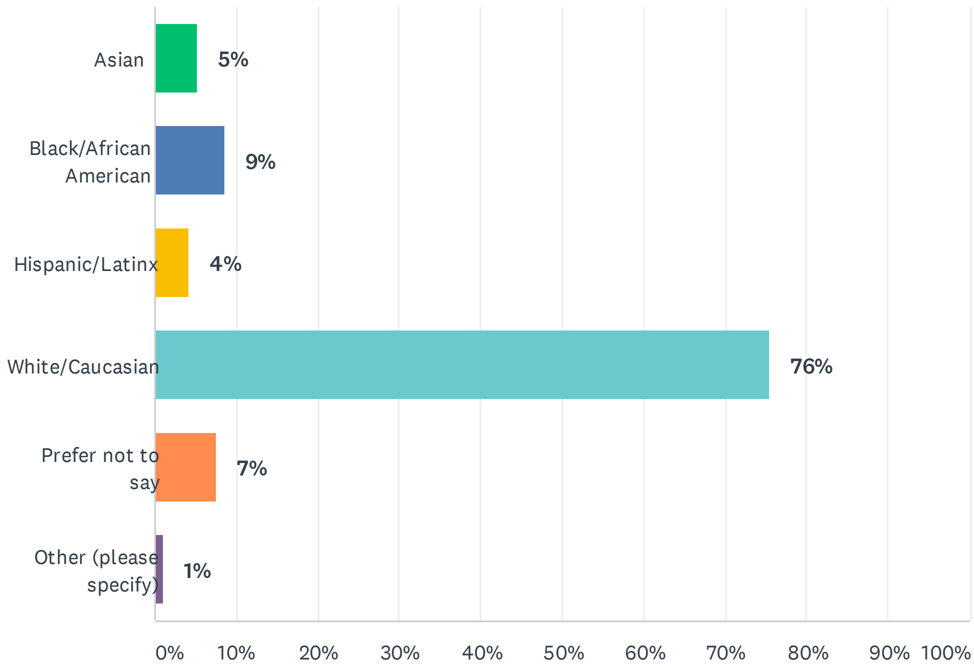
ANSWER CHOICES	RESPONSES	
19-25	14%	13
26-35	28%	27
36-45	16%	15
46-55	21%	20
56-65	14%	13
66-75	6%	6
76+	0%	0
Prefer not to say	2%	2
TOTAL		96

Q15 What ZIP Code do you live in?

Answered: 93 Skipped: 10

Q16 How do you identify your race/ethnicity?

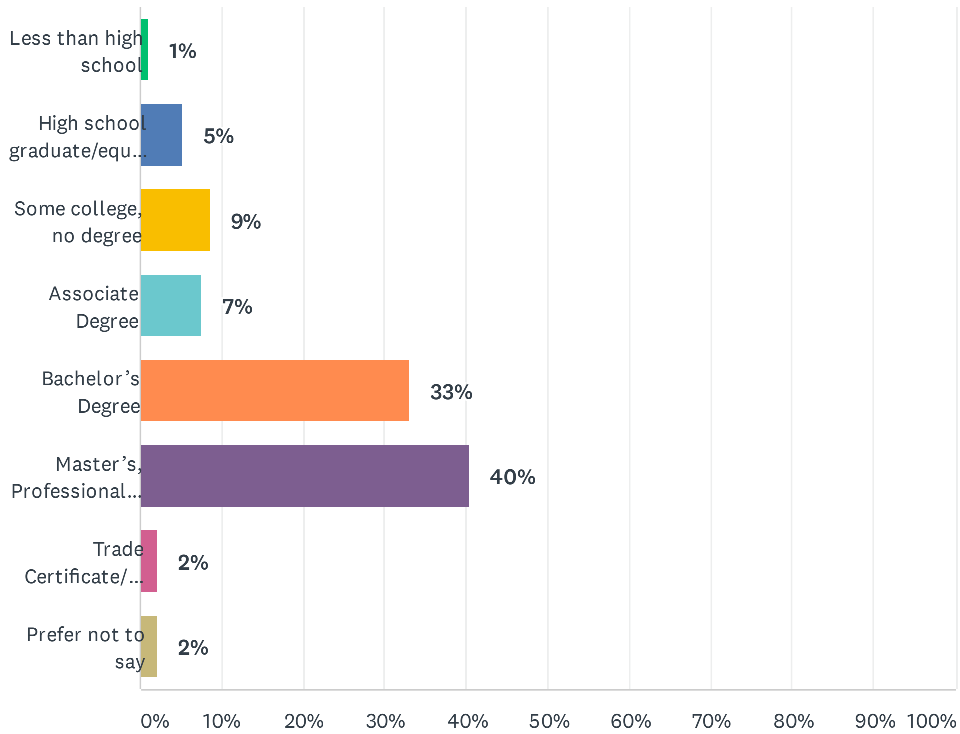
Answered: 94 Skipped: 9



ANSWER CHOICES	RESPONSES	
Asian	5%	5
Black/African American	9%	8
Hispanic/Latinx	4%	4
White/Caucasian	76%	71
Prefer not to say	7%	7
Other (please specify)	1%	1
Total Respondents: 94		

Q17 What is your highest level of education?

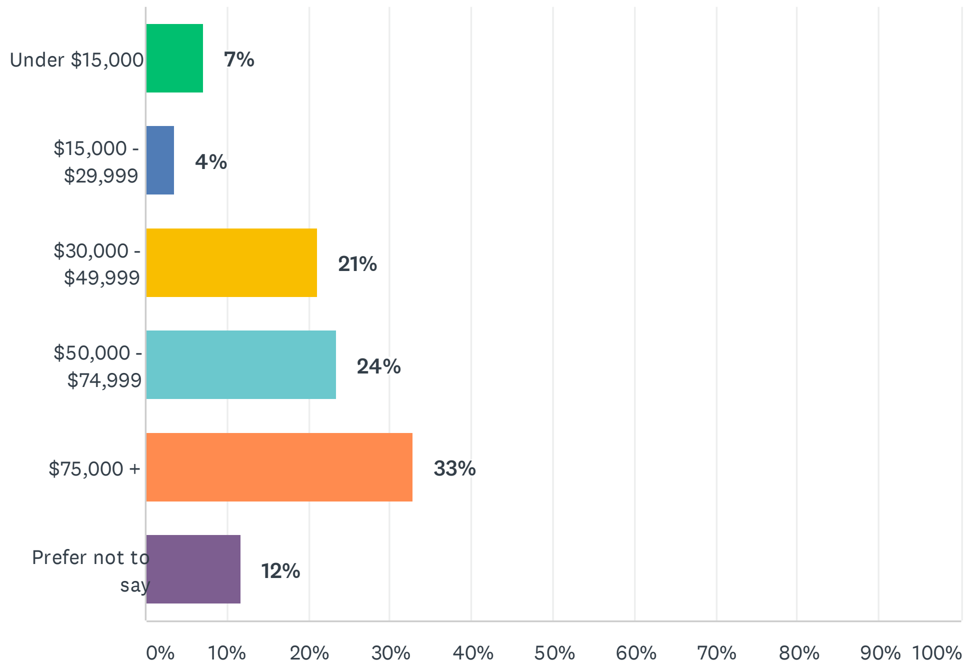
Answered: 94   Skipped: 9



ANSWER CHOICES	RESPONSES	
Less than high school	1%	1
High school graduate/equivalent	5%	5
Some college, no degree	9%	8
Associate Degree	7%	7
Bachelor's Degree	33%	31
Master's, Professional or Doctoral degree	40%	38
Trade Certificate/Apprenticeship	2%	2
Prefer not to say	2%	2
TOTAL		94

Q18 What is your annual household income?

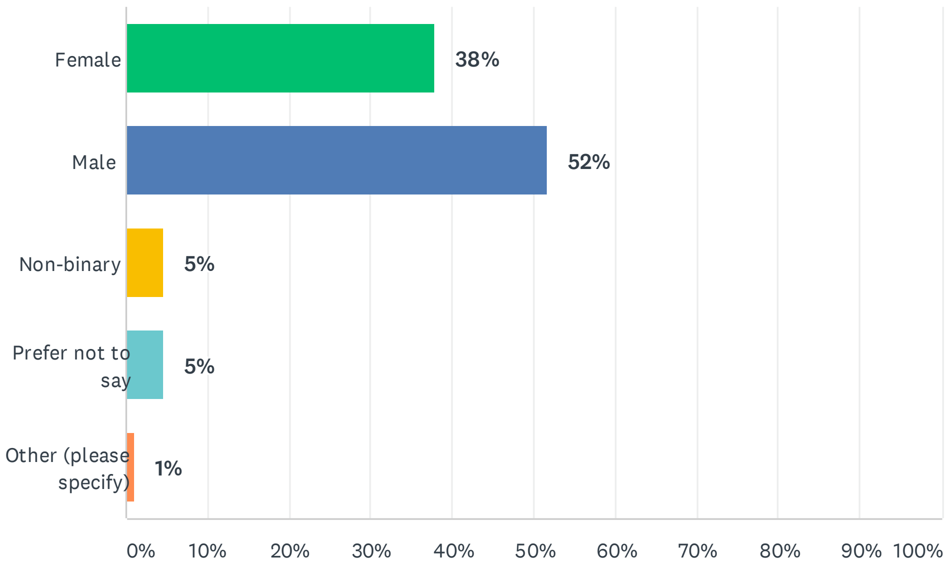
Answered: 85 Skipped: 18



ANSWER CHOICES	RESPONSES	
Under $15,000	7%	6
$15,000 - $29,999	4%	3
$30,000 - $49,999	21%	18
$50,000 - $74,999	24%	20
$75,000 +	33%	28
Prefer not to say	12%	10
TOTAL		85

Q19 How do you identify your gender?

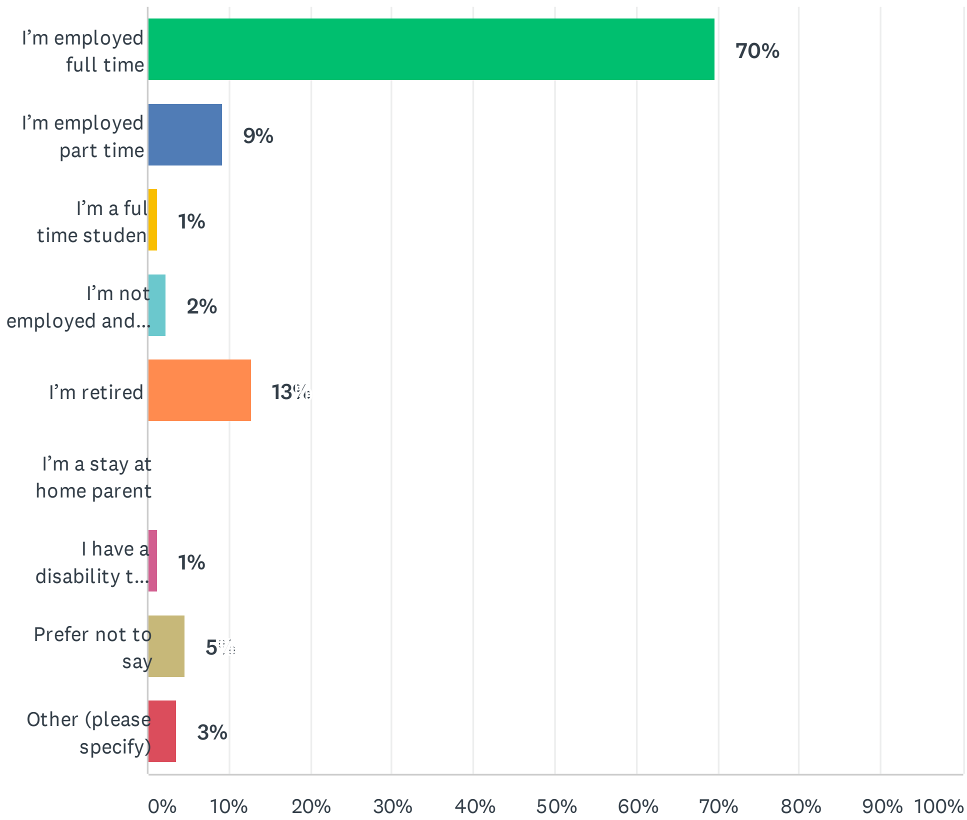
Answered: 87 Skipped: 16



ANSWER CHOICES	RESPONSES	
Female	38%	33
Male	52%	45
Non-binary	5%	4
Prefer not to say	5%	4
Other (please specify)	1%	1
TOTAL		87

Q20 Are you currently employed?

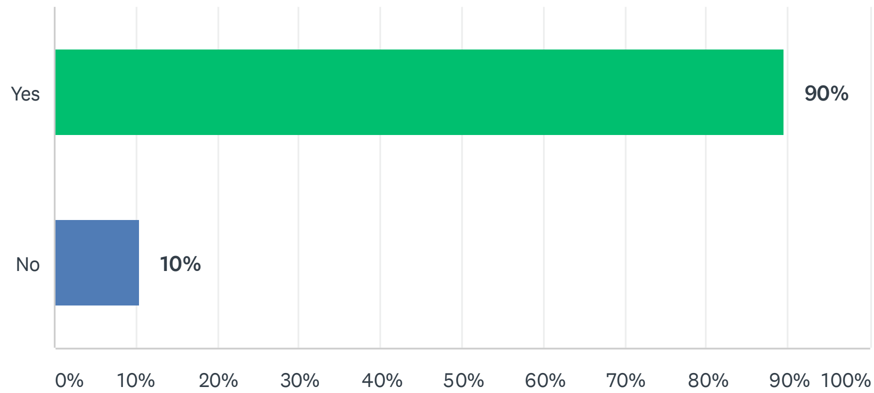
Answered: 86 Skipped: 17



ANSWER CHOICES	RESPONSES	
I'm employed full time	70%	60
I'm employed part time	9%	8
I'm a full time student	1%	1
I'm not employed and looking for work	2%	2
I'm retired	13%	11
I'm a stay at home parent	0%	0
I have a disability that prevents me from working	1%	1
Prefer not to say	5%	4
Other (please specify)	3%	3
Total Respondents: 86		

Q21 Are you taking this survey at an in-person demonstration event?

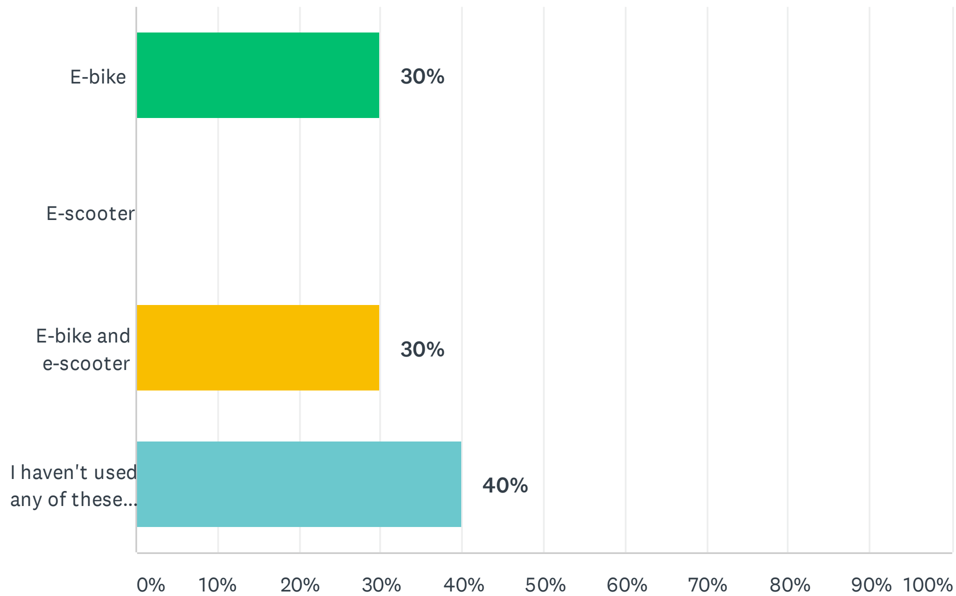
Answered: 96 Skipped: 7



ANSWER CHOICES	RESPONSES	
Yes	90%	86
No	10%	10
TOTAL		96

Q22 Which of the following devices have you used before?

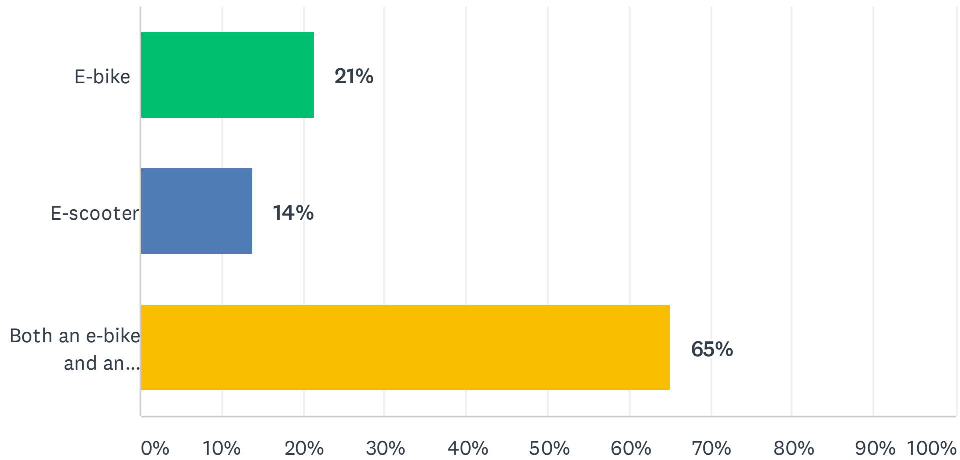
Answered: 10 Skipped: 93



ANSWER CHOICES	RESPONSES	
E-bike	30%	3
E-scooter	0%	0
E-bike and e-scooter	30%	3
I haven't used any of these devices before.	40%	4
TOTAL		10

Q23 Which devices did you try out today?

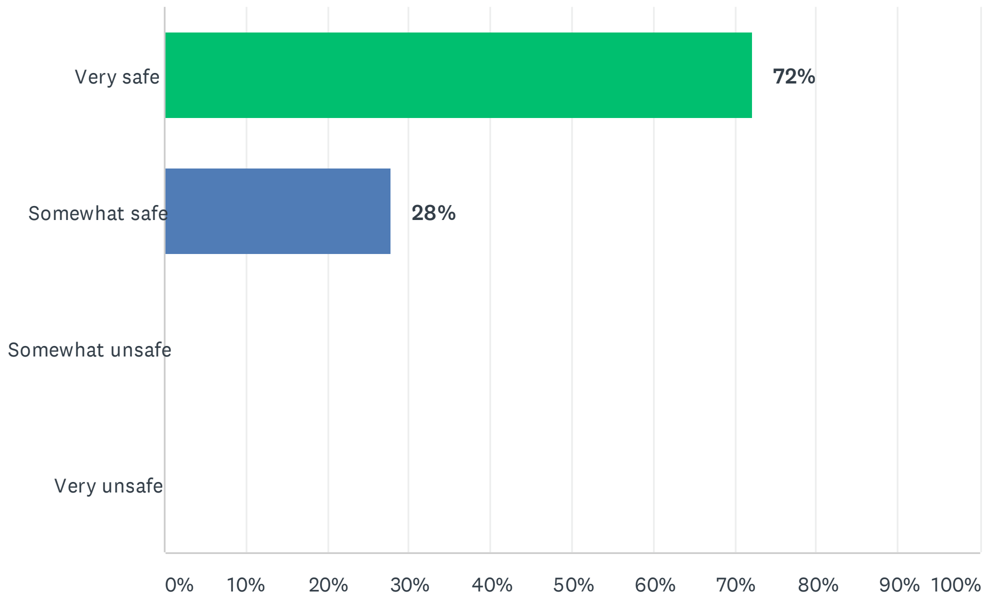
Answered: 80   Skipped: 23



ANSWER CHOICES	RESPONSES	
E-bike	21%	17
E-scooter	14%	11
Both an e-bike and an e-scooter	65%	52
TOTAL		80

Q24 How safe did you feel riding an e-bike, in general?

