# Travel, Environmental, and Equity Impacts of Income-Conditioned E-Bike Rebates in British Columbia



Final Report

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Towards Evidence-Based Transportation Equity Policy







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# **Executive Summary**

# E1. Study Scope and Objectives

Electric-assist bicycles (e-bikes) are an increasingly popular mode of transportation with the potential to advance transportation system goals related to affordability, sustainability, and health. The potential benefits have led to the implementation of e-bike promotion programs by some local, regional and national governments. However, there has been limited empirical investigation of the impacts of e-bike promotion programs on e-bike adoption and use. In addition, many of the expected benefits of e-bike promotion rely on displacement of automobile use, and travel mode substitution from e-bike adoption varies widely. These uncertainties limit the strategic use of e-bike promotion programs to achieve transportation and climate mitigation goals.

In this study we investigate the travel, environmental, and equity impacts of the "BC Electric Bike Rebate Program," which was launched by the British Columbia Ministry of Transportation and Infrastructure in June 2023. The program provided e-bike purchase rebates in three income-conditioned tiers, aiming to support active transportation, make transportation more affordable for lower-income households, and contribute to the Province's greenhouse gas (GHG) reduction goals. Our study objectives were to examine how the rebates changed e-bike purchase decisions, how the incentivized e-bikes were subsequently used, the associated reductions in automobile use and GHG emissions, and how the program benefits varied across dimensions of equity related to the person, household, and geographic context. We surveyed rebate recipients in three waves to collect data on e-bike purchase decisions, use of the purchased e-bikes, and short-term (+3 months) and long-term (+12 months) travel behaviour changes after e-bike purchase.

# E2. Study Sample

A 35% response rate from recruited BC e-bike rebate recipients yielded a sample of 1,004 cleaned survey responses at Wave 1, with 60% and 45% of the sample retained at Waves 2 and 3 respectively

(Figure E.1). The sample compares well to the study population of BC e-bike rebate recipients, most (86%) of whom received the largest \$1,400

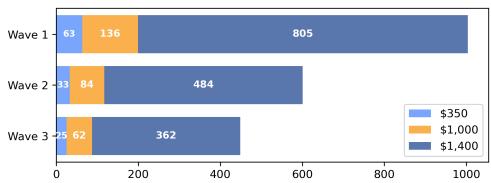


Figure E.1. Number of cleaned responses by rebate value and survey wave

rebates. Survey weights were developed to account for non-representation in recruitment and retention across study waves with respect to gender, age, race, household income, children in household, cycling before purchase, metropolitan region, and rebate value.

#### E3. Rebate-Driven E-Bike Purchases

Rebate recipients purchased e-bikes with an average price of \$3,200, paying an average of \$1,900 after the rebate. E-bike price was inversely related to rebate value, showing that the rebates were primarily used to decrease cost rather than to acquire more expensive e-bikes. This inverse relationship also enhanced the effectiveness of higher-value rebates, because they covered a larger share of the e-bike price. Although rebate value generally decreased with higher household income, most recipients in high-income households (even over \$150,000 per year) were still able to qualify for the largest \$1,400 rebates due to low personal income.

The program was effective in generating new (marginal) e-bike purchases, as the average self-reported likelihood of not purchasing an e-bike without the rebate increased from 21% to 62% with rebate value (Figure E.2).

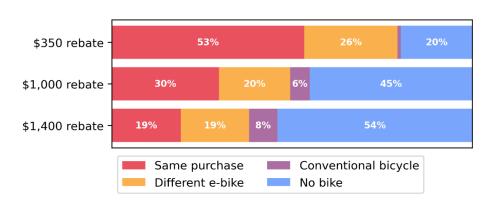


Figure E.2. Likelihood of alternative purchase decisions without rebate

Regression analysis showed that at a given rebate value, rebates were more likely to generate marginal purchases when the e-bike price was lower, and when the rebate recipient was younger, from a lower-income household, living in a milder winter climate, with higher educational attainment, and commuting regularly, but not previously cycling or e-biking. These relationships are positive for mode shift potential because rebates disproportionately induce marginal purchases by people who regularly commute but are not already cycling or e-biking.

#### E4. Use of Incentivized E-bikes

The reported combinations of trip purpose and alternative (replaced) travel mode for e-bike trips are illustrated in Figure E.3, showing that the most common types were utilitarian trips (shopping, errands, or commuting) that would have been made by automobile and exercise or leisure trips that would not have been made at all. The share of exercise/leisure trips decreased over time, while the shares of social/recreational/dining and escort/chauffeur trips increased. Recipients of the larger, income-conditioned rebates reported higher shares of utilitarian trips and lower shares of exercise/leisure trips. Utilitarian trips were also more common in the larger

metropolitan areas of Vancouver and Victoria. Participants who cycled pre-purchase reported higher likelihoods of e-bike trips replacing conventional bicycle use, and lower likelihoods of replacing automobile use.

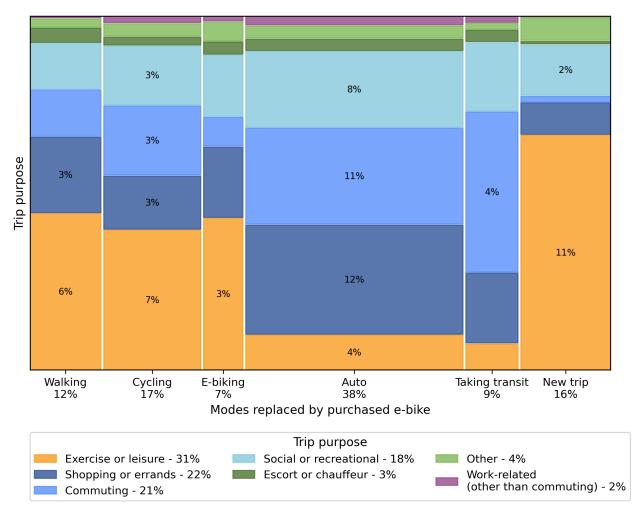


Figure E.3. Trip purpose and modes replaced by trips on the purchased e-bike<sup>1</sup>

The average changes in person-kilometers traveled (PKT) associated with each reported e-bike trip are illustrated in Figure E.4, which combines alternative trip mode and length. On average, each return trip using the purchased e-bike represented 15.2 km of new e-biking, with 3.6 km being net new travel and the rest displacing travel by other modes: 5.9 km of travel by automobile, 2.7 km by conventional bike, 1.6 km by public transit, and the other 1.4 km by walking or other modes.

<sup>&</sup>lt;sup>1</sup> Only cells >2% are labelled; "other" alternative mode (<1%) not shown

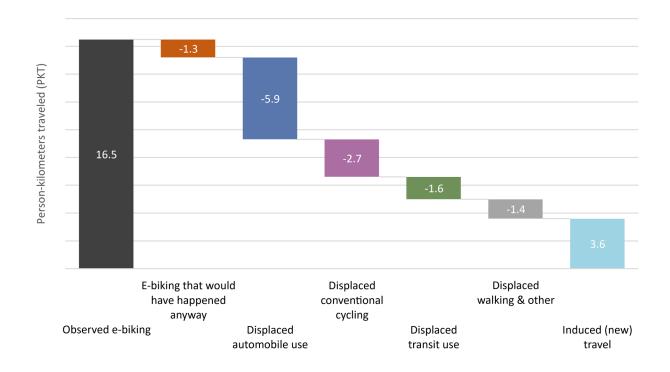
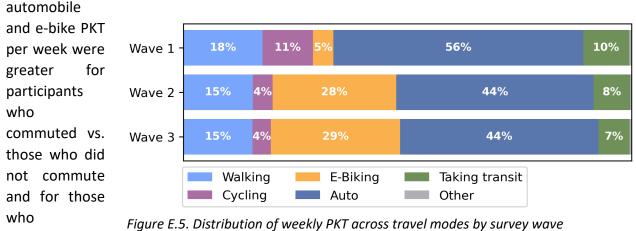


Figure E.4. Illustration of average PKT changes attributable to the reported e-bike (return) trips

# E5. Post-Purchase Changes in Weekly Travel by Mode

Figure E.5 shows the modal distribution of weekly PKT by rebate recipients in each study wave,<sup>2</sup> revealing remarkably similar average mode shares of weekly PKT after 3 and 12 months of e-bike ownership. Most participants (87%) still had access to a private motor vehicle after the e-bike purchase, with an average of 0.75 motor vehicles per adult in the household. Regression analysis revealed that post-purchase automobile use fell by 20% while e-bike use increased by a factor of 16, without a significant difference between short-term and long-term changes. Changes in both



<sup>2</sup> Only for those who took all three survey waves and owned an incentivized e-bike at Waves 2 & 3

conventional cycled before the e-bike purchase. Reductions in automobile use were also greater for those with higher household income and those living in suburban areas that are relatively dense but with poorer access to destinations by walking, cycling, or public transit. Increases in e-bike use were also greater for those with lower household income and those living in hillier areas.

The weekly travel data and trip-level e-bike mode substitution data align in indicating that most travel on the purchased e-bikes is new e-biking, and most of that new e-biking is displacing travel by other modes: roughly half replacing automobile use and a quarter replacing conventional cycling. Applying modal greenhouse gas (GHG) emission rates, we estimate that over 95% of GHG from personal travel by the participants is generated by automobile use. Overall weekly GHG fell by 22% between Wave 1 and Wave 2, and then partially rebounded to a net 17% reduction in Wave 3 (from 35.2 to 29.2 kg CO2eq/wk).

# E6. Total Program Costs and Impacts on Auto Use and Greenhouse Gas Emissions

Figure E.6 illustrates the aggregate cost of e-bikes purchased using rebates from the BC Program, for which \$6.5 million in rebates generated \$8.7 million in new retailer revenue. In addition to the \$4.0 million in rebates that induced marginal purchases, the remaining rebates reduced \$2.5 million of costs for non-marginal purchasers, almost all (98%) for people who met the program's low-income criteria (including 88% for the lowest-income recipients). Each \$1000 in rebates generated \$720 in new spending on e-bikes by marginal purchasers and \$390 in reduced costs for non-marginal purchasers. The BC Program provided approximately \$2,200 in rebates for each marginal e-bike purchased.

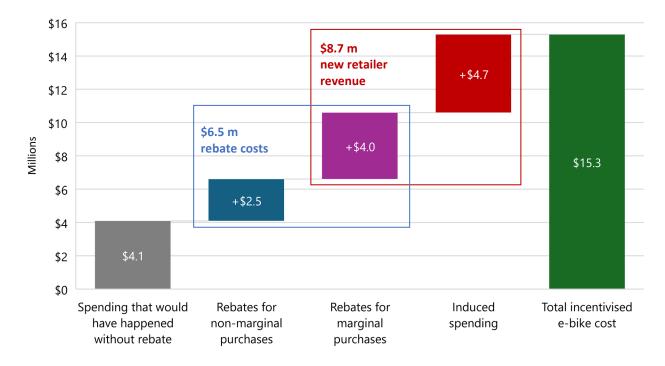


Figure E.6. Illustration of aggregate e-bike costs and spending for the BC Rebate Program