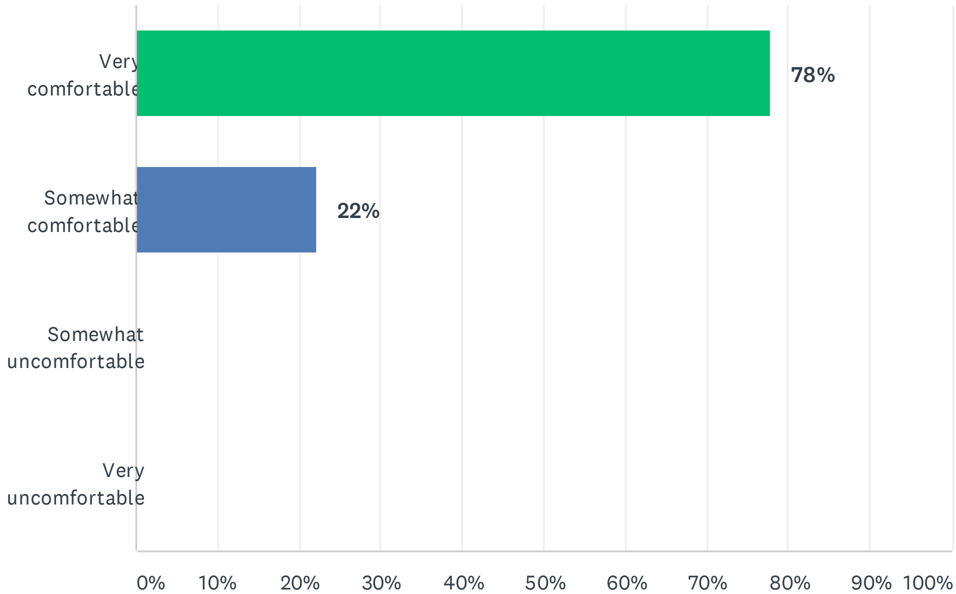
Answered: 18 Skipped: 85



ANSWER CHOICES	RESPONSES	
Very safe	72%	13
Somewhat safe	28%	5
Somewhat unsafe	0%	0
Very unsafe	0%	0
TOTAL		18

Q25 How comfortable would you feel riding an e-bike in your neighborhood?

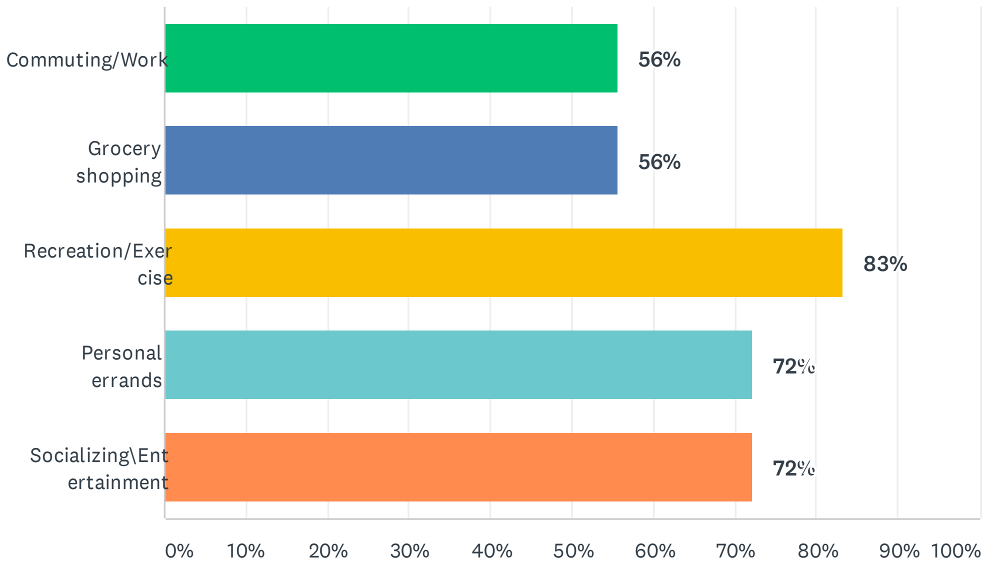
Answered: 18 Skipped: 85



ANSWER CHOICES	RESPONSES	
Very comfortable	78%	14
Somewhat comfortable	22%	4
Somewhat uncomfortable	0%	0
Very uncomfortable	0%	0
TOTAL		18

Q26 Would you consider using an e-bike for any of the following trips?

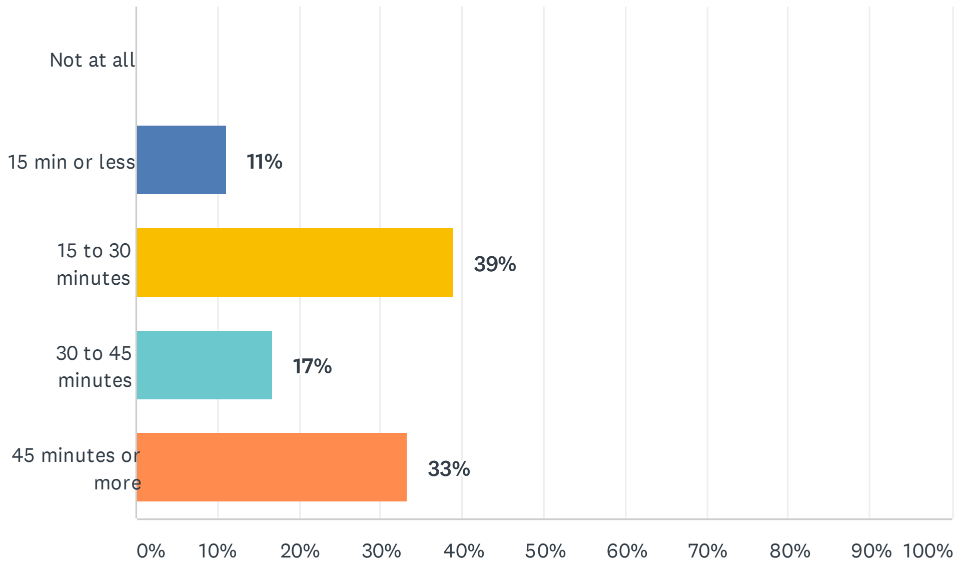
Answered: 18 Skipped: 85



ANSWER CHOICES	RESPONSES	
Commuting/Work	56%	10
Grocery shopping	56%	10
Recreation/Exercise	83%	15
Personal errands	72%	13
Socializing\Entertainment	72%	13
Total Respondents: 18		

Q27 How far would you be willing to ride an e-bike to make a typical trip (one way)?

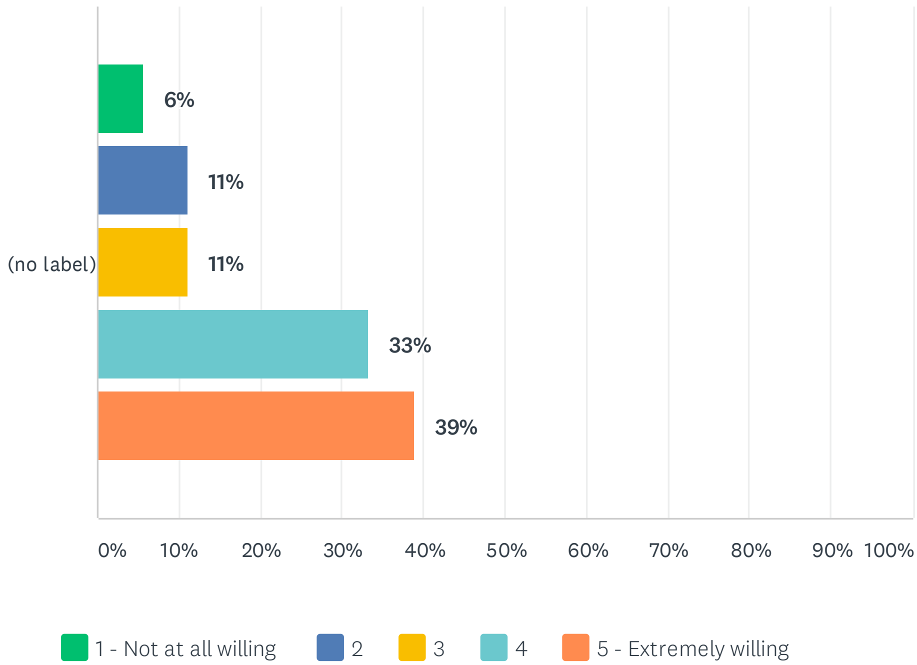
Answered: 18 Skipped: 85



ANSWER CHOICES	RESPONSES	
Not at all	0%	0
15 min or less	11%	2
15 to 30 minutes	39%	7
30 to 45 minutes	17%	3
45 minutes or more	33%	6
TOTAL		18

Q28 On a scale of 1 to 5, how willing would you be to use an e-bike for your local transportation needs?

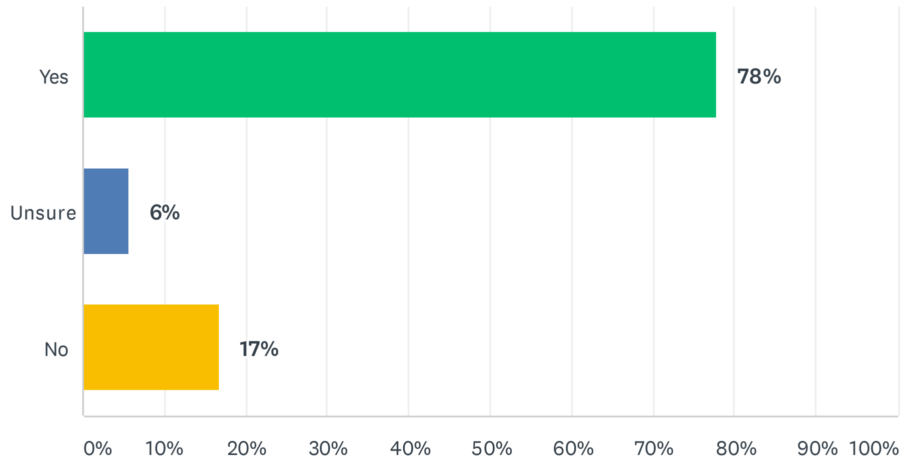
Answered: 18 Skipped: 85



	1 - NOT AT ALL WILLING	2	3	4	5 - EXTREMELY WILLING	TOTAL	WEIGHTED AVERAGE
(no label)	6% 1	11% 2	11% 2	33% 6	39% 7	18	1.00

Q29 Would you consider using an e-bike through a shared system or “bikeshare” program?

Answered: 18 Skipped: 85



ANSWER CHOICES	RESPONSES	
Yes	78%	14
Unsure	6%	1
No	17%	3
TOTAL		18

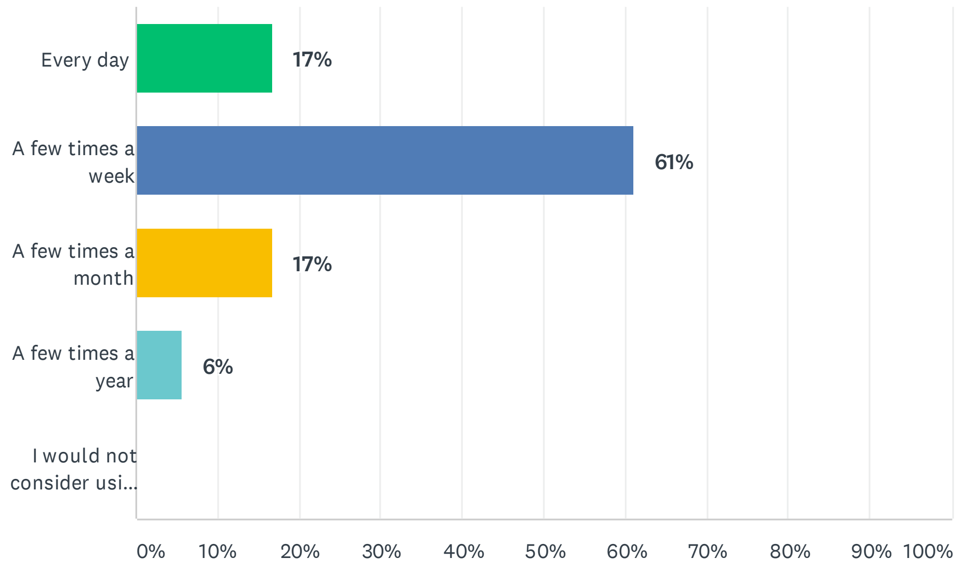
Q30 How much would you pay to purchase an e-bike?

Answered: 18   Skipped: 85

ANSWER CHOICES	RESPONSES	
I wouldn’t want to buy one	22%	4
Less than $500	22%	4
$500 to $1,000	28%	5
$1,000 to $2,000	22%	4
$2,000 or more	6%	1
Unsure	0%	0
TOTAL		18

Q31 How often would you consider using an e-bike?

Answered: 18 Skipped: 85



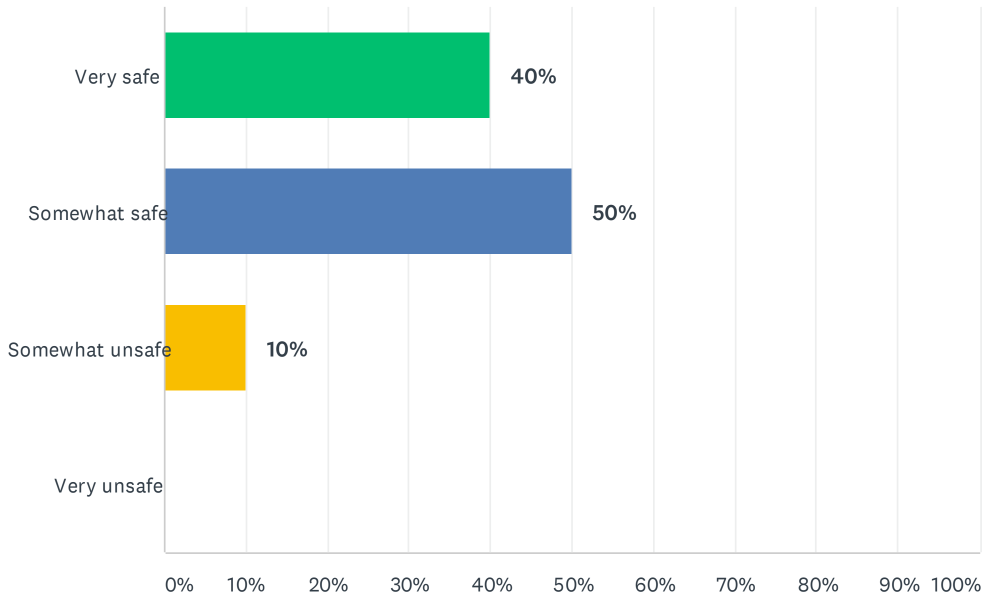
ANSWER CHOICES	RESPONSES	
Every day	17%	3
A few times a week	61%	11
A few times a month	17%	3
A few times a year	6%	1
I would not consider using an e-bike	0%	0
TOTAL		18

Q32 If this was your first time riding an e-bike, in a few words, how has your view of e-bikes changed after using one?

Answered: 14 Skipped: 89

Q33 How safe did you feel riding an e-scooter, in general?

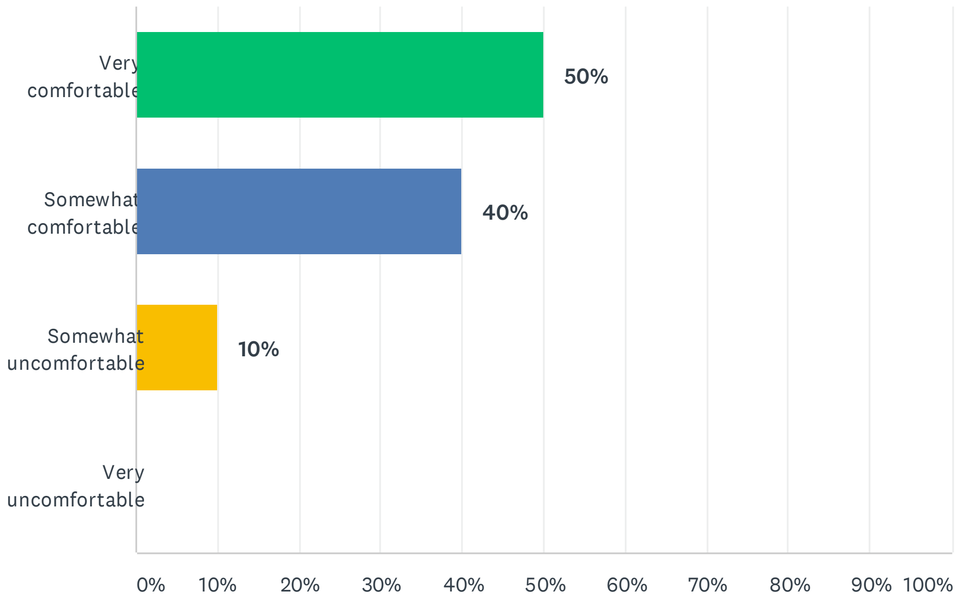
Answered: 10   Skipped: 93



ANSWER CHOICES	RESPONSES	
Very safe	40%	4
Somewhat safe	50%	5
Somewhat unsafe	10%	1
Very unsafe	0%	0
TOTAL		10

Q34 How comfortable would you feel riding an e-scooter in your neighborhood?

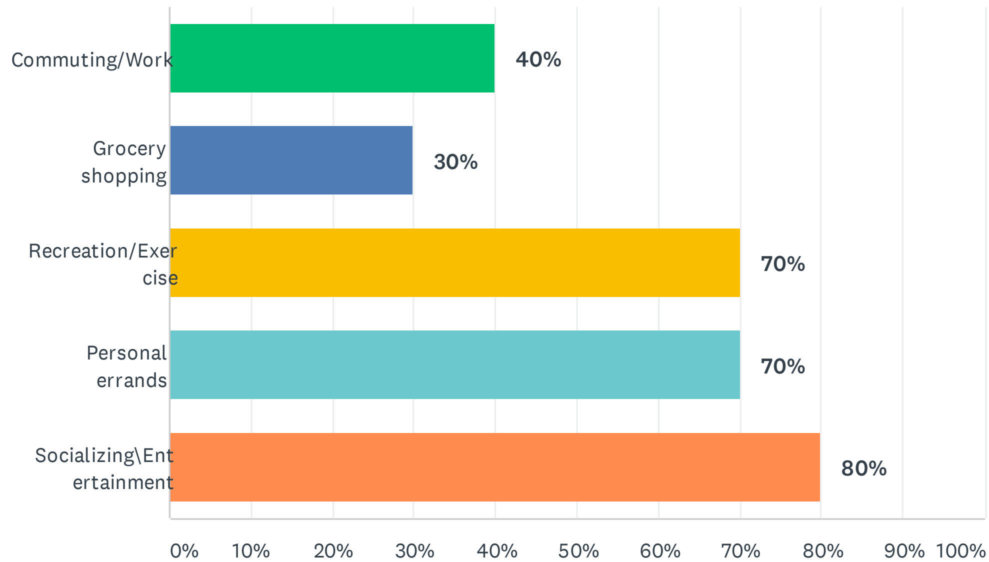
Answered: 10 Skipped: 93



ANSWER CHOICES	RESPONSES	
Very comfortable	50%	5
Somewhat comfortable	40%	4
Somewhat uncomfortable	10%	1
Very uncomfortable	0%	0
TOTAL		10

Q35 Would you consider using an e-scooter for any of the following trips?

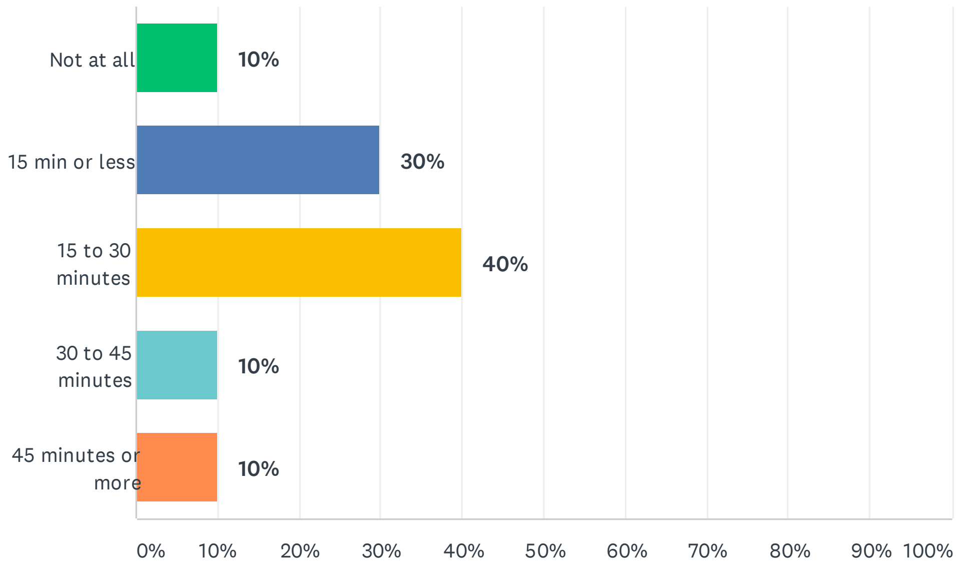
Answered: 10   Skipped: 93



ANSWER CHOICES	RESPONSES	
Commuting/Work	40%	4
Grocery shopping	30%	3
Recreation/Exercise	70%	7
Personal errands	70%	7
Socializing\Entertainment	80%	8
Total Respondents: 10		

Q36 How far would you be willing to ride an e-scooter to make a typical trip (one way)?