One year after their e-bike purchase, BC rebate recipients had increased their e-bike use by 40 km/wk and decreased their automobile use by 17 km/wk on average, which reduced their weekly GHG from travel by 5.4 kg CO<sub>2</sub>eq. Restricting the impacts to marginal (rebate-induced) e-bike purchases, the average rebate generated 20 km/wk of new e-bike use, and reductions of 12 km/wk in automobile use and 3.9 kg CO<sub>2</sub>eq/wk in GHG from travel. Extrapolating these 1-year changes out to an assumed 5-year e-bike use life, the rebate program induced new e-bike purchases that will be used for 25 million km of travel and result in 15 million fewer person-km travelled by automobile and 5,000 tonnes less CO<sub>2</sub>eq emissions. We also estimate a reduction of approximately \$1.3 million annually in travel-related externalities for all rebate recipients. The implied GHG abatement costs are \$1,300 or \$900 per tonne CO<sub>2</sub>eq using marginal or non-marginal accounting methods (lower for the \$350 rebate tier than for the \$1,000 or \$1,400 rebates). The BC e-bike rebates were cost-competitive for GHG reduction with electric vehicle incentives, but not with general carbon markets.<sup>3</sup>

Table E.1. Summary of factors affecting three key determinants of e-bike rebate program outcomes

Influencing factor	More marginal	Potential for	Potential for displaced
	e-bike purchases	new e-biking	automobile use
Being a marginal purchaser		<b>V</b>	
Higher rebate value	1	•	•
Higher e-bike price	<b>V</b>	•	•
Men	•		*
Older age	<b>V</b>		
Educational attainment		•	
Higher household income	<b>V</b>	▼	
Larger households (with children)	•	•	
More motor vehicles per person	•	•	
Cycling pre-purchase	<b>V</b>		
Regular commuting			
Bike parking inside home	•		
Higher population density	•	•	
Better non-auto access to destinations	•	•	▼
Higher annual precipitation	•	*	•
More moderate winter temperatures		*	*
More cycling infrastructure near home	•	*	•
Hillier areas	•		*

<sup>▲</sup> indicates greater effects and ▼ indicates smaller effects for these participants than for others; • indicates no significant difference in effects between these participants and others

<sup>\*</sup> Effects observed at a 90% (rather than 95%) confidence level

<sup>&</sup>lt;sup>1</sup> Larger effect per rebate, but not per rebate-dollar

 $<sup>^3</sup>$  The GHG mitigation cost of electric car rebates in BC is around \$1,000 per tonne  $CO_2$ eq, while the carbon market price in Canada is less than \$300 per tonne  $CO_2$ eq.

Table E.1 summarizes some of the factors shown to influence the key determinants of program outcomes. Beneficial factors include rebates distributed to commuters, in more moderate winter climates, in hillier areas, and to those who can park an e-bike inside their home. Other factors have trade-offs, such as marginal purchasers using their new e-bikes less, but reducing their automobile use more. Rebate recipients living in lower-income households are more likely to make marginal purchases and subsequently use their e-bike more, but have less automobile use to displace with e-biking. In addition, rebate recipients who are older or already conventional cycling are less likely to make marginal purchases, but use the purchased e-bikes more, and displace more automobile use. We find that the twin objectives of increased e-bike use and decreased automobile use were most realized by those in households with moderately low income (1x to 2x the low-income cut-offs or LICO) and by those with moderate or low satisfaction with household income.

# E7. Personal and Equity-Related Impacts

Table E2 illustrates key program benefits for rebate recipients and how they varied across population subgroups. The rebates made e-bike purchases more affordable, reducing purchase costs by an average of 43%. E-bike ownership enabled net new mobility for both exercise and utilitarian purposes, helped to reduce total weekly travel costs by 12% (approximately \$2.3 million in annual travel cost savings for all 4,943 rebate recipients), and increased travel-related physical activity by 13%. To varying extents, these benefits were disproportionately gained by

Table E2. Benefits for rebate recipients and variation across population subgroups

	Rebate amount	E-bike purchase cost¹	Net new mobility	Net change in weekly travel costs	Net change in physical activity
Average for all recipients	\$1,320	\$1,771	+5.8 km/week	-\$9.07 (-12%)	+153 MMM <sup>2</sup> (+13%)
Low household income	<b>A</b>			•	•
Low satisfaction with household income	<b>A</b>		•	<b>A</b>	
Non-man	•	•	*	•	*
Non-white			<b>V</b>	•	•
Disability	•	•		•	•
No college	*		•	•	•
Senior	<b>V</b>	<b>V</b>		•	•
Rural	•	<b>V</b>		•	•

<sup>▲</sup> indicates greater benefits (larger rebate, lower cost, more mobility, greater reduction in travel cost, more physical activity) and ▼indicates smaller benefits for these participants as compared to others; • indicates no significant difference in benefits between these participants and others

<sup>\*</sup> Effects observed at a 90% (rather than 95%) confidence level

<sup>&</sup>lt;sup>1</sup> Price paid by participants after rebate applied

<sup>&</sup>lt;sup>2</sup> Marginal MET minutes (from weekly travel alone)

those in low-income households, with less educational attainment, or with a disability, while women and non-binary folks benefitted less than men in new mobility and physical activity. Non-white rebate recipients benefitted more than others in regard to purchase costs but gained less new mobility. This pattern was reversed for seniors and rural residents who reduced their purchase costs less than others but gained more new mobility.

Quantitative and qualitative data revealed overall positive experiences with e-bike adoption. Fun and enjoyment stood out as important aspects of owning and using an e-bike, which many participants connected to mental and physical health improvements. Participants also highlighted the "freedom, flexibility, and independence" of new mobility options gained with e-bike adoption and the opportunity for travel mode shift. Conversely, participants expressed concerns about limited availability of safe places to ride and secure bike parking. Weather emerged as another primary consideration that increased in importance, possibly due to negative experiences e-biking in inclement weather.