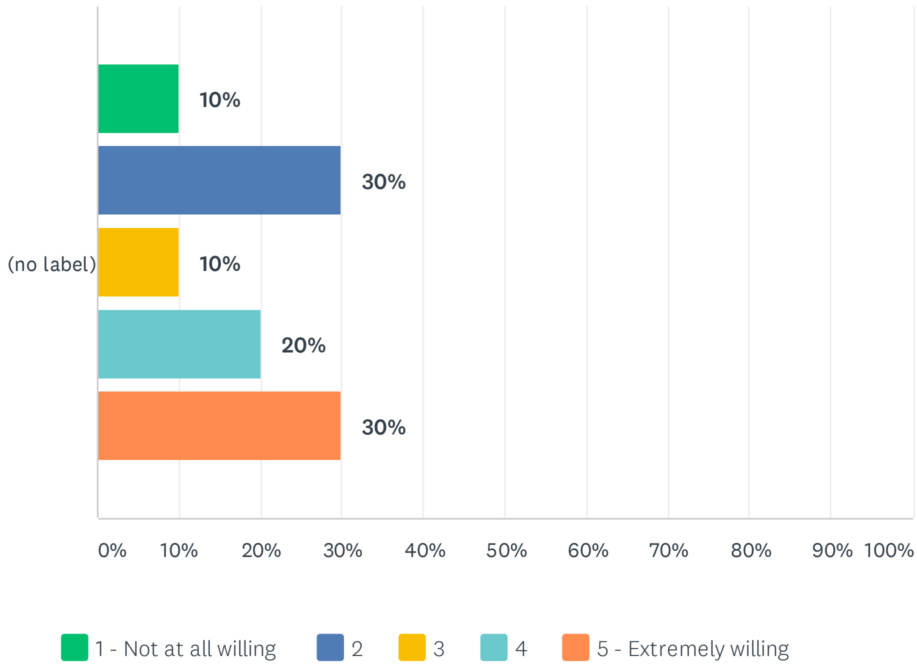
Answered: 10 Skipped: 93



ANSWER CHOICES	RESPONSES	
Not at all	10%	1
15 min or less	30%	3
15 to 30 minutes	40%	4
30 to 45 minutes	10%	1
45 minutes or more	10%	1
TOTAL		10

Q37 On a scale of 1 to 5, how willing would you be to use an e-scooter for your local transportation needs?

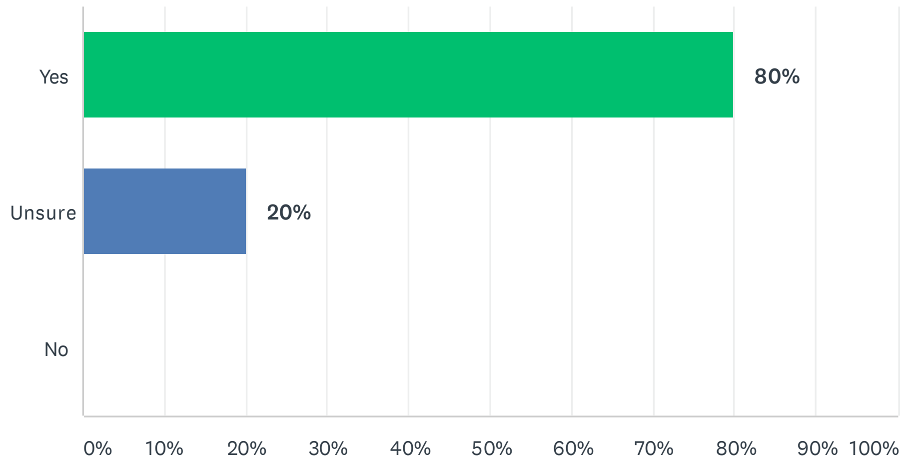
Answered: 10 Skipped: 93



	1 - NOT AT ALL WILLING	2	3	4	5 - EXTREMELY WILLING	TOTAL	WEIGHTED AVERAGE
(no label)	10% 1	30% 3	10% 1	20% 2	30% 3	10	1.00

Q38 Would you consider using an e-scooter through a shared system or scootershare program?

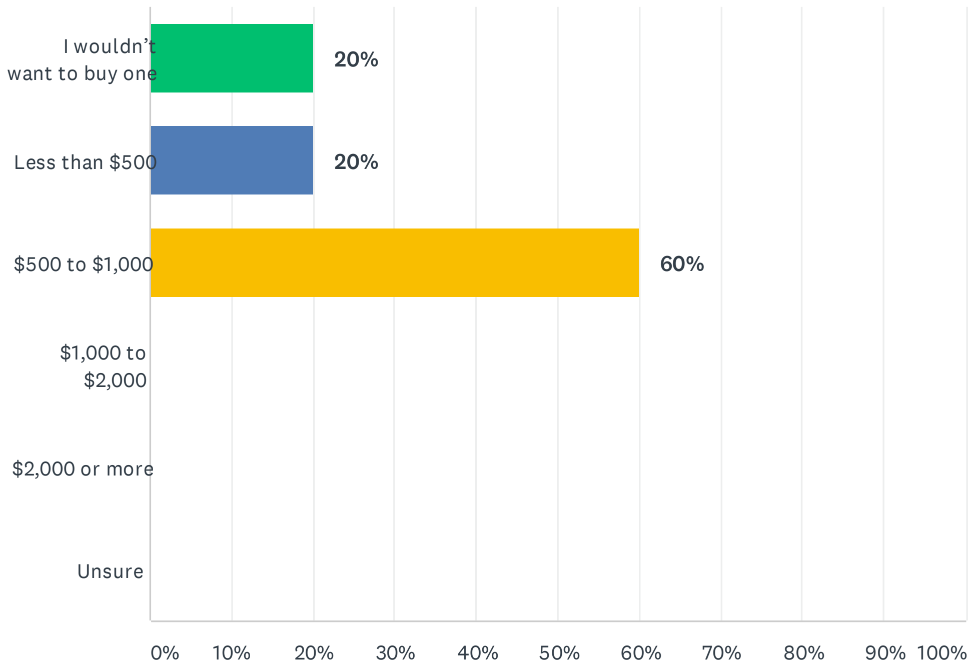
Answered: 10 Skipped: 93



ANSWER CHOICES	RESPONSES	
Yes	80%	8
Unsure	20%	2
No	0%	0
TOTAL		10

Q39 How much would you pay to purchase an e-scooter?

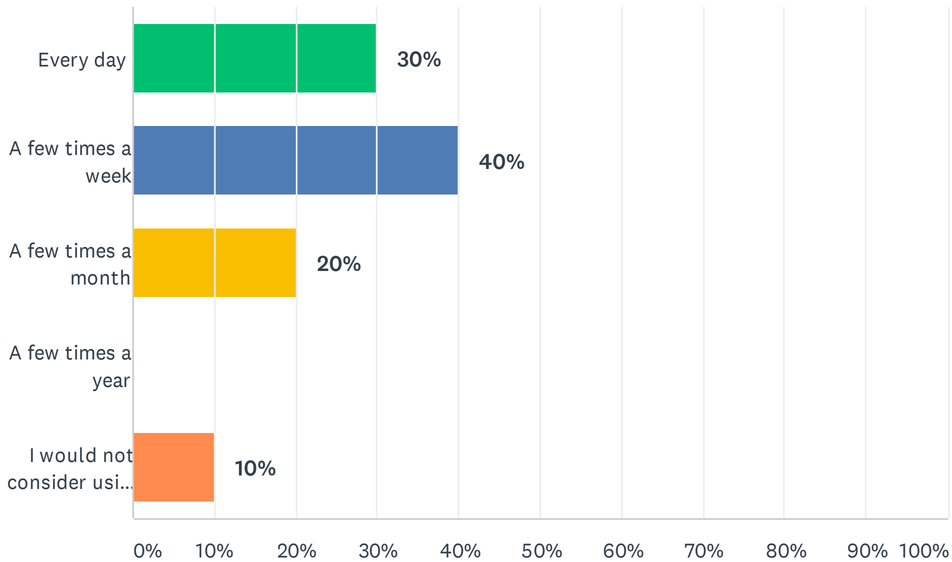
Answered: 10 Skipped: 93



ANSWER CHOICES	RESPONSES	
I wouldn't want to buy one	20%	2
Less than $500	20%	2
$500 to $1,000	60%	6
$1,000 to $2,000	0%	0
$2,000 or more	0%	0
Unsure	0%	0
TOTAL		10

Q40 How often would you consider using an e-scooter?

Answered: 10   Skipped: 93



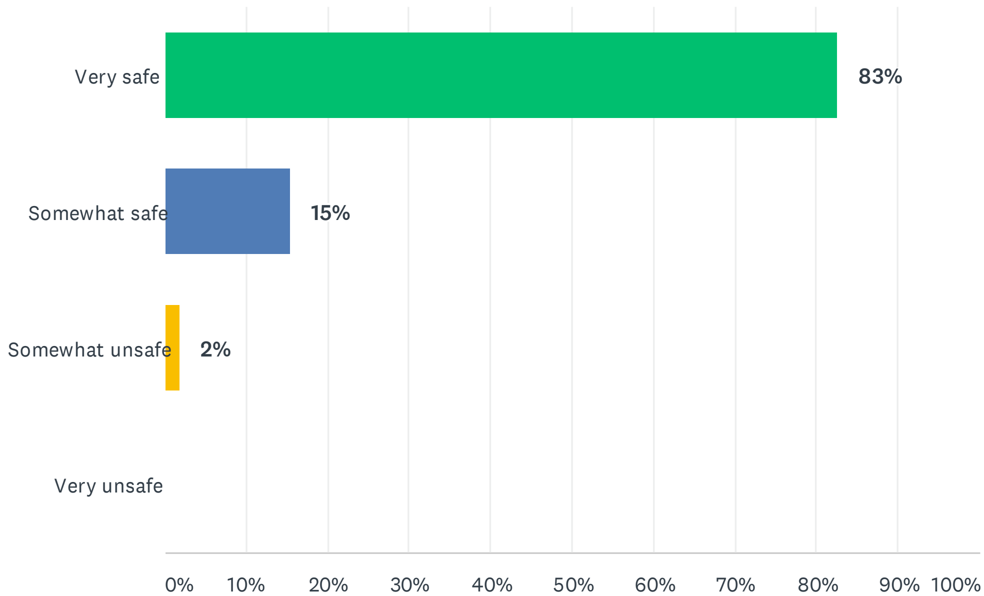
ANSWER CHOICES	RESPONSES	
Every day	30%	3
A few times a week	40%	4
A few times a month	20%	2
A few times a year	0%	0
I would not consider using an e-scooter	10%	1
TOTAL		10

Q41 If this was your first time riding an e-scooter, in a few words, how has your view of e-scooters changed after using one?

Answered: 9 Skipped: 94

Q42 How safe did you feel riding an e-bike, in general?

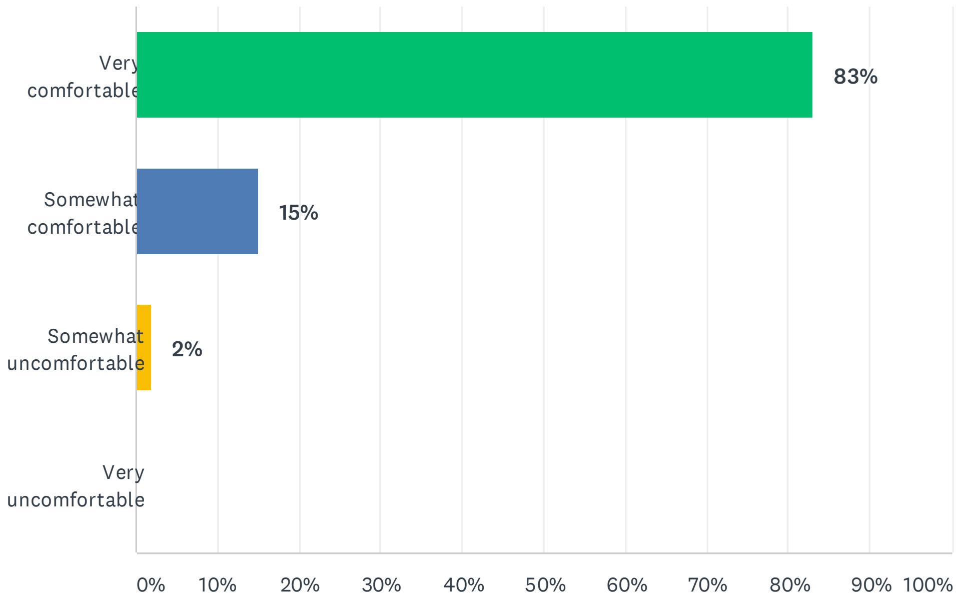
Answered: 52 Skipped: 51



ANSWER CHOICES	RESPONSES	
Very safe	83%	43
Somewhat safe	15%	8
Somewhat unsafe	2%	1
Very unsafe	0%	0
TOTAL		52

Q43 How comfortable would you feel riding an e-bike in your neighborhood?

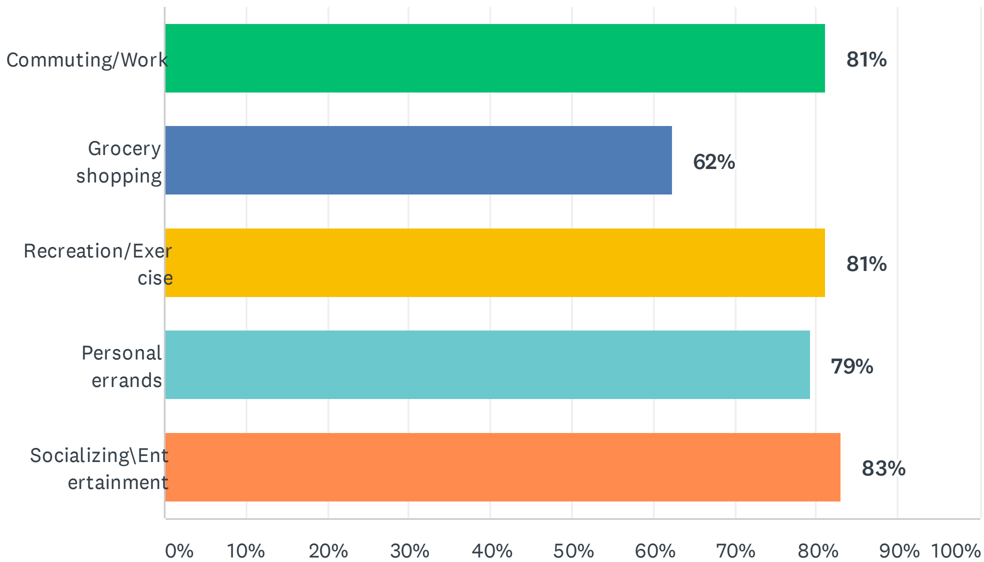
Answered: 53 Skipped: 50



ANSWER CHOICES	RESPONSES	
Very comfortable	83%	44
Somewhat comfortable	15%	8
Somewhat uncomfortable	2%	1
Very uncomfortable	0%	0
TOTAL		53

Q44 Would you consider using an e-bike for any of the following trips?

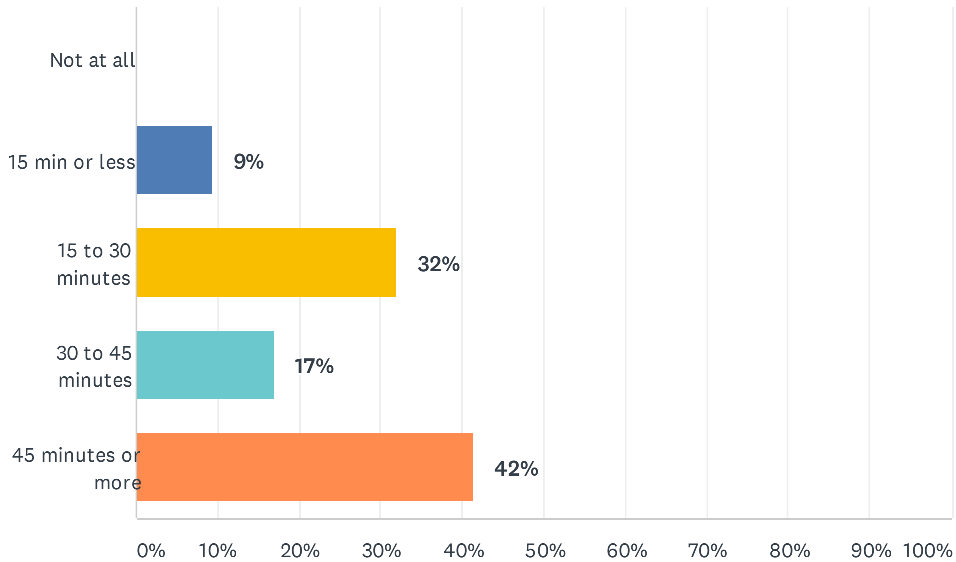
Answered: 53 Skipped: 50



ANSWER CHOICES	RESPONSES	
Commuting/Work	81%	43
Grocery shopping	62%	33
Recreation/Exercise	81%	43
Personal errands	79%	42
Socializing\Entertainment	83%	44
Total Respondents: 53		

Q45 How far would you be willing to ride an e-bike to make a typical trip (one way)?

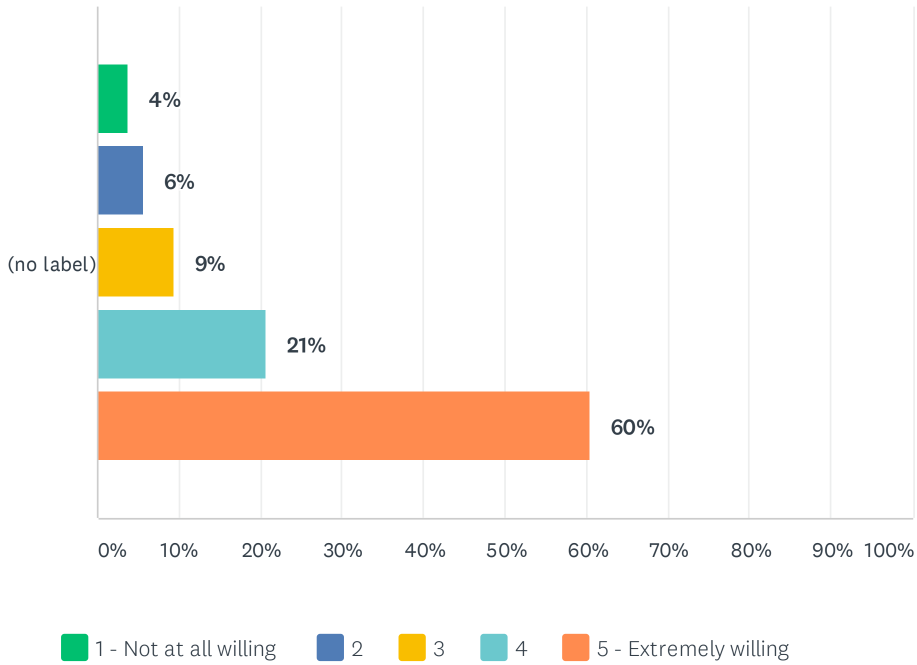
Answered: 53 Skipped: 50



ANSWER CHOICES	RESPONSES	
Not at all	0%	0
15 min or less	9%	5
15 to 30 minutes	32%	17
30 to 45 minutes	17%	9
45 minutes or more	42%	22
TOTAL		53

Q46 On a scale of 1 to 5, how willing would you be to use an e-bike for your local transportation needs?

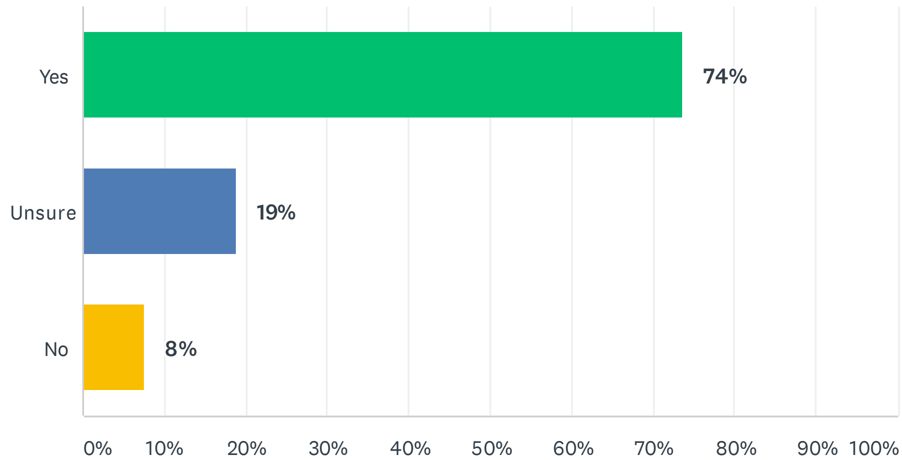
Answered: 53 Skipped: 50



	1 - NOT AT ALL WILLING	2	3	4	5 - EXTREMELY WILLING	TOTAL	WEIGHTED AVERAGE
(no label)	4% 2	6% 3	9% 5	21% 11	60% 32	53	1.00

Q47 Would you consider using an e-bike through a shared system or "bikeshare" program?

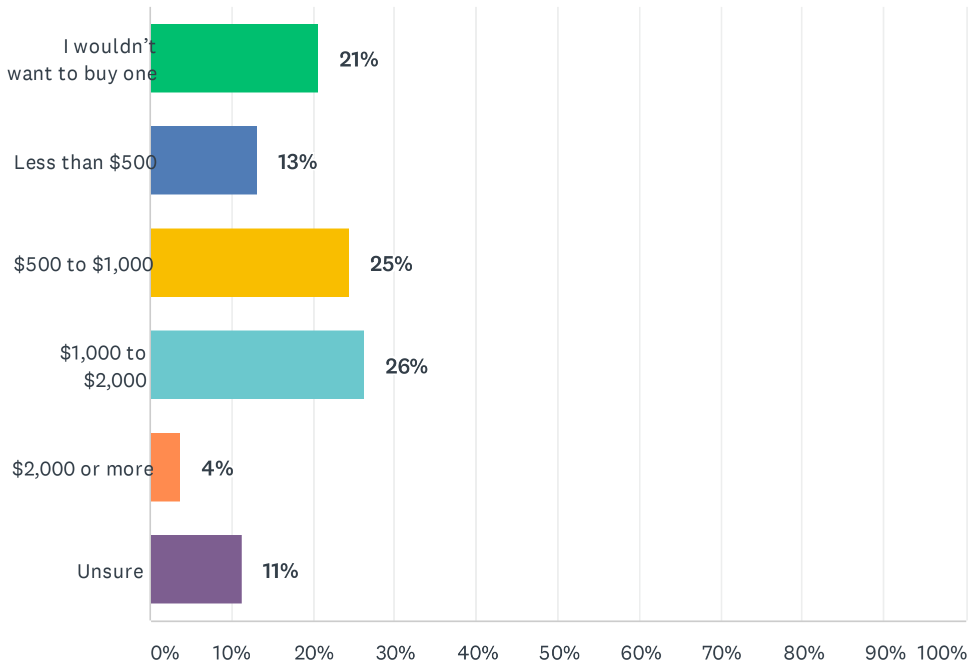
Answered: 53   Skipped: 50



ANSWER CHOICES	RESPONSES	
Yes	74%	39
Unsure	19%	10
No	8%	4
TOTAL		53

Q48 How much would you pay to purchase an e-bike?

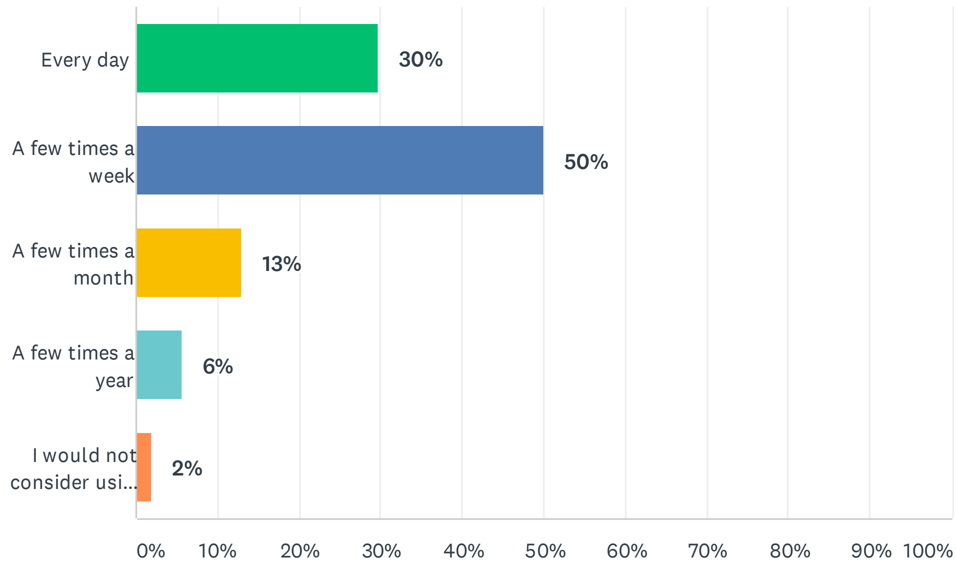
Answered: 53 Skipped: 50



ANSWER CHOICES	RESPONSES	
I wouldn't want to buy one	21%	11
Less than $500	13%	7
$500 to $1,000	25%	13
$1,000 to $2,000	26%	14
$2,000 or more	4%	2
Unsure	11%	6
TOTAL		53

Q49 How often would you consider using an e-bike?

Answered: 54 Skipped: 49



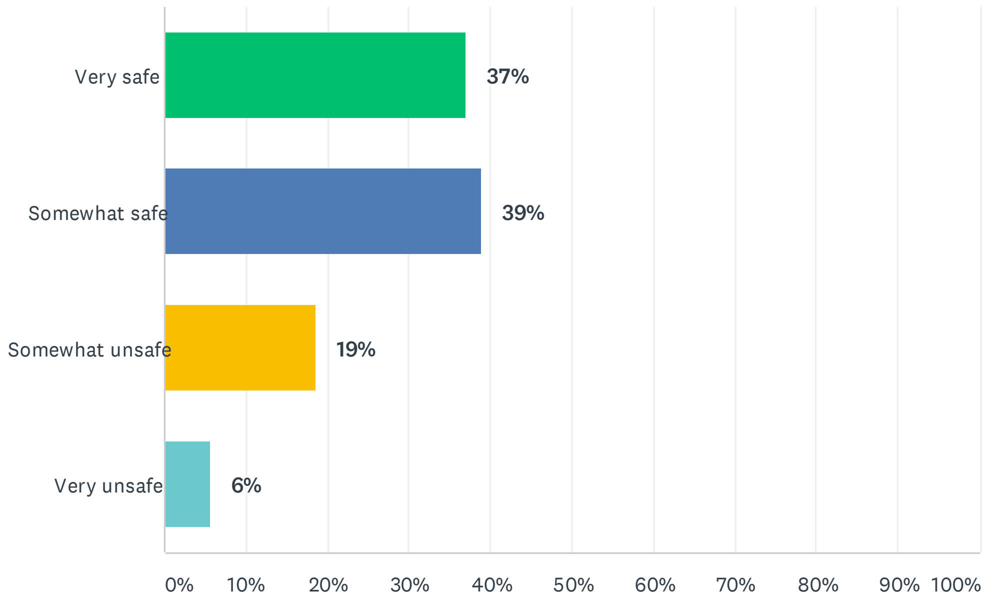
ANSWER CHOICES	RESPONSES	
Every day	30%	16
A few times a week	50%	27
A few times a month	13%	7
A few times a year	6%	3
I would not consider using an e-bike	2%	1
TOTAL		54

Q50 If this was your first time riding an e-bike, in a few words, how has your view of e-bikes changed after using one?

Answered: 42 Skipped: 61

Q51 How safe did you feel riding an e-scooter, in general?

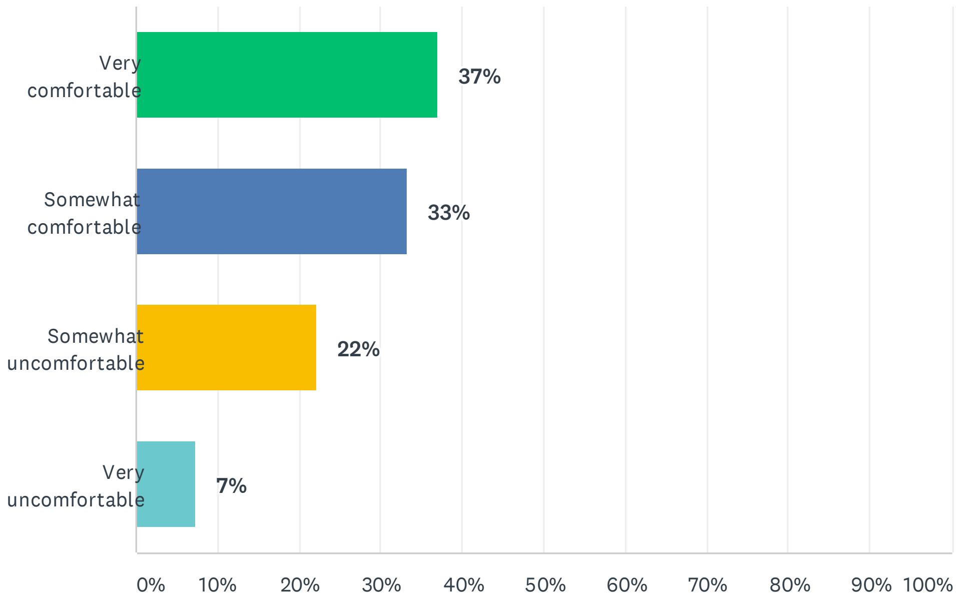
Answered: 54   Skipped: 49



ANSWER CHOICES	RESPONSES	
Very safe	37%	20
Somewhat safe	39%	21
Somewhat unsafe	19%	10
Very unsafe	6%	3
TOTAL		54

Q52 How comfortable would you feel riding an e-scooter in your neighborhood?

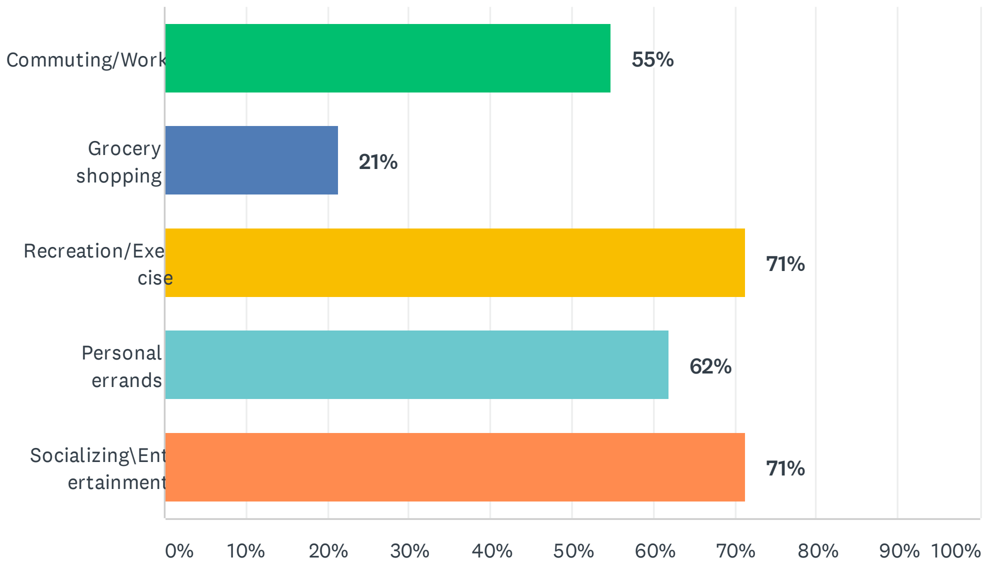
Answered: 54 Skipped: 49



ANSWER CHOICES	RESPONSES	
Very comfortable	37%	20
Somewhat comfortable	33%	18
Somewhat uncomfortable	22%	12
Very uncomfortable	7%	4
TOTAL		54

Q53 Would you consider using an e-scooter for any of the following trips?

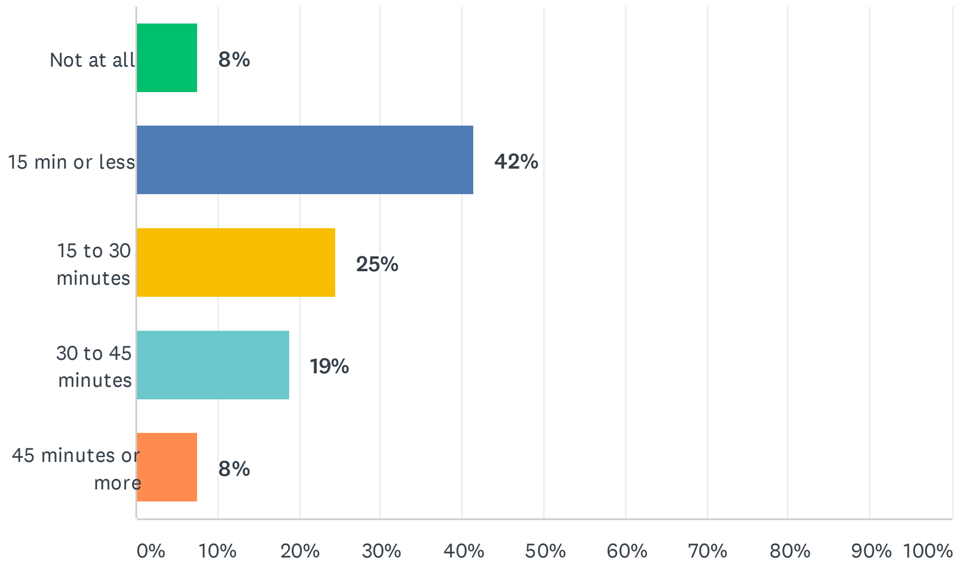
Answered: 42 Skipped: 61



ANSWER CHOICES	RESPONSES	
Commuting/Work	55%	23
Grocery shopping	21%	9
Recreation/Exercise	71%	30
Personal errands	62%	26
Socializing\Entertainment	71%	30
Total Respondents: 42		

Q54 How far would you be willing to ride an e-scooter to make a typical trip (one way)?

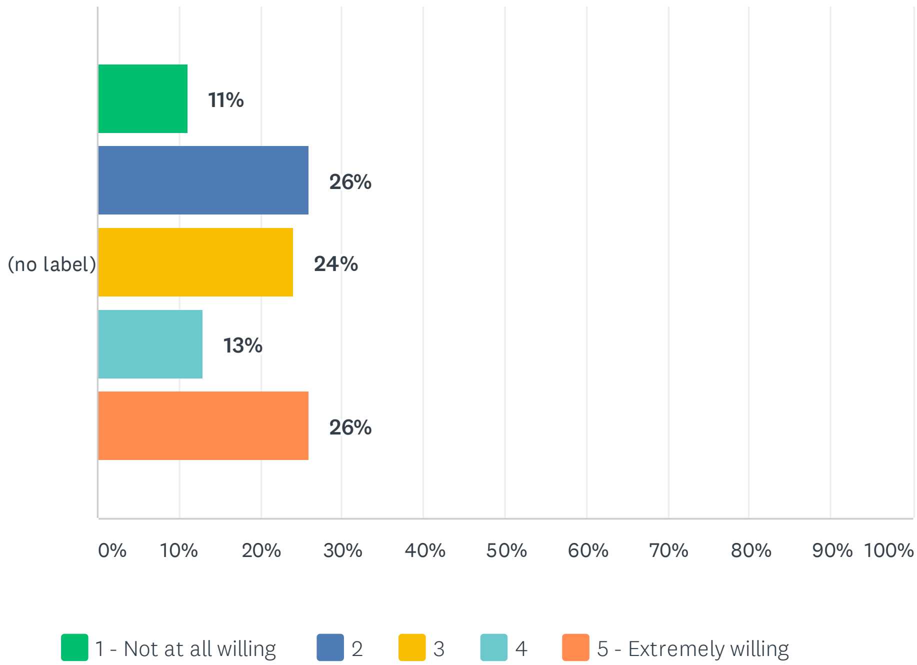
Answered: 53 Skipped: 50



ANSWER CHOICES	RESPONSES	
Not at all	8%	4
15 min or less	42%	22
15 to 30 minutes	25%	13
30 to 45 minutes	19%	10
45 minutes or more	8%	4
TOTAL		53

Q55 On a scale of 1 to 5, how willing would you be to use an e-scooter for your local transportation needs?

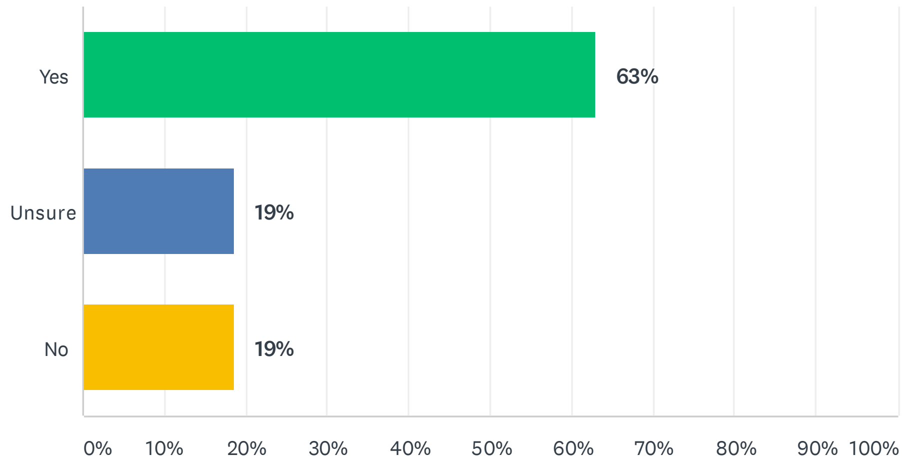
Answered: 54 Skipped: 49



	1 - NOT AT ALL WILLING	2	3	4	5 - EXTREMELY WILLING	TOTAL	WEIGHTED AVERAGE
(no label)	11% 6	26% 14	24% 13	13% 7	26% 14	54	1.00

Q56 Would you consider using an e-scooter through a shared system or scootershare program?

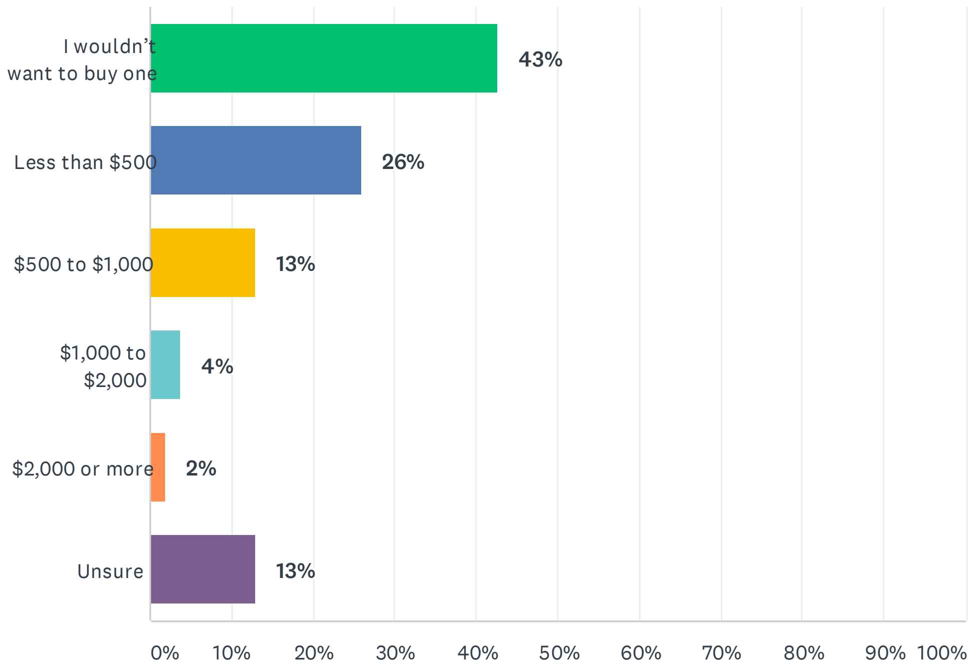
Answered: 54 Skipped: 49



ANSWER CHOICES	RESPONSES	
Yes	63%	34
Unsure	19%	10
No	19%	10
TOTAL		54

Q57 How much would you pay to purchase an e-scooter?