#### E8. Conclusions and Recommendations

Overall, the BC Program was successful in achieving its aims of supporting active transportation, making transportation more affordable for lower-income households, and reducing GHG emissions. Approximately 3 out 5 rebates induced a new (marginal) purchase that would not have happened without the rebate. The incentivized e-bikes were used regularly for a variety of purposes; a large portion of the e-bike use displaced automobile travel, which led to net reductions in travel costs and GHG emissions and a net increase in physical activity during travel. Most of the program benefits were equitably distributed, with people in lower-income households receiving larger rebates and greater mobility and cost benefits, although most e-bike purchasers in high-income households also received the largest rebates. Generally, larger rebate values had greater impact per rebate but smaller impact per rebate-dollar. The changes in travel patterns were similar at the +3 and +12 month survey waves, which is promising for longer-term impacts. In addition to practical considerations such as travel time, "fun" was a key factor motivating sustained e-bike use.

The study results are largely consistent with past research and pre-program modelling. One major difference from the Saanich E-bike Incentive Program (which preceded the BC program) is that Saanich rebate values were strongly differentiated by household income, as a consequence of applying household income criteria (rather than personal income criteria, as in the BC program). BC rebates were slightly less cost efficient in inducing marginal purchases, likely due to higher e-bike prices, higher household income, more pre-purchase e-bike use, and more recipients living in areas with colder winters. Although post-purchase e-bike use was similar for recipients of the Saanich and BC rebates, changes in automobile use 12 months after purchase were smaller for the BC program due to particularly high pre-purchase automobile use by recipients of the income-conditioned Saanich rebates. We are more confident generalizing from the BC study

results, given the larger sample, more diverse contexts, and greater consistency with other studies on e-bike use and automobile mode substitution.

The results of this study support the core assumptions of e-bike rebate programs and provide insights to inform future rebate program design. Rebate program designers should consider the potential trade-offs in program impacts when selecting program criteria to prioritize rebate cost efficiency, new e-bike use, or automobile mode substitution. We recommend continuing the BC Electric Bicycle Rebate Program but changing from a personal to a household income criterion. Our findings indicate this change would likely increase the program's effectiveness in generating marginal e-bike purchases and use. It would also shift the rebate demand of high-income households to the more cost-efficient lower-value rebates. We also recommend setting LICO-based income thresholds (which account for household size and geographic context) for future e-bike rebates at around 2x LICO, which would prioritize income-constrained households while still capturing households with the potential for substantial automobile mode substitution.

Additionally, there are other factors beyond income that can influence program effectiveness. Given the strong positive impact of providing rebates to regular commuters, designing a rebate program that prioritizes this group (possibly in partnership with employers) may be a promising strategy to enhance program outcomes. Geographic prioritization is another option, based on contextual factors associated with greater rebate impacts such as milder winters, hillier terrain, and suburban settings with limited public transit. E-bike rebates need not be constrained to areas with high "bikeability". Other strategies to increase rebate availability and cost efficiency are to restrict the total number of rebates available at the high-value tiers, or to reduce the value of rebates at the upper tiers.

While e-bike rebates are effective in generating new e-bike use, there are persistent perceived barriers limiting use, particularly concerns about poor riding facilities (especially in rural areas) and theft (especially in urban areas). Thus, in addition to rebates, continued effort is required to improve cycling networks and mitigate bike theft, as these issues are particularly salient for those who are seniors, non-white, or have a disability.

We find that e-bike rebates are cost-competitive with electric vehicle rebates for GHG mitigation. They also generate a range of other important benefits through automobile mode substitution and increased physical activity. Thus, although GHG mitigation is an important and significant benefit of e-bike rebates, these programs need not (and likely should not) be justified solely through climate action. Considering mobility and physical activity co-benefits will be increasingly important if declining automobile emission rates diminish the effectiveness of e-bike rebates for GHG reduction. As interest in e-bike incentive programs continues to expand, we look forward to further investigations on their effectiveness in various scales and settings, and their comprehensive impacts on public health, traffic safety, and transportation system costs.

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# Final Report Part 1: Rebate Impacts on E-bike Purchases, Travel, and Greenhouse Gas Emissions





## 1.1 Introduction

This research report provides findings from a study of the "BC Electric Bike Rebate Program," which was launched by the British Columbia Ministry of Transportation and Transit<sup>4</sup> in June of 2023. The goals of the program were to support active transportation, make transportation more affordable for lower-income households, and contribute to the Province's greenhouse gas (GHG) reduction goals by providing rebates for the purchase of electric-assist bicycles. The program provided e-bike rebates in three income-conditioned tiers of \$350, \$1,000, and \$1,400. Proof of income was required for the larger two rebate levels, according to the schedule shown in Table 1. Rebate recipients had to be residents of British Columbia, aged 19 or older, and could claim no more than one rebate per person, among other requirements. Rebate recipients also had to obtain pre-approval before purchasing the e-bike from participating retailers. Eligibility requirements for e-bikes included: pre-rebate sale price of at least \$2,000, new (not used), for personal (not commercial) use, and meeting the definition of Motor Assisted Cycle in the BC Motor Vehicle Act (MVA).

Table 1. Personal income thresholds for BC rebate tiers

Net (post-tax) income range	Rebate value
Less than \$38,950	\$1,400
\$38,951 to \$51,130	\$1,000
\$51,131 and over	\$350

The objectives of this study were to investigate the travel and environmental impacts of the BC Program by examining: how rebates changed e-bike purchase decisions, how the incentivized e-bikes were subsequently used, and the travel mode substitution and GHG benefits from incentivized e-bike adoption. We also aimed to investigate the equity impacts of the program by examining how income-conditioned rebates affected e-bike purchase decisions for different segments of the population, whether lower-income e-bike purchasers experienced unique benefits or obstacles from access to an e-bike, and whether program benefits varied across other dimensions of equity beyond income.