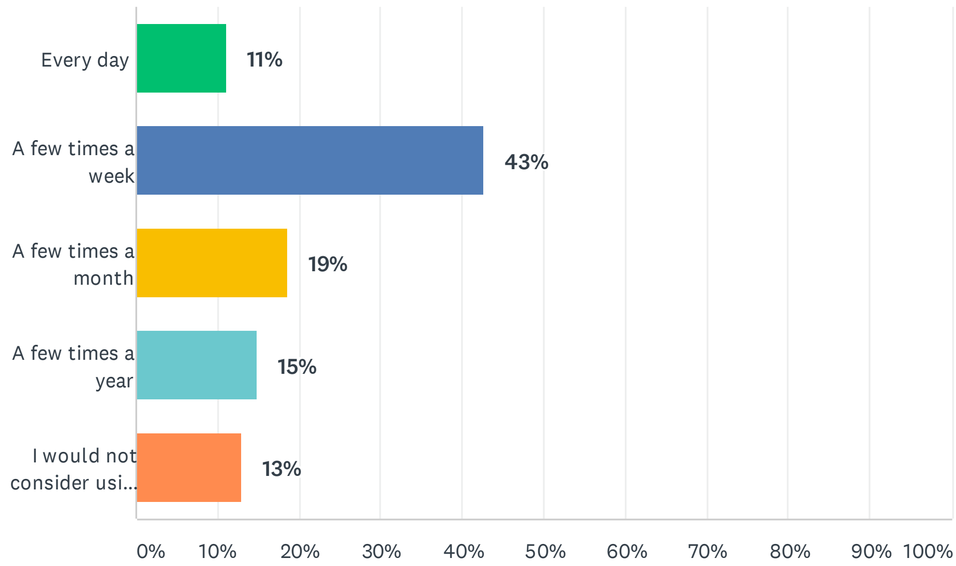
Answered: 54 Skipped: 49



ANSWER CHOICES	RESPONSES	
I wouldn't want to buy one	43%	23
Less than $500	26%	14
$500 to $1,000	13%	7
$1,000 to $2,000	4%	2
$2,000 or more	2%	1
Unsure	13%	7
TOTAL		54

Q58 How often would you consider using an e-scooter?

Answered: 54   Skipped: 49



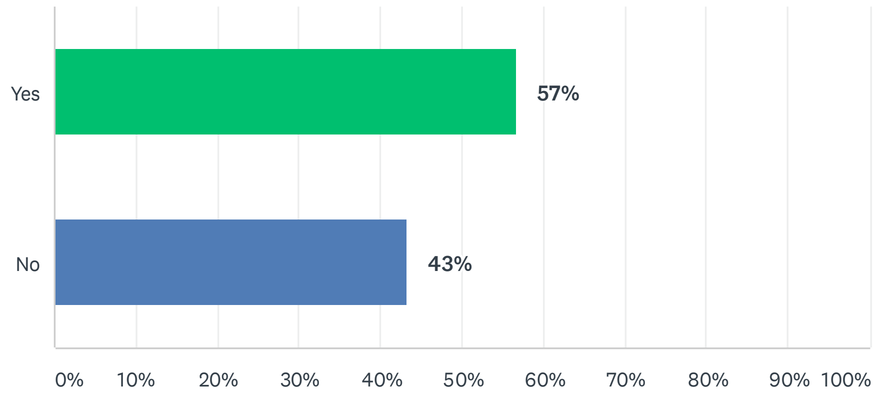
ANSWER CHOICES	RESPONSES	
Every day	11%	6
A few times a week	43%	23
A few times a month	19%	10
A few times a year	15%	8
I would not consider using an e-scooter	13%	7
TOTAL		54

Q59 If this was your first time riding an e-scooter, in a few words, how has your view of e-scooters changed after using one?

Answered: 42 Skipped: 61

Q60 Do you have about ten more minutes to help us answer a couple more questions?

Answered: 83 Skipped: 20



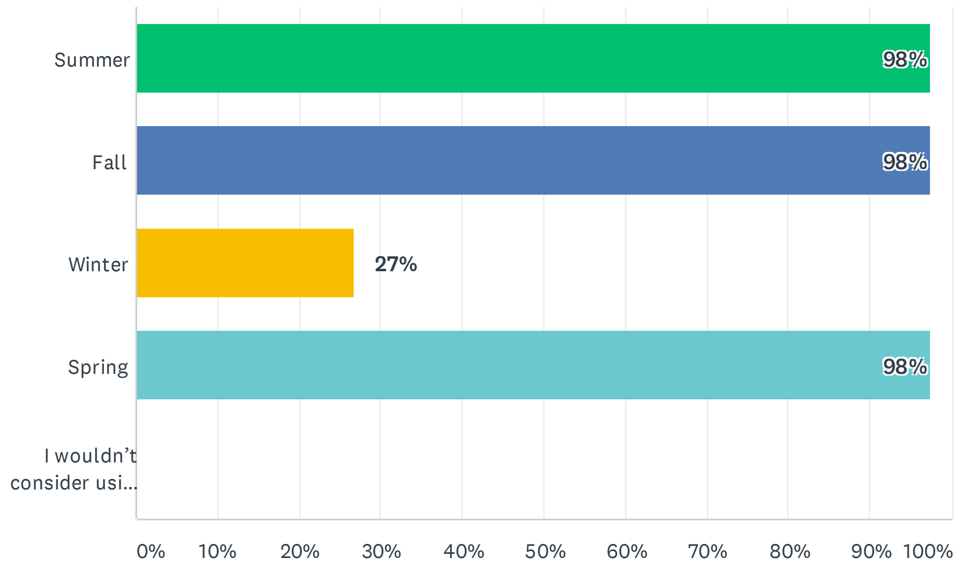
ANSWER CHOICES	RESPONSES	
Yes	57%	47
No	43%	36
TOTAL		83

Q61 If you would like to complete the remainder of the survey in the future, please provide your email address so we can send you a link to the rest of the survey. If not, just click "Next".

Answered: 11 Skipped: 92

Q62 In what seasons would you consider using an e-bike?

Answered: 41   Skipped: 62

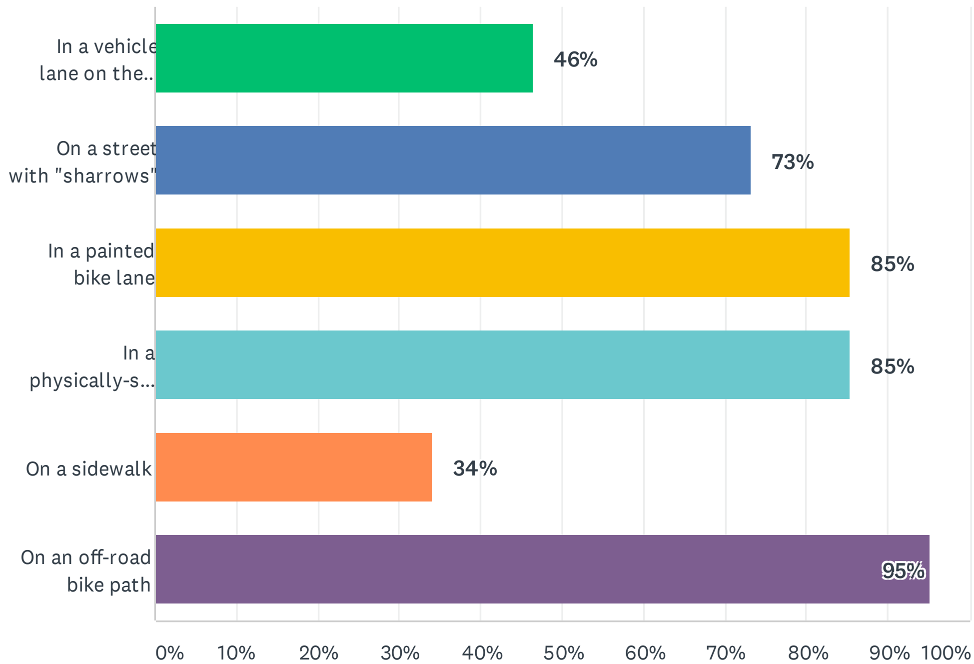


ANSWER CHOICES	RESPONSES	
Summer	98%	40
Fall	98%	40
Winter	27%	11
Spring	98%	40
I wouldn't consider using an e-bike.	0%	0

Total Respondents: 41

Q63 In what street settings do you feel comfortable using an e-bike?

Answered: 41 Skipped: 62

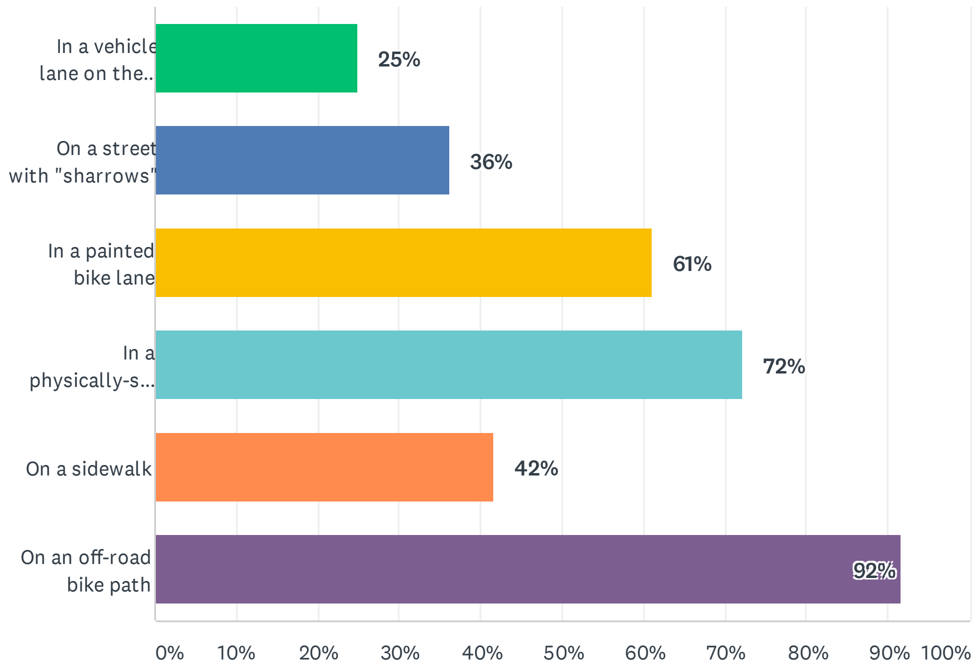


ANSWER CHOICES	RESPONSES	
In a vehicle lane on the street	46%	19
On a street with "sharrows"	73%	30
In a painted bike lane	85%	35
In a physically-separated bike lane	85%	35
On a sidewalk	34%	14
On an off-road bike path	95%	39

Total Respondents: 41

Q64 In what street settings do you feel comfortable using an e-scooter?

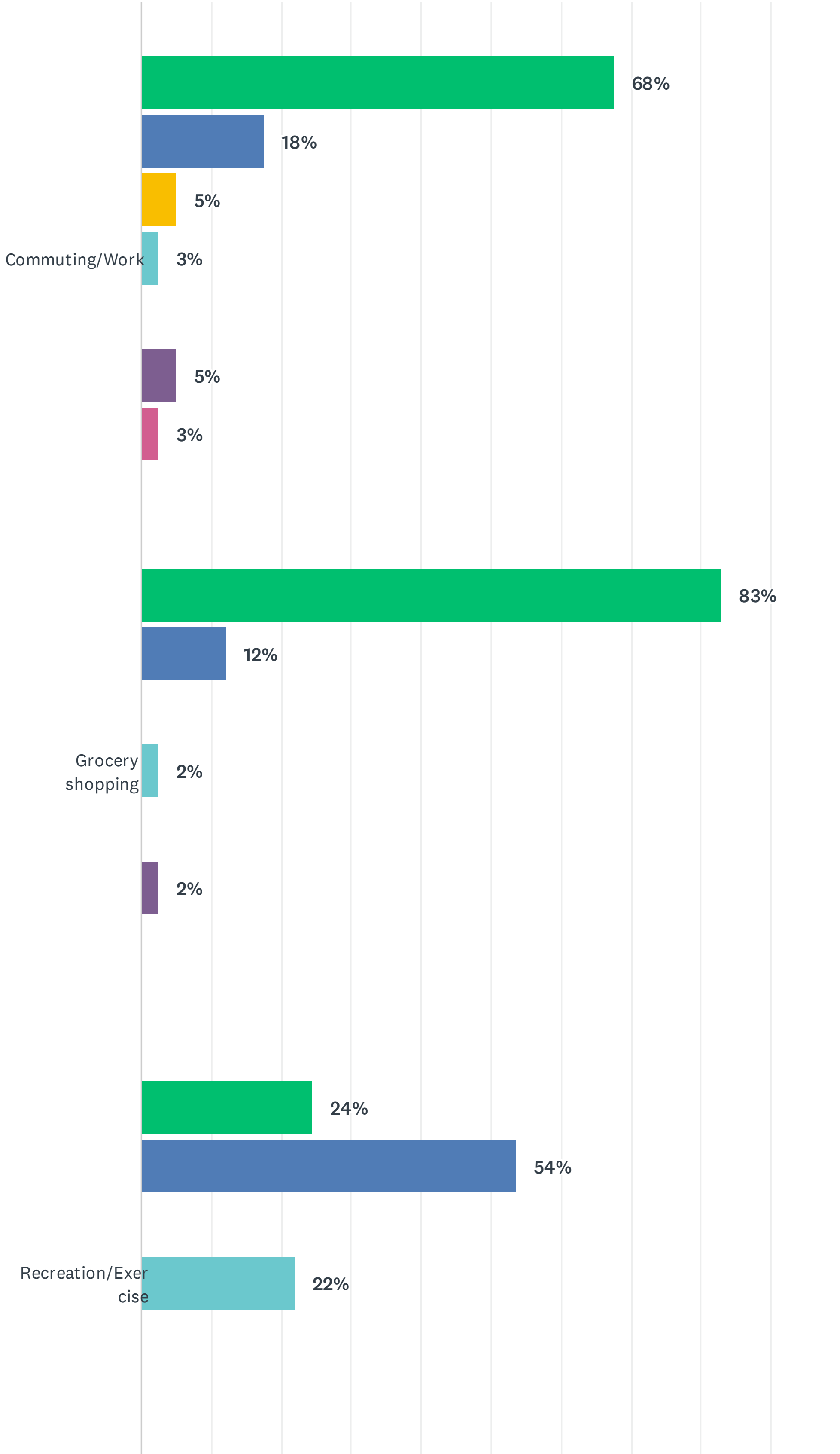
Answered: 36 Skipped: 67

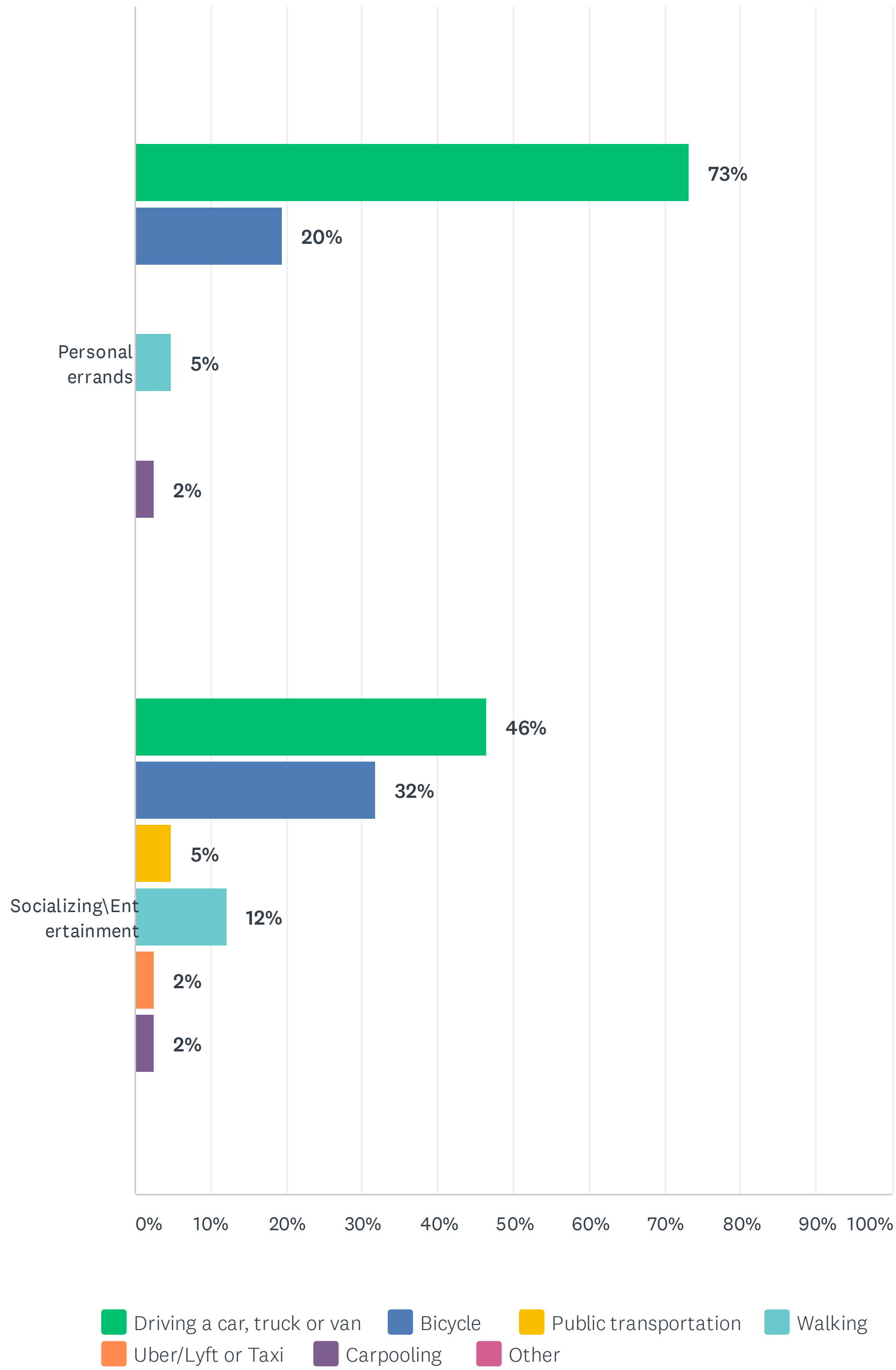


ANSWER CHOICES	RESPONSES	
In a vehicle lane on the street	25%	9
On a street with "sharrows"	36%	13
In a painted bike lane	61%	22
In a physically-separated bike lane	72%	26
On a sidewalk	42%	15
On an off-road bike path	92%	33
Total Respondents: 36		

Q65 What mode of travel do you use most often for these types of trips?