Part 1 of this report presents findings on the travel and environmental impacts of the rebate program, while Part 2 examines the personal and equity effects of incentivized e-bike adoption. Within Part 1, the next section provides an overview of the state-of-knowledge on e-bike incentives. The Part 1 study methods are then described in Section 3, with results presented in Section 4 before the conclusions of Part 1 are provided in Section 5.

<sup>&</sup>lt;sup>4</sup> Then the BC Ministry of Transportation and Infrastructure

<sup>&</sup>lt;sup>5</sup> https://bcebikerebates.ca/



#### 1.2 Literature Review

# 1.2.1 E-Bike Adoption and Mode Shift

Electric-assist bicycles (e-bikes) are an increasingly popular mode of transportation for a variety of trip purposes (Cairns et al., 2017; Hassanpour and Bigazzi, 2024; Huang et al., 2024; Johnson et al., 2023). Research on e-bike adopters has shown that e-bikes are a viable and attractive travel option for some people uninterested or unable to use conventional bicycles, due to factors such as distance, hills, cargo, and perspiration (Fishman and Cherry, 2016; MacArthur et al., 2018a; Marincek and Rérat, 2021; Plazier et al., 2017; Wolf and Seebauer, 2014). Compared to travel by private motor vehicles, e-bikes enable physically active, low-cost, and low-carbon mobility (Bigazzi and Berjisian, 2019; Fishman and Cherry, 2016; Goins et al., 2025; Pierce et al., 2013; Sundfør and Fyhri, 2017).

The mode substitution effects of e-bike adoption are often studied because displacement of automobile use is essential to advancing transportation system goals related to costs, congestion, sustainability, accessibility, and health (Andersson et al., 2021; Mason et al., 2015; McQueen et al., 2020; Sun et al., 2020; Sundfør and Fyhri, 2017). A 2020 meta-analysis of survey research from around the world found that e-bike substitution of automobile trips ranged from 2% to almost 60%, depending on context, while substitution of conventional bicycle trips ranged from 5% to 70% (Bigazzi and Wong, 2020). Rates of automobile substitution were higher in North America and Europe than in Asia, and in more recent studies. Modelling studies of e-bike adoption scenarios suggest that widespread uptake of e-bikes could yield GHG savings from the reduction of automobile travel of 10% in Switzerland (Bucher et al., 2019), 11% worldwide (Mason et al., 2015), 12% in Portland, USA (McQueen et al., 2020), or 20% in Sweden (Hiselius and Svensson, 2017).

# 1.2.2 E-Bike Incentive Programs

The potential benefits of e-bike adoption displacing motor vehicle travel have led to growing interest in e-bike promotion programs and policies by local, regional and national governments worldwide (Aono and Bigazzi, 2019; McQueen et al., 2019; Nosratzadeh et al., 2025b). The main barriers to e-bike adoption are purchase price, safety concerns, fear of theft, and unfamiliarity (Fishman and Cherry, 2016; MacArthur et al., 2018a; Wolf and Seebauer, 2014). To address these barriers, e-bike promotion efforts often involve purchase rebates, improved cycling infrastructure (with co-benefits for conventional cycling), provision of secure bicycle parking (with electric power access), and free or low-cost e-bike rentals or loans (Aono et al., 2019; McQueen et al., 2019; Nosratzadeh et al., 2025b). A recent review of 289 e-bike incentive programs worldwide found that most e-bike programs provide rebates for 20% to 30% of the e-bike price, and 22% of programs include some low-income conditioning for rebate value or eligibility (Nosratzadeh et al., 2025b). We next examine the literature on the impacts of these e-bike incentive programs.



# 1.2.3 Impacts of E-Bike Rebate Programs

Studies on the impacts of e-bike rebate address two sets of questions: 1) did the rebates lead to more e-bike purchases, and 2) how did travel behavior change after purchase? The first question raises the concept of additionality or marginality in e-bike purchases: the likelihood that the incentivized purchases would not have occurred without the rebate. The impacts attributed to rebate programs should be limited to the travel behavior changes associated with marginal purchases (Bigazzi et al., 2025; Bigazzi and Berjisian, 2021).

Although the number of e-bike rebate programs has increased in recent years, to date there has been limited quantification of the effects of e-bike incentives on e-bike purchases or e-bike use (Nosratzadeh et al., 2025a). We previously used econometric modelling to evaluate the expected impacts of hypothetical purchase rebate program designs on e-bike adoption in Vancouver and Victoria, BC (Bigazzi and Berjisian, 2021). Study results showed that e-bike purchase demand is expected to exceed the available rebates, and that higher rebate values led to fewer marginal purchases but a larger share of rebates going to marginal and low-income purchasers. The share of marginal purchasers ranged from 9% to 45% for rebate values of \$200 to \$1,600.

We subsequently had the opportunity to study the municipal e-bike rebate program in the District of Saanich, BC, which provided 389 rebates of \$350, \$800, or \$1,600 in 2021, with the higher two values requiring household income qualification (Bigazzi et al., 2025).<sup>7</sup> The study used a three-wave panel survey design to examine travel behaviour changes up to 1 year after purchase. The results indicated that 23% (for \$350 rebates) to 76% (for \$1,600 rebates) of rebate recipients made marginal purchases. Purchased e-bikes were used regularly (3 to 4 days and 30 to 70 km per week), and rebate recipients reduced their automobile use by 49 km per week a year after purchase. Larger rebates were associated with greater automobile travel reduction due to higher pre-purchase automobile use. The long-run reduction in GHG from travel averaged 16 kg CO<sub>2</sub>e per week, and the calculated marginal and non-marginal GHG abatement costs were \$722 and \$190 per tonne CO<sub>2</sub>e, respectively.

A study of three local e-bike rebate programs  $^8$  in California, USA did not examine marginality, but found that use of the purchased e-bikes replaced 35% to 44% of rebate recipients' car travel, translating to an estimated GHG reduction of 12 to 44 kg  $CO_2$  per month (Johnson et al., 2023). Approximately 56% of the reported e-bike trips were for recreation, followed by 15% for shopping or errands and 15% for social outings. An analysis of Denver, USA's income-conditioned e-bike rebates  $^9$  also did not examine marginality, but reported e-bike use of 42 km/wk and

<sup>&</sup>lt;sup>6</sup> Sometimes contrasted with the "free rider" who would have purchased the e-bike anyway.

<sup>&</sup>lt;sup>7</sup> The BC rebate program was informed by the Saanich program design and outcomes, and we use similar methods in this study to evaluate the BC program impacts, with the Saanich results providing a useful comparator.

<sup>&</sup>lt;sup>8</sup> Rebate amounts ranged from US\$150 to US\$800, some of them income-conditioned.

<sup>&</sup>lt;sup>9</sup> Rebate amounts ranged from US\$400 to US\$1,700, and were higher for income-qualified residents and those purchasing e-cargo-bikes.



estimated a GHG reduction of 0.43 kg CO<sub>2</sub>eq for each rebate-dollar provided (City and County of Denver et al., 2022).

Another study from the USA used an online survey to estimate the effect of price subsidies on e-bike purchase intentions (Jones et al., 2024). Over a range of assumed rebate program parameters, they estimated that 14% to 18% of the rebates would produce marginal e-bike purchases, translating to a cost per marginal e-bike of US\$3,700 to US\$4,800. Unexpectedly, they found lower-income purchasers to be less price-sensitive, which they attributed to the high net price of e-bikes still being unaffordable for those households.

A study of a national e-bike rebate program in Sweden<sup>10</sup> estimated that 66% of the subsidized e-bike purchases were marginal based on responses to the question "How important was the subsidy for your decision to buy the electric bike?" (Anderson and Hong, 2022). They estimated average annual reductions of 1,146 km/year (22 km/week) in automobile commuting for each e-bike purchaser, with no major difference between marginal and non-marginal purchasers, which translated to an average GHG reduction of 177 kg CO<sub>2</sub>e per year (3.4 kg CO<sub>2</sub>e per week). A study of municipal e-bike rebates<sup>11</sup> in Oslo, Norway was the only other study to use a longitudinal (panel) study design (up to 5 months after purchase), and a comparison sample of regional cyclists (Sundfør and Fyhri, 2022). Marginal purchases were not evaluated, but survey results showed that incentivized purchasers increased their daily e-bike use by 5.3 km, and decreased their daily automobile and transit use by 2.1 and 2.9 km respectively.

# 1.2.4 Impacts of Other E-Bike Incentive Programs

Given the limited and mixed quantitative evidence on the impacts of e-bike rebates, it is also useful to consider related studies on other types of e-bike incentives. A recent study of a pilot incentive program in Worchester, USA that provided free e-bike loans to 96 income-qualified residents reported average use of 105 km per month (24 km/wk) (Goins et al., 2025). The three most common trip purposes were for commuting, recreation, and shopping. Other studies of free e-bike loan programs in the USA (Fitch et al., 2022; MacArthur et al., 2017) and Europe (Bjørnarå et al., 2019; Cairns et al., 2017; Fyhri and Fearnley, 2015; Mildestvedt et al., 2020) have also reported substantial increases in e-bike use (and overall cycling), accompanied by smaller decreases in automobile use.

De Kruijf et al. (2018) evaluated a unique program in the Netherlands that provided monetary incentives of €0.08 to €0.15 per km to e-bike owners to use their e-bikes for commuting. <sup>12</sup> Program participants increased their e-bike commute mode share from 0% to 68% after 1 month, and to 73% after 6 months in the program, with half of the e-bike trips replacing car trips. The e-

<sup>&</sup>lt;sup>10</sup> The program provided a 25% e-bike purchase price subsidy up to CA\$1,500, not income-conditioned, which averaged around CA\$670 in 2018.

<sup>&</sup>lt;sup>11</sup> Rebate amounts of up to €500 (\$730), not income-conditioned, which were distributed in 2016.

<sup>&</sup>lt;sup>12</sup> For those not already commuting by e-bike.



bike use was higher for people who were men, owned fewer motor vehicles, and were commuting by conventional bicycle before the program. A follow-up study found that 2 out of 3 participants used the e-bike as much as they intended to, and that this rate was higher for people who were commuting by conventional bicycle before the program (de Kruijf et al., 2024).

# 1.2.5 Summary

In summary, the impacts of e-bike incentive programs on e-bike adoption and use are still not well understood. The literature is particularly lacking empirical studies including consideration of purchase marginality and long-term behaviour change. In addition, the only study in Canada was in a single municipality (Saanich, BC), with unknown transferability to other locations and scales. These uncertainties limit the strategic use of e-bike incentives to achieve local, national, and international transportation goals. We aim to address these knowledge gaps with an investigation of how the BC e-bike rebate program affected e-bike purchase decisions, how the incentivized e-bikes were subsequently used, and the travel mode substitution and GHG benefits from incentivized e-bike adoption.

#### 1.3 Methods

#### 1.3.1 Overview

The conceptual framework for the study is illustrated in Figure 1. We aimed to quantify the net travel and related impacts that can be attributed to the e-bike rebate program by examining how travel behaviour (primarily e-bike and automobile use) change from before to after e-bike purchase. We consider a range of personal and contextual factors that are known to influence travel behaviour as control variables and potential moderators of the rebate program effects. Program impacts include private benefits for the e-bike user (increased access to destinations, increased physical activity, and reduced travel costs) <sup>13</sup> and social benefits from reduced automobile use (reduced greenhouse gas emissions and other externalities such as noise and air pollution and traffic congestion). The program impacts are calculated from the proportion of travel behaviour changes associated with marginal e-bike purchases (i.e., purchases that would not have happened without the rebate).