Answered: 41 Skipped: 62

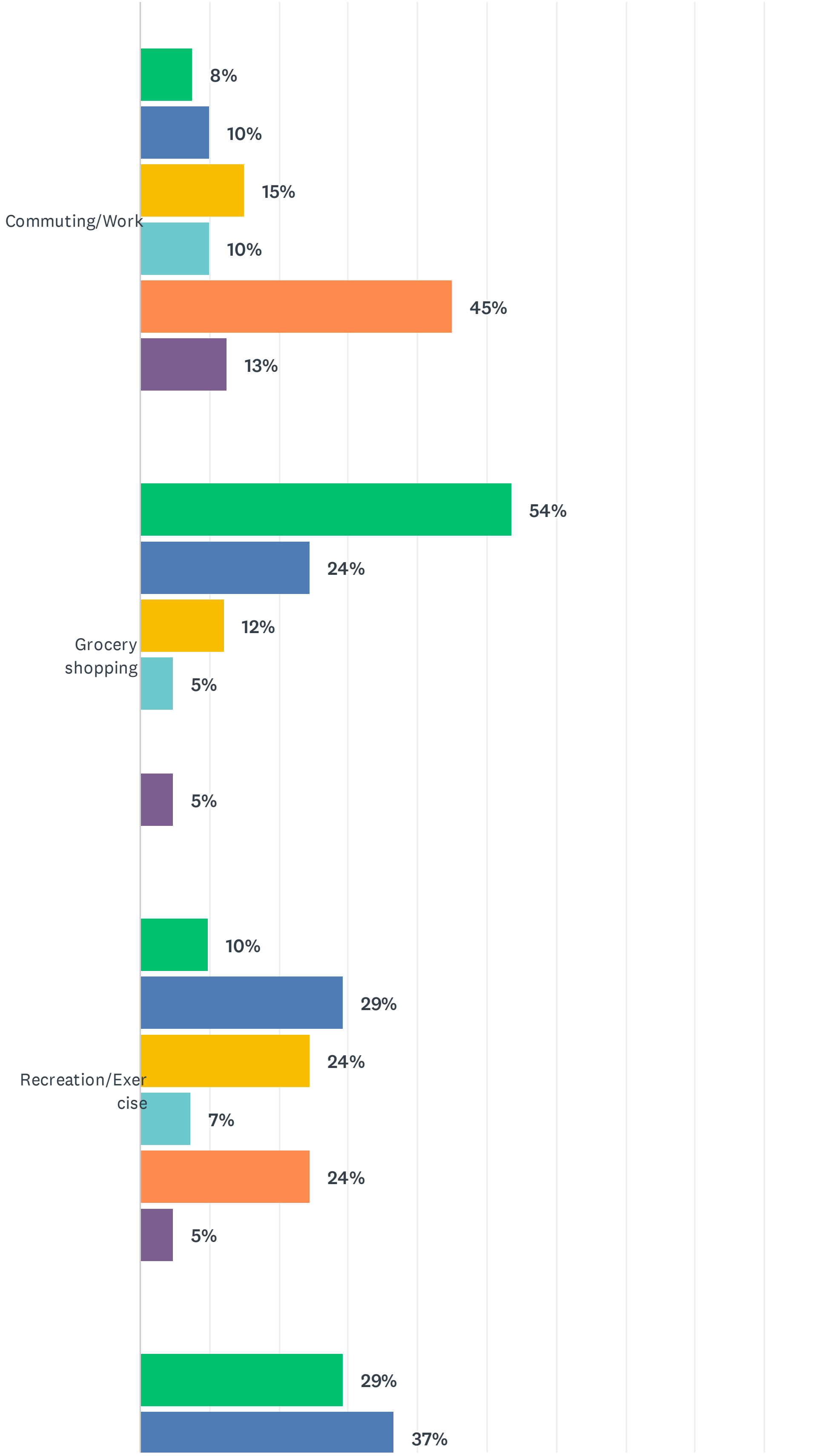


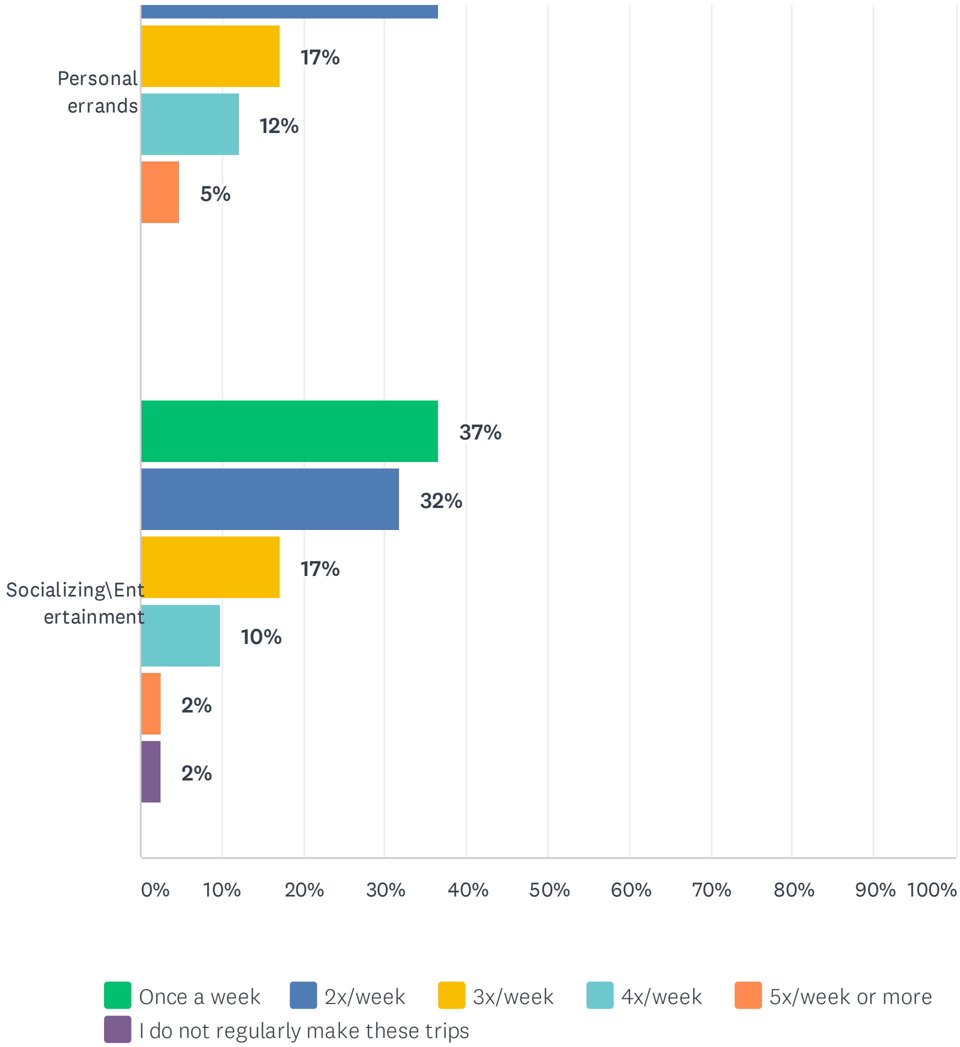

73%
20%
Personal errands
5%
2%
46%
32%
5%
Socializing\Entertainment
12%
2%
2%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Driving a car, truck or van
Bicycle
Public transportation
Walking
Uber/Lyft or Taxi
Carpooling
Other

	DRIVING A CAR, TRUCK OR VAN	BICYCLE	PUBLIC TRANSPORTATION	WALKING	UBER/LYFT OR TAXI	CARPOOLING	OTHER	TOT
Commuting/Work	68% 27	18% 7	5% 2	3% 1	0% 0	5% 2	3% 1	
Grocery shopping	83% 34	12% 5	0% 0	2% 1	0% 0	2% 1	0% 0	
Recreation/Exercise	24% 10	54% 22	0% 0	22% 9	0% 0	0% 0	0% 0	
Personal errands	73% 30	20% 8	0% 0	5% 2	0% 0	2% 1	0% 0	
Socializing\Entertainment	46% 19	32% 13	5% 2	12% 5	2% 1	2% 1	0% 0	

Q66 How often do you make these trips within a typical week?

Answered: 41 Skipped: 62

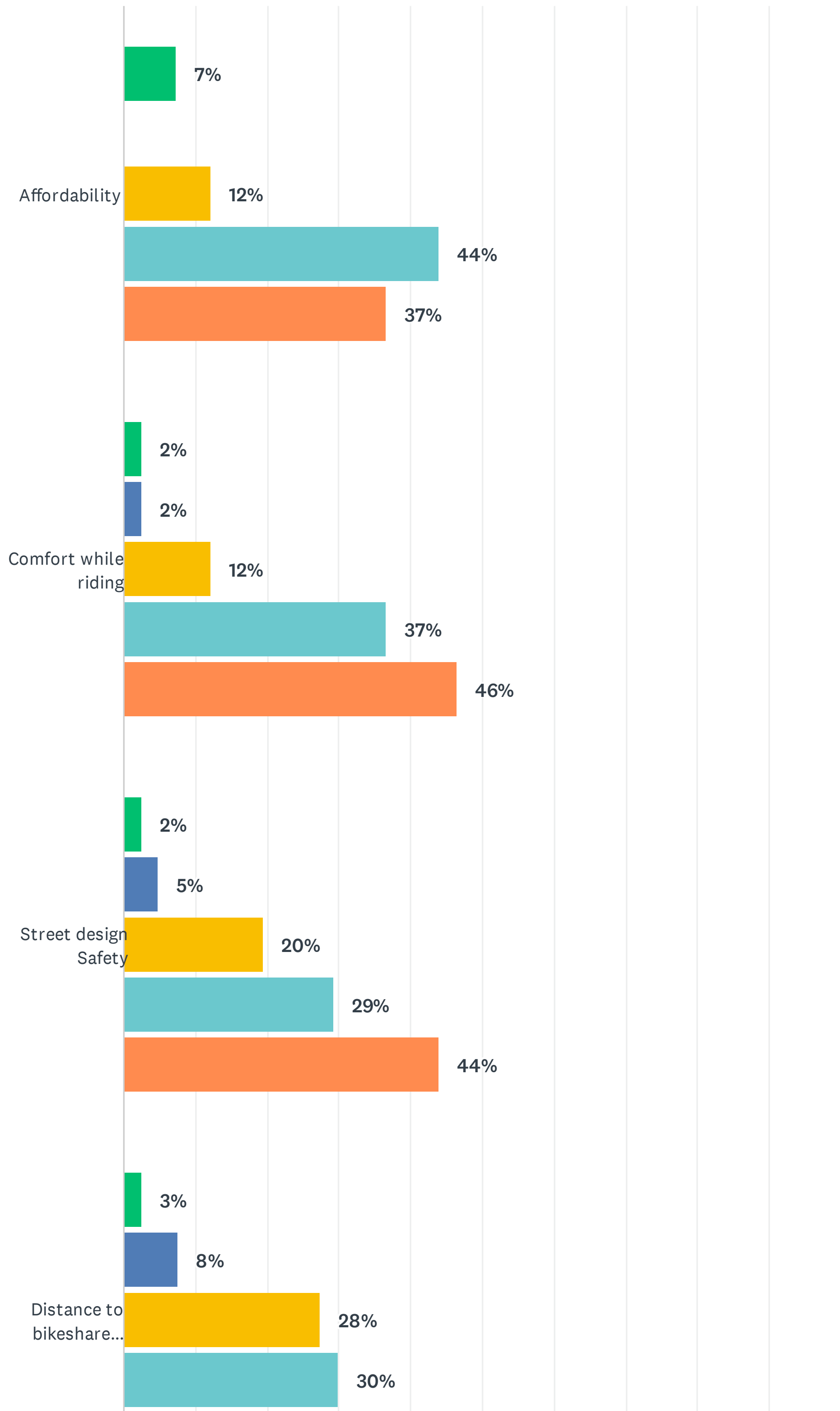


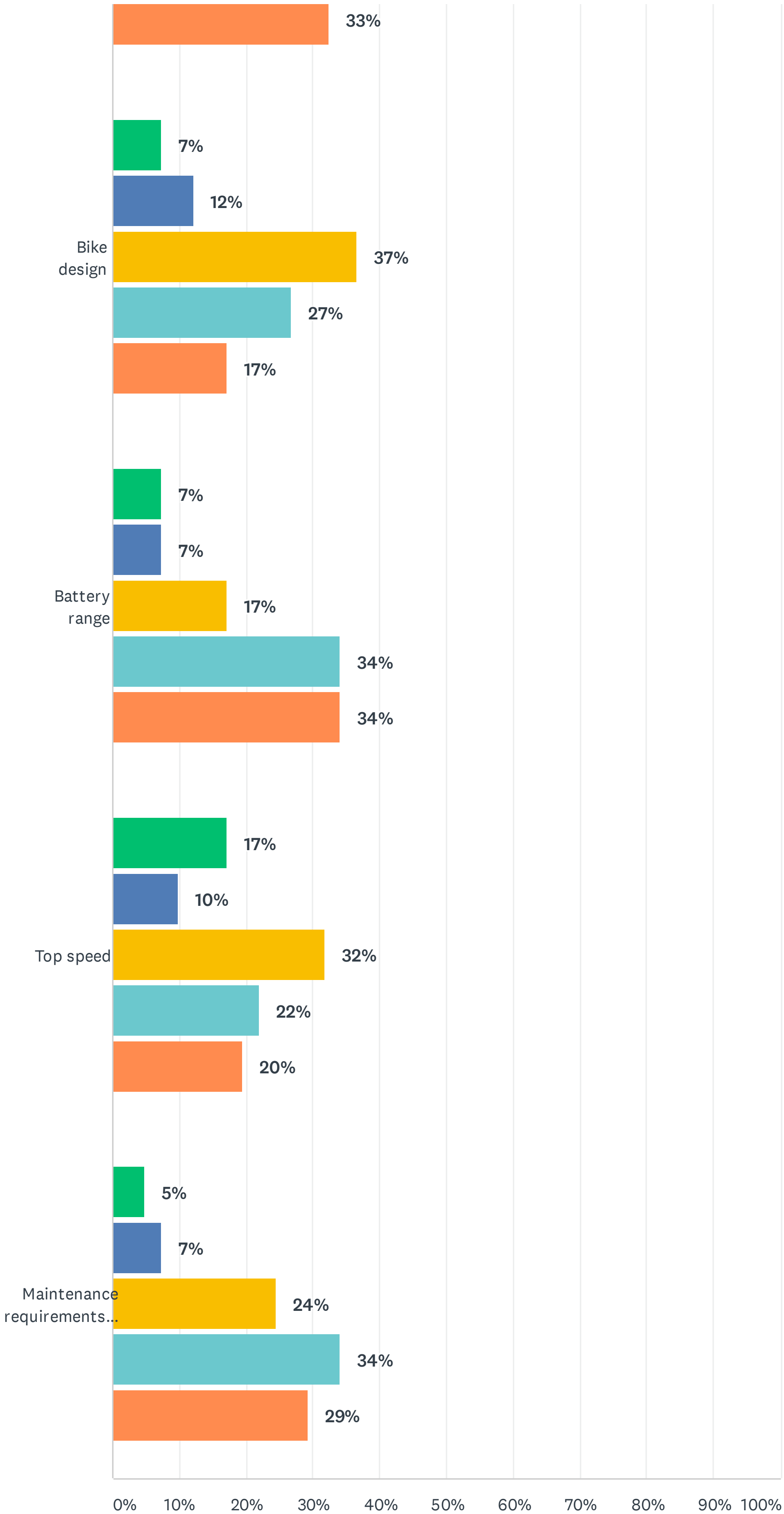


	ONCE A WEEK	2X/WEEK	3X/WEEK	4X/WEEK	5X/WEEK OR MORE	I DO NOT REGULARLY MAKE THESE TRIPS	TOTAL
Commuting/Work	8% 3	10% 4	15% 6	10% 4	45% 18	13% 5	40
Grocery shopping	54% 22	24% 10	12% 5	5% 2	0% 0	5% 2	41
Recreation/Exercise	10% 4	29% 12	24% 10	7% 3	24% 10	5% 2	41
Personal errands	29% 12	37% 15	17% 7	12% 5	5% 2	0% 0	41
Socializing\Entertainment	37% 15	32% 13	17% 7	10% 4	2% 1	2% 1	41

Q67 When considering whether or not you would use an e-bike, rate the following factors on their importance on a scale of 1-5, with 1 being "not at all important" and 5 being "very important".

Answered: 41 Skipped: 62



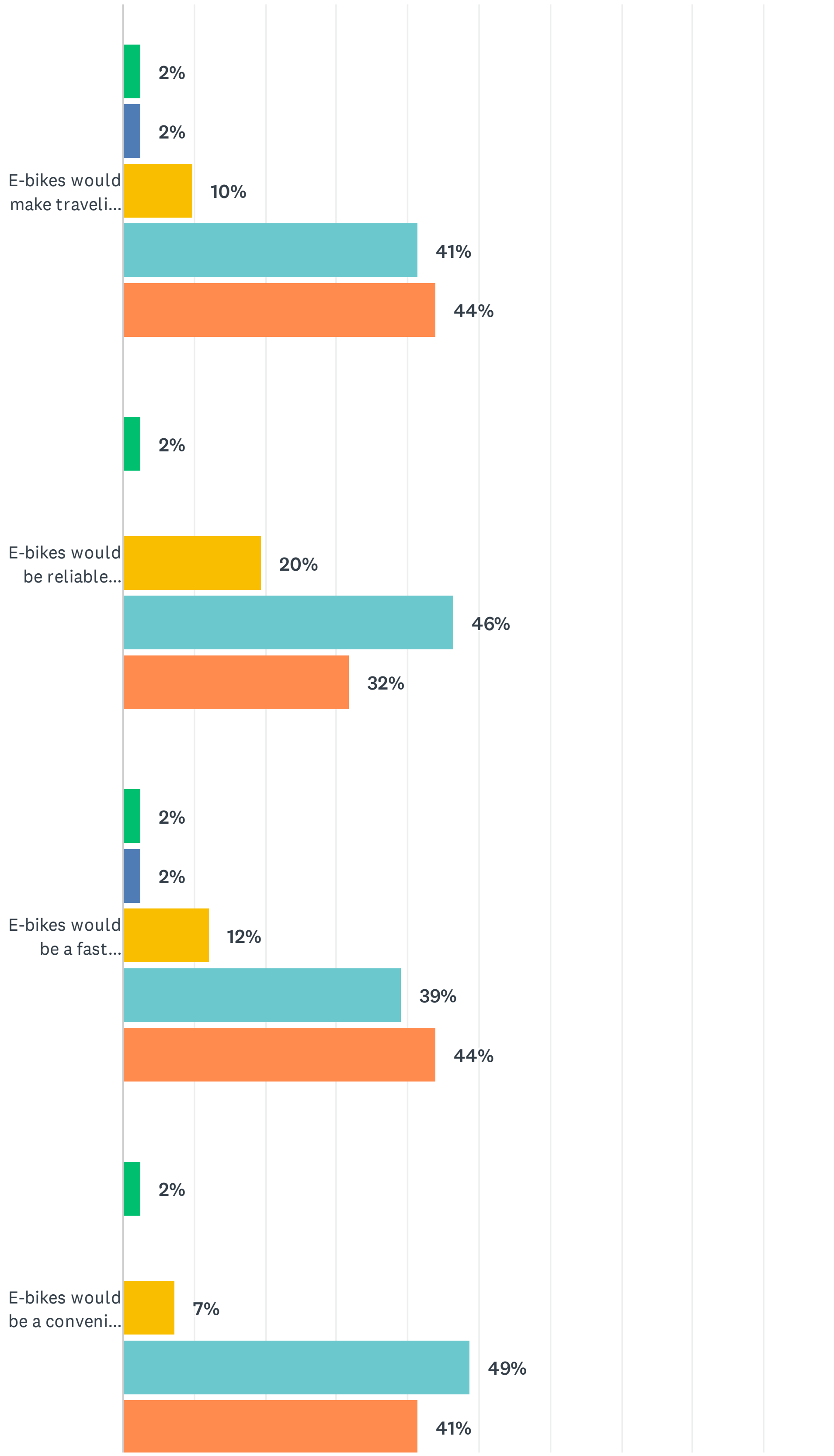

33%
Bike design
7%
12%
37%
27%
17%
Battery range
7%
7%
17%
34%
34%
Top speed
17%
10%
32%
22%
20%
Maintenance requirements...
5%
7%
24%
34%
29%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