<sup>&</sup>lt;sup>13</sup> Personal impacts such as physical activity and travel costs are presented in Part 2 of this report.



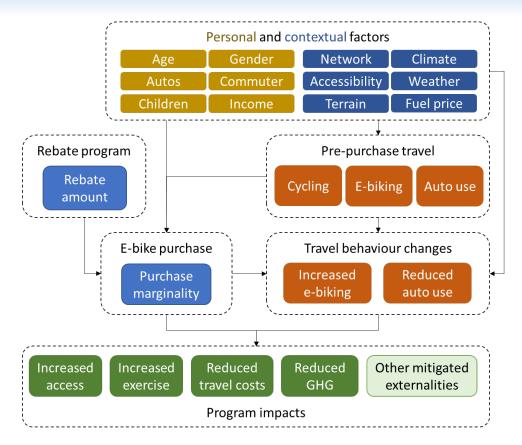


Figure 1. Conceptual framework for the study

Measuring the impacts of interventions such as rebates is challenging due to the impossibility of observing the counterfactual situation in which the intervention did not occur. Our approach to quantifying the rebate effect is illustrated in Figure 2. The impact of the rebates is the difference between the (observable) post-purchase behaviour, and the (unobservable) counterfactual behaviour that would have occurred if the rebates had not been available. In the counterfactual scenario, we do not know whether the rebate recipient would have purchased an e-bike anyway, or how their travel behaviour might depend on whether they purchased an e-bike. "Marginal purchasers" are those that would not have purchased an e-bike in the counterfactual scenario without a rebate. We allow for uncertainty in the counterfactual scenario by defining the "purchase marginality" as likelihood that an e-bike purchase would not have been made without the rebate.



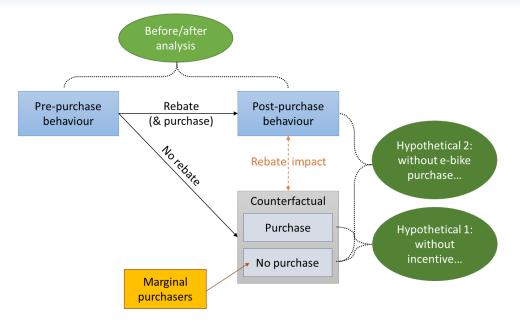


Figure 2. Illustration of counterfactuals for e-bike rebates

We use two different common techniques to contrast the observed post-purchase behaviour with an unobserved counterfactual. The first is to ask rebate recipients to self-report their hypothetical behaviour in the counterfactual scenario without a rebate. Two different hypothetical aspects must be considered: 1) the likelihood of not purchasing an e-bike without the rebate (i.e., purchase marginality), and 2) the most likely alternative behaviour for e-bike use if the e-bike had not been purchased. We also use a second technique to characterize hypothetical #2 (alternative behaviour if the e-bike had not been purchased), which is to assume that their pre-purchase behaviour represents their behaviour in a counterfactual without the e-bike purchase, after controlling for any expected difference between the pre-purchase and counterfactual scenarios (typically related to time-varying factors such as season or fuel price).

#### 1.3.2 Data collection

We used a three-wave panel survey design to collect data on pre-purchase travel behaviour and short- and long-term travel behaviour changes after e-bike purchase, as illustrated in Figure 3. Wave 1 was completed by the participants at the time of recruitment, Wave 2 at 3 months after Wave 1, and Wave 3 at 12 months after Wave 1. Each survey wave recorded data on: 1) the e-bike purchase, 2) typical weekly travel activity in the preceding month or the month before purchase, 3) the last two trips taken using the purchased e-bike, and 3) household composition and socio-demographics including vehicle ownership. The complete survey instrument, implemented in Qualtrics software, is provided in Appendix B.



#### Wave 1 Wave 2 (+3 month) - Recent e-bike purchase Wave 3 (+12 month) - Travel habits (month - E-bike status before purchase) (kept/lost/replaced) E-bike status - Last 2 e-bike trips - Travel habits (previous - Travel habits (previous month) - Household/demographic month) info ... - Last 2 e-bike trips - Last 2 e-bike trips - Household/demographic - Household/demographic changes ... changes ...

Figure 3. Data collection process

BC e-bike rebate recipients were offered the option to "opt in" to be contacted to participate in the study when they completed their rebate application form (see Appendix A). The contact information of those who opted in was given to the study team, and invitation emails were sent to them with up to three reminders for those who did not complete the survey. Participants completing Wave 3 were also given an option to opt in for a possible future follow-up study up to 5 years later. Survey participation was incentivized with a draw for one of 10 gift cards in each survey wave, with values of \$25, \$40, and \$50 in Waves 1 through 3, respectively. Before recruitment began, the study methods were reviewed and approved by the University of British Columbia Behavioural Research Ethics Board (H21-02361).

The last Wave 1 survey invitations were sent in October 2023, so that Wave 3 could be completed at the end of 2024. Although most rebates were distributed near the program launch in June 2023, more rebates became available due to previously allocated rebates which went unclaimed. As a consequence, some program rebates were distributed up through July 2024. Recipients of rebates after October 2023 were not invited to participate, but all rebate recipients are used as the program population for sample comparison in the analysis below.

#### 1.3.3 Data Processing

Survey response data were downloaded from Qualtrics on January 23, 2025. Analyses were conducted using Python version 3.12.7 with the packages Pandas, Geopandas, Numpy, and Matplotlib (Harris et al., 2020; Hunter, 2007; The pandas development team, 2022; Jordahl et al., 2020). Regression analysis was completed using R Statistical language, version 4.3.1, with packages "survey", "DirichletReg", "glmmTMB" (Brooks et al., 2017; Lumley, 2019; Maier, 2014; R Core Team, 2025a).