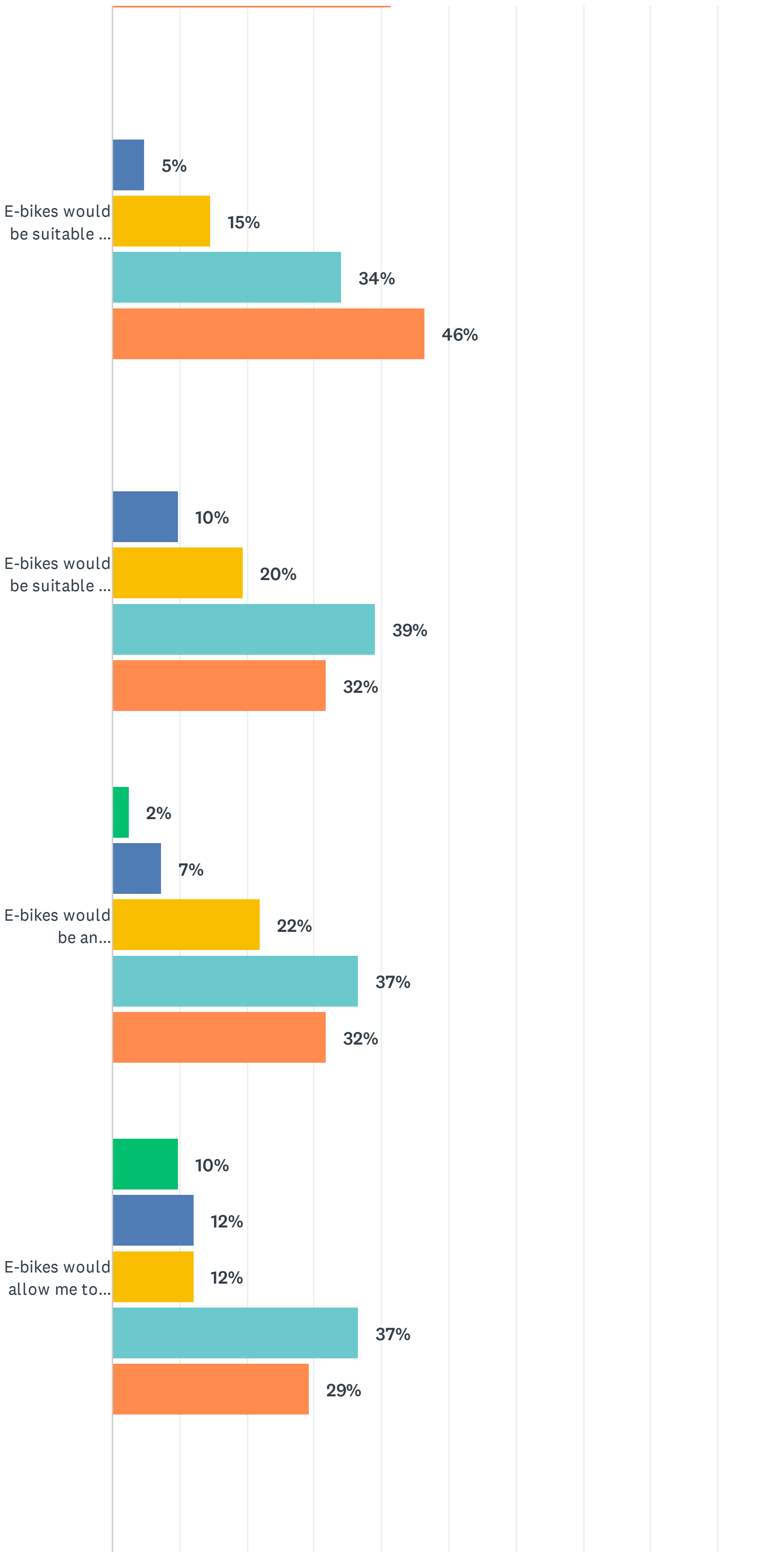
1 - Not at all important 2 3 4 5 - Very important

	1 - NOT AT ALL IMPORTANT	2	3	4	5 - VERY IMPORTANT	TOTAL
Affordability	7% 3	0% 0	12% 5	44% 18	37% 15	41
Comfort while riding	2% 1	2% 1	12% 5	37% 15	46% 19	41
Street design Safety	2% 1	5% 2	20% 8	29% 12	44% 18	41
Distance to bikeshare station	3% 1	8% 3	28% 11	30% 12	33% 13	40
Bike design	7% 3	12% 5	37% 15	27% 11	17% 7	41
Battery range	7% 3	7% 3	17% 7	34% 14	34% 14	41
Top speed	17% 7	10% 4	32% 13	22% 9	20% 8	41
Maintenance requirements	5% 2	7% 3	24% 10	34% 14	29% 12	41

Q68 To what extent do you disagree or agree with the following statements regarding the usefulness of e-bikes?

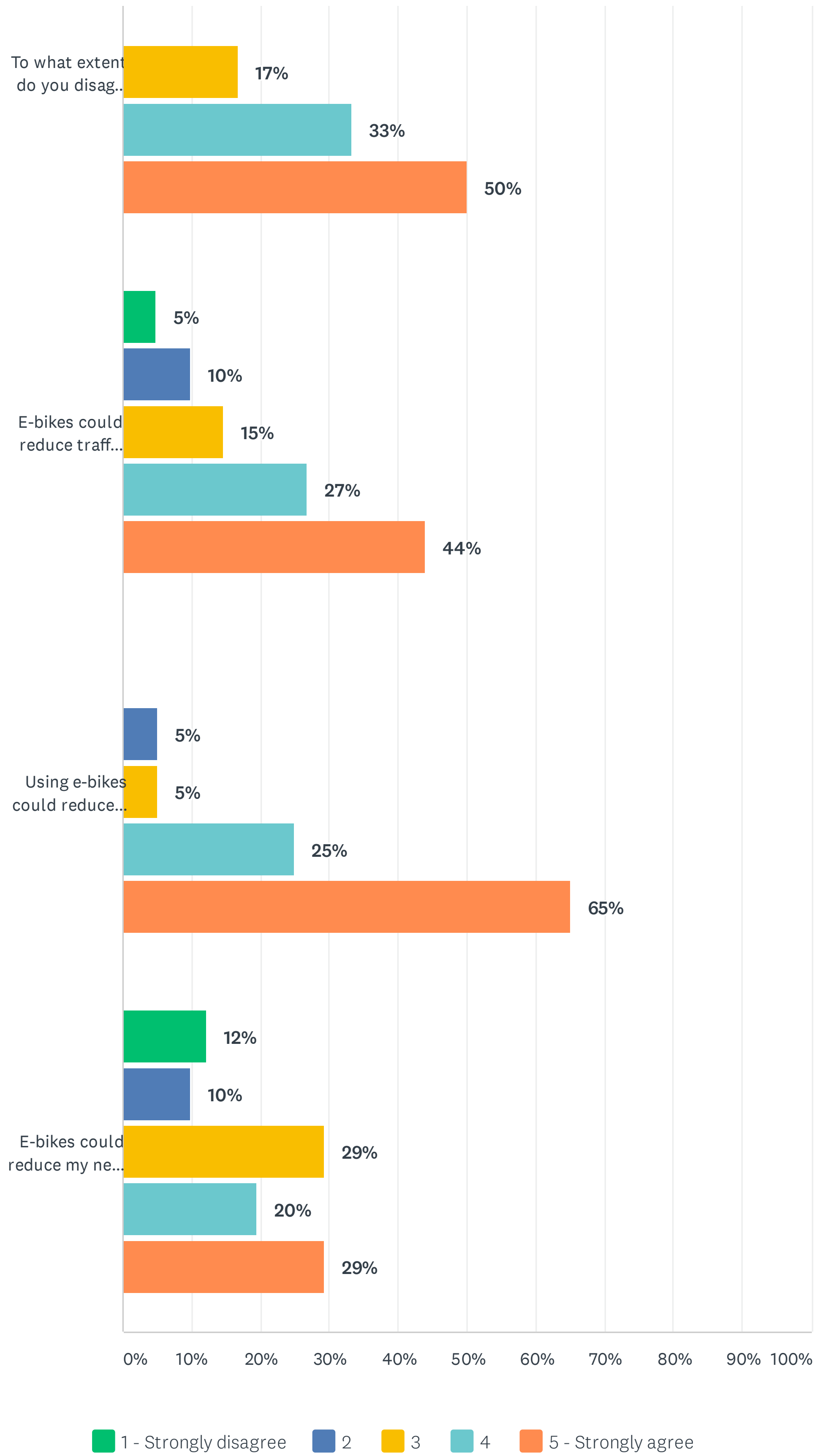
Answered: 41 Skipped: 62





E-bikes would be suitable ...
5%
15%
34%
46%
E-bikes would be suitable ...
10%
20%
39%
32%
E-bikes would be an...
2%
7%
22%
37%
32%
E-bikes would allow me to...
10%
12%
12%
37%
29%

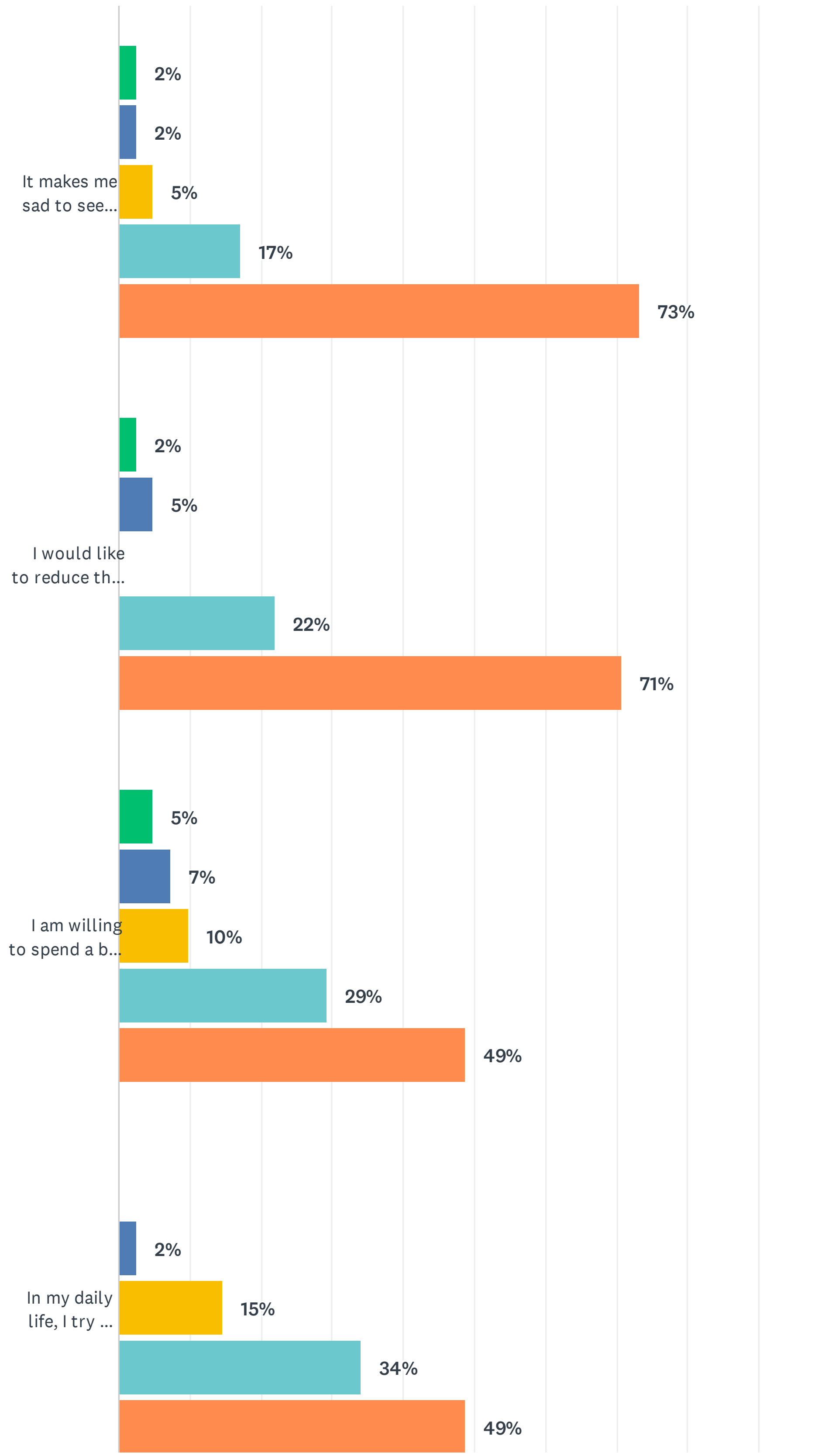
Shared Mobility Survey on Electric Micromobility

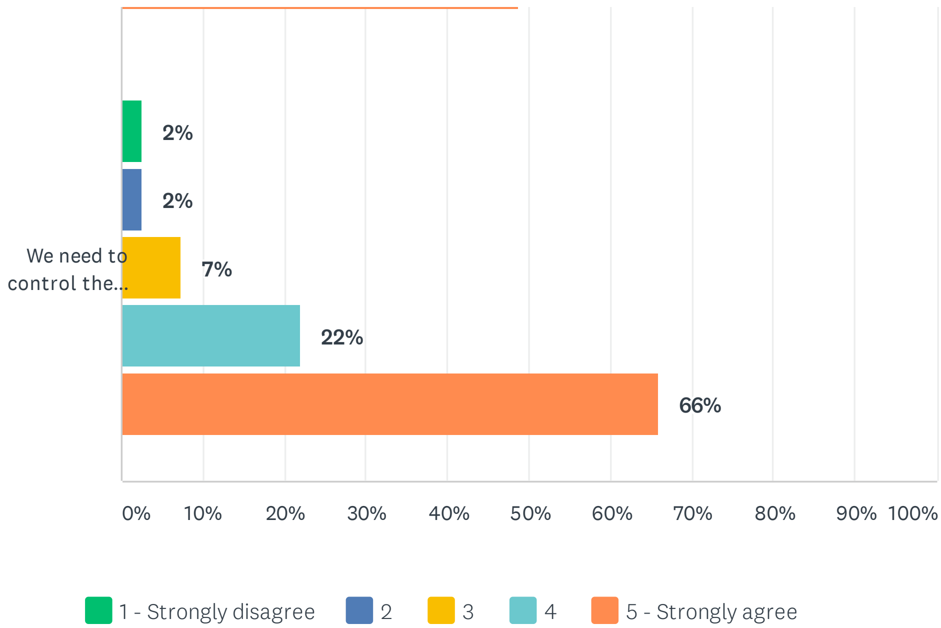


	1 - STRONGLY DISAGREE	2	3	4	5 - STRONGLY AGREE	TOTAL
E-bikes would make traveling flexible	2% 1	2% 1	10% 4	41% 17	44% 18	41
E-bikes would be reliable	2% 1	0% 0	20% 8	46% 19	32% 13	41
E-bikes would be a fast option to travel	2% 1	2% 1	12% 5	39% 16	44% 18	41
E-bikes would be a convenient way of traveling	2% 1	0% 0	7% 3	49% 20	41% 17	41
E-bikes would be suitable for non-work trips (e.g. shopping, a day-out, attending parties, visiting family, friends etc.)	0% 0	5% 2	15% 6	34% 14	46% 19	41
E-bikes would be suitable for work trips	0% 0	10% 4	20% 8	39% 16	32% 13	41
E-bikes would be an affordable way of traveling	2% 1	7% 3	22% 9	37% 15	32% 13	41
E-bikes would allow me to exercise more when traveling	10% 4	12% 5	12% 5	37% 15	29% 12	41
To what extent do you disagree or agree with the following statements regarding the environmental benefits of e-bikes?	0% 0	0% 0	17% 1	33% 2	50% 3	6
E-bikes could reduce traffic congestion	5% 2	10% 4	15% 6	27% 11	44% 18	41
Using e-bikes could reduce environmental pollution associated with my travel	0% 0	5% 2	5% 2	25% 10	65% 26	40
E-bikes could reduce my need for a personal vehicle	12% 5	10% 4	29% 12	20% 8	29% 12	41

Q69 To what extent do you disagree or agree with the following statements about the environment?

Answered: 41 Skipped: 62

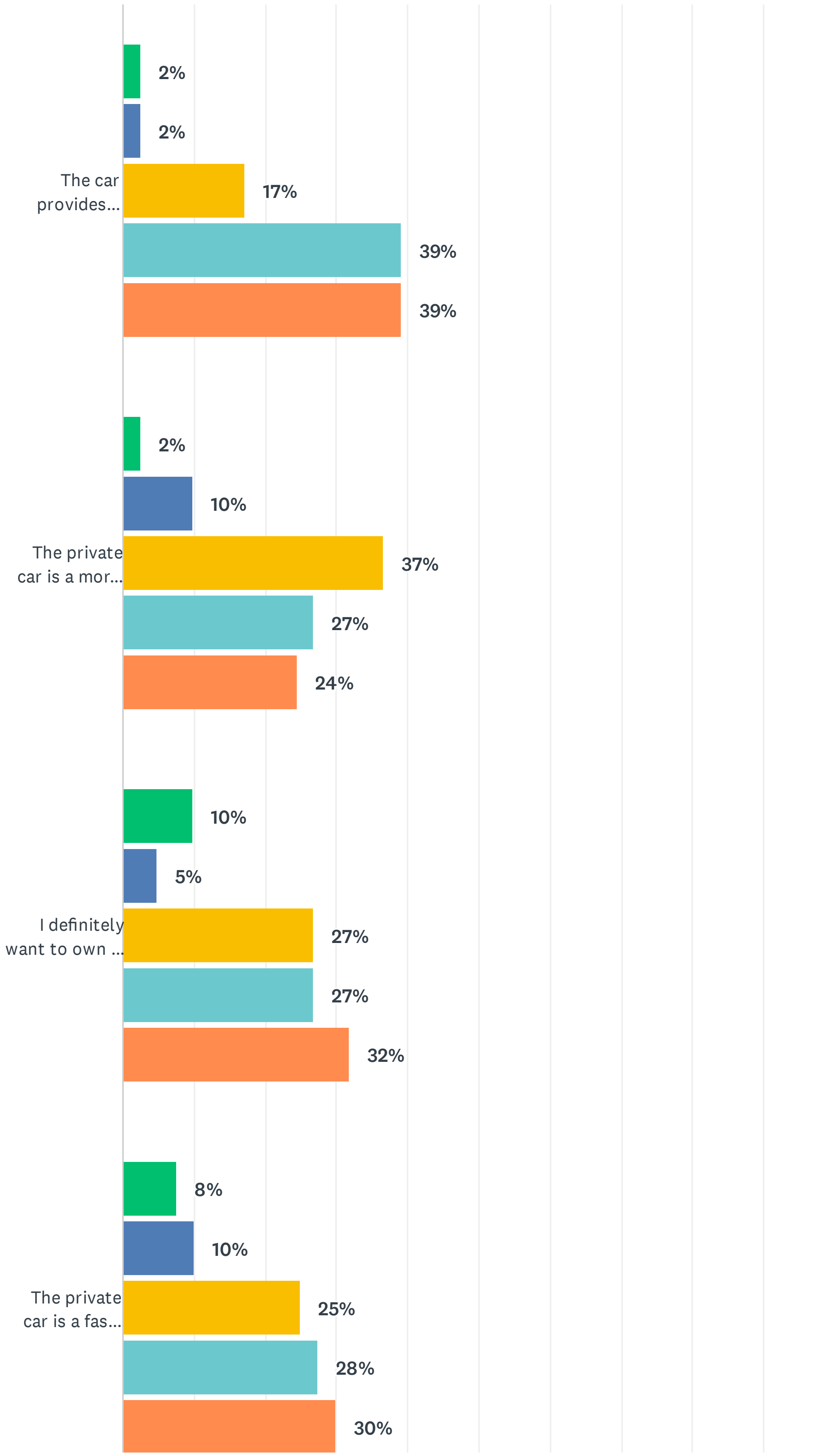


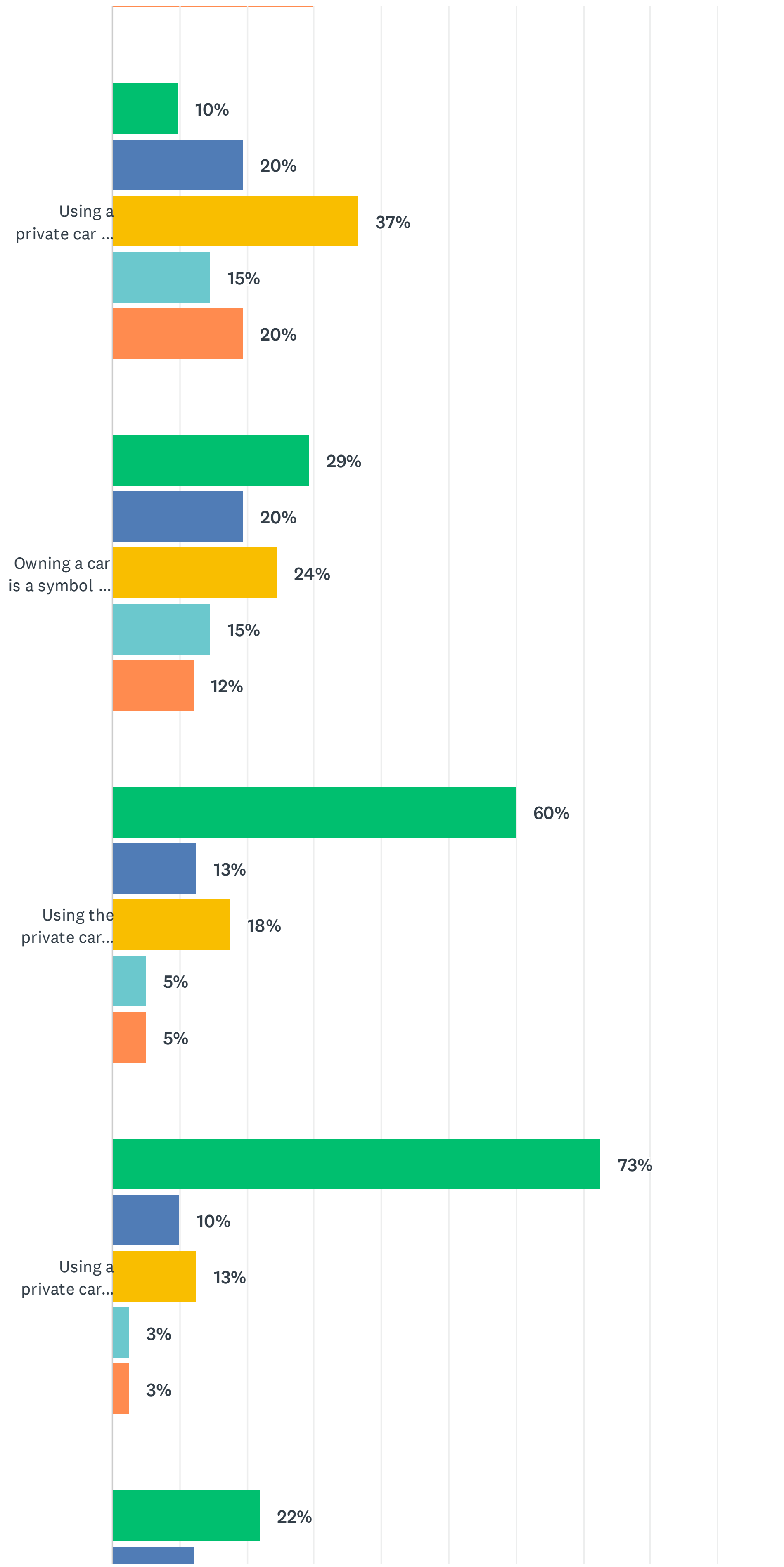


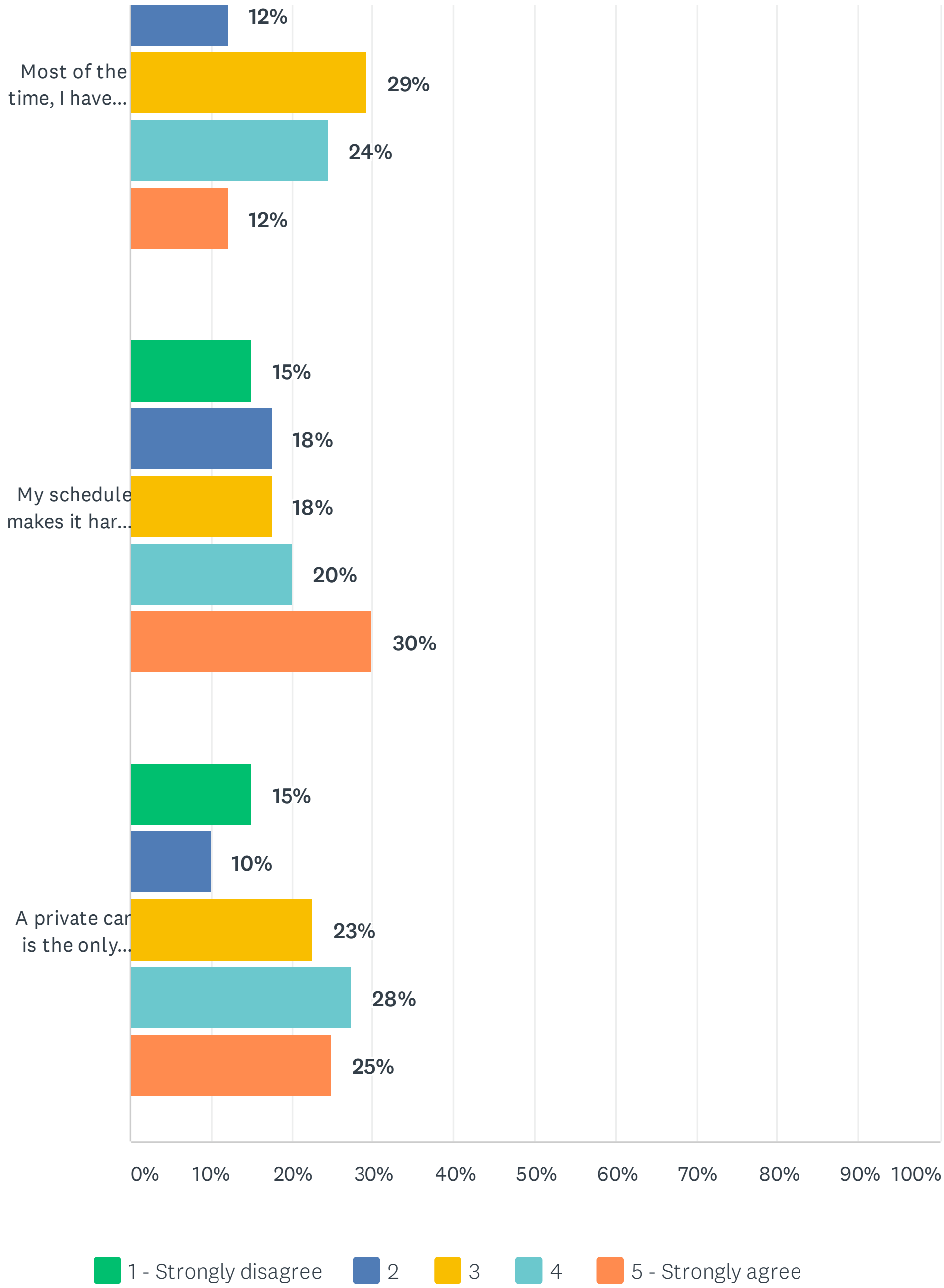
	1 - STRONGLY DISAGREE	2	3	4	5 - STRONGLY AGREE	TOTAL
It makes me sad to see natural environment destroyed	2% 1	2% 1	5% 2	17% 7	73% 30	41
I would like to reduce the consumption of energy and other resources while traveling	2% 1	5% 2	0% 0	22% 9	71% 29	41
I am willing to spend a bit more to buy a product or use a service that is more environmentally friendly	5% 2	7% 3	10% 4	29% 12	49% 20	41
In my daily life, I try to find ways to conserve energy	0% 0	2% 1	15% 6	34% 14	49% 20	41
We need to control the rate at which raw materials are used to ensure that they last as long as possible	2% 1	2% 1	7% 3	22% 9	66% 27	41

Q70 To what extent do you disagree or agree with the following statements about car-ownership/use?

Answered: 41 Skipped: 62



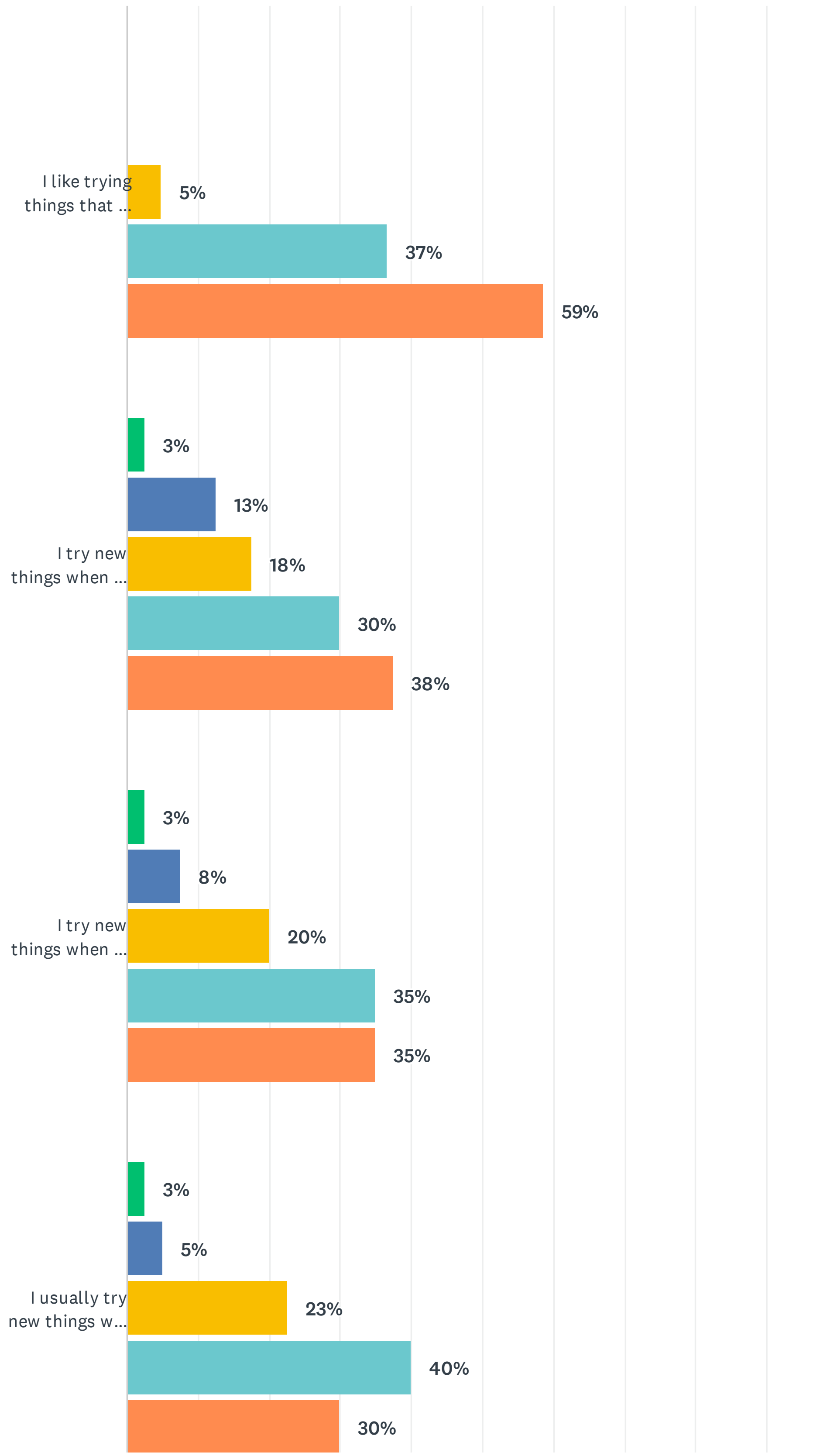

Using a private car ...
10%
20%
37%
15%
20%
Owning a car is a symbol ...
29%
20%
24%
15%
12%
Using the private car...
60%
13%
18%
5%
5%
Using a private car...
73%
10%
13%
3%
3%
22%

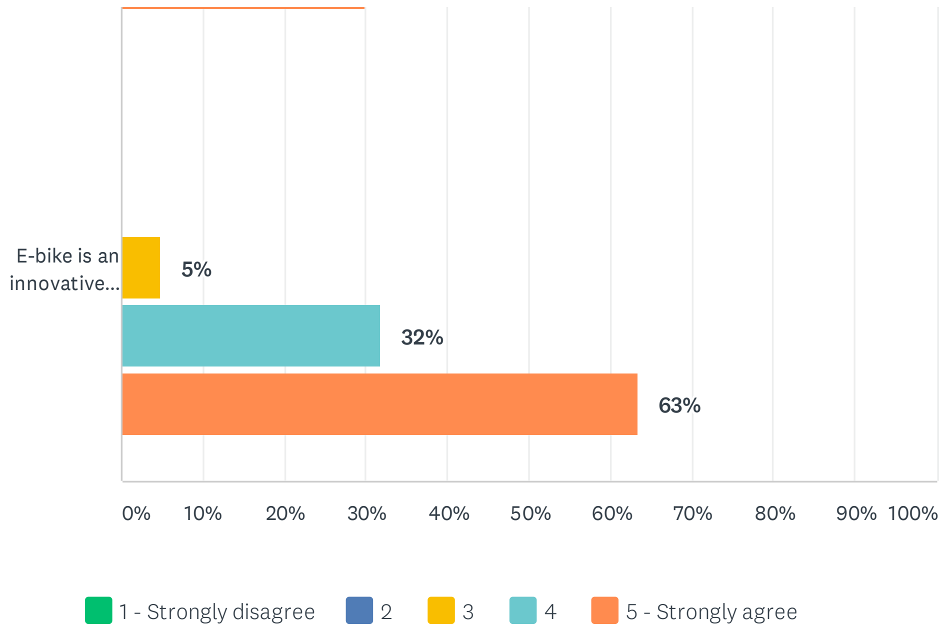

12%
Most of the time, I have...
29%
24%
12%
15%
18%
My schedule makes it har...
18%
20%
30%
15%
10%
A private car is the only...
23%
28%
25%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1 - Strongly disagree
2
3
4
5 - Strongly agree

	1 - STRONGLY DISAGREE	2	3	4	5 - STRONGLY AGREE	TOTAL
The car provides privacy while traveling	2% 1	2% 1	17% 7	39% 16	39% 16	41
The private car is a more comfortable mode of travel	2% 1	10% 4	37% 15	27% 11	24% 10	41
I definitely want to own a car	10% 4	5% 2	27% 11	27% 11	32% 13	41
The private car is a faster mode of travel	8% 3	10% 4	25% 10	28% 11	30% 12	40
Using a private car is safer	10% 4	20% 8	37% 15	15% 6	20% 8	41
Owning a car is a symbol of status in society	29% 12	20% 8	24% 10	15% 6	12% 5	41
Using the private car pollutes less (air and noise pollution)	60% 24	13% 5	18% 7	5% 2	5% 2	40
Using a private car reduces congestion	73% 29	10% 4	13% 5	3% 1	3% 1	40
Most of the time, I have no reasonable alternative to driving	22% 9	12% 5	29% 12	24% 10	12% 5	41
My schedule makes it hard or impossible for me to use public transport	15% 6	18% 7	18% 7	20% 8	30% 12	40
A private car is the only transportation I’d use during winter or bad weather	15% 6	10% 4	23% 9	28% 11	25% 10	40

Q71 To what extent do you disagree or agree with the following statements about innovation and social influence?

Answered: 41 Skipped: 62



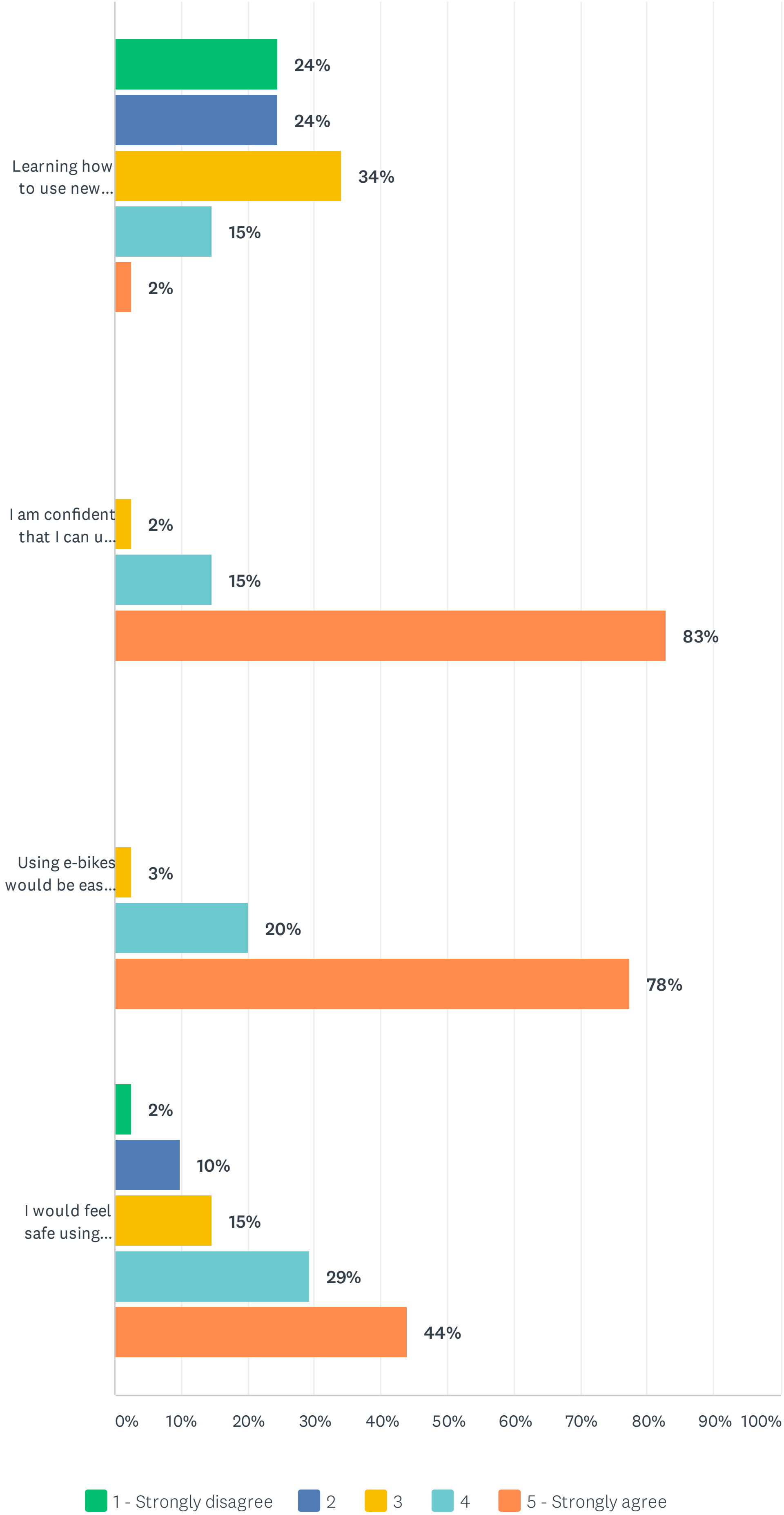


	1 - STRONGLY DISAGREE	2	3	4	5 - STRONGLY AGREE	TOTAL
I like trying things that are new and different	0% 0	0% 0	5% 2	37% 15	59% 24	41
I try new things when I see other people are also doing or using them	3% 1	13% 5	18% 7	30% 12	38% 15	40
I try new things when I see someone in my family doing or using them	3% 1	8% 3	20% 8	35% 14	35% 14	40
I usually try new things when I know my friends have done same	3% 1	5% 2	23% 9	40% 16	30% 12	40
E-bike is an innovative transport/mobility service	0% 0	0% 0	5% 2	32% 13	63% 26	41

Q72 To what extent do you disagree or agree with the following statements about yourself?

Answered: 41 Skipped: 62

Shared Mobility Survey on Electric Micromobility



	1 - STRONGLY DISAGREE	2	3	4	5 - STRONGLY AGREE	TOTAL
Learning how to use new technologies is often frustrating	24% 10	24% 10	34% 14	15% 6	2% 1	41
I am confident that I can use an e-bike	0% 0	0% 0	2% 1	15% 6	83% 34	41
Using e-bikes would be easy for me	0% 0	0% 0	3% 1	20% 8	78% 31	40
I would feel safe using e-bike on our streets	2% 1	10% 4	15% 6	29% 12	44% 18	41

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