Data were filtered by first removing pilot test responses and responses that declined consent. Incomplete responses were also removed using a 95% completion threshold (equivalent to completing the survey but not selecting a consent option for the next survey wave). Finally, all responses were removed for those study participants who reported no e-bike purchase or not receiving a rebate from the BC program in any wave.

For data cleaning, some values were manually corrected based on supporting information provided in open text responses. Compositional data (responses to questions with instructions that "numbers should add up to 100%") were scaled to total 100% over all options, if necessary. E-bike purchase dates were cleaned in three ways: 1) purchase dates prior to the program launch in June 2023 were set to June 1, 2023, 2) purchase dates later than the survey response were set to the survey submission date, and 3) new purchases reported in Waves 2 or 3 as having occurred on a date before a previous survey wave submission were changed to one day after that previous survey submission date. E-bike odometer readings that decreased over time were set to null; one unrealistic odometer value of 60,000 km at Wave 3 was also set to null.

Participants were asked to provide the first 3 digits of their home postal code (i.e., Forward Sortation Area or FSA), or provide another location identifier. Those who regularly commute for work or school were also asked to provide their work or school FSA or location. A central FSA was manually assigned for qualitative location identifiers such as neighbourhood or municipality. Missing home location responses were assigned the participant's work or school location, when available.

# 1.3.4 Variable Development

Table 2 presents the purchase, personal, household, and travel-related variables which were derived directly from the survey responses. Table 3 presents a list of contextual variables: either geospatial variables assigned to each participant based on their home FSA, or temporal variables assigned to each survey response based on the completion date. Contextual data only available in other spatial aggregations were assigned to FSAs using area- or population-weighted averages (as described in the table).



Table 2. Purchase, personal, household, and travel variables

Variable name	Description Description
Purchase	
Rebate value	Value of rebate received from BC e-bike rebate program (\$100)
Purchase alternative: No purchase Other e-bike	Self-reported likelihood (from 0 to 1) ofnot purchasing any e-bike without the rebate (marginal purchase)purchasing a different e-bike without the rebate
Same purchase	purchasing the same e-bike without the rebate
E-bike price	E-bike price without any rebate or incentive (\$100)
Share of expected e-bike use by purchaser	Self-reported share of "e-bike's useyou expect will be by you (versus others in your household)" (from 0 to 1)
After e-bike purchase	Observations recorded after (incentivized) e-bike purchase and while still owning the e-bike (binary)
Personal	
Man (exclusive)	Reported "man" as only gender (binary) <sup>3</sup>
Age (decades)	Age assigned to midpoint of 10 y reported increments (10 y)
College certificate	Received at least a college certificate or diploma (binary) <sup>3</sup>
Physical disability	Self-reported "difficulty walking, using stairs, or doing other physical activities" at least "often" (binary) <sup>3</sup>
Non-white	Reported any racial identity besides (or in addition to) "white" (binary) <sup>3</sup>
Household	
Natural log of income	Natural logarithm of annual pre-tax household income (In(\$10,000))
3+ adults in household	Households with more than two adults (binary) <sup>3</sup>
Children in household	Households with at least one child (binary) <sup>3</sup>
Motor vehicles per adult	Number of motor vehicles per adult in household
Fewer cars than adults	Households with fewer cars than there are adults in household (binary) <sup>3</sup>
Conventional bikes per adult	Number of conventional adult bicycles per adult in household
Bike parking inside	Reported "Inside my unit/house" for the prompt "At home, where do you normally park your bike(s)?" (binary)
Detached or semi-detached dwelling	Reported household dwelling type of "Single-detached house" or "Semi- detached house (duplex, row house, townhouse)" (binary) <sup>3</sup>
Travel	
Comfort riding on painted bike lanes	Self-reported comfort of "cycling on your ownon major streets that have a painted bike lane with no physical barrier" (ordinal)
Commuter	Reported "commuting to work or school" (binary) <sup>3</sup>
Cycling pre-purchase	Reported conventional bicycle use at least one day/week at Wave 1 (binary)
E-biking pre-purchase	Reported e-bike use at least one day/week at Wave 1 (binary)
Automobile PKT/week	Self-reported kilometers of travel per week by "Car, truck, or motorcycle (private, shared, or taxi)" (km/wk)
E-bike PKT/week	Self-reported kilometers of travel per week by e-bike <sup>2</sup> (km/wk)
Experienced injury crash with new e-bike	Reported experiencing a crash with the purchased e-bike that resulted in any type of injury (binary)  2) to "Very comfortable" (+2). Missing responses assigned a value of 0

<sup>&</sup>lt;sup>1</sup>From "Very uncomfortable" (-2) to "Very comfortable" (+2). Missing responses assigned a value of 0

<sup>&</sup>lt;sup>2</sup> On average in the previous month or the month before purchase
<sup>3</sup> The reference levels for binary variables include "Prefer not to answer" and missing responses



Table 3. Contextual variables

Variable name	Description or development method
Metropolitan region	Three regions aligned with the largest metropolitan areas (by population) in BC: Vancouver, Victoria, and Kelowna, as well as a fourth region of Elsewhere
Fuel price	Regular gasoline prices (\$/L) by month and metropolitan region (Kalibrate, 2025)
Population density	Population per unit area based on 2021 Census data (100 people/km²) (Statistics Canada, 2022a)
Average annual precipitation	Historic (1991-2020) data for cumulative annual precipitation (m) across the FSA (Wang et al., 2016)
Average winter temperature	Historic (1991-2020) data for average winter (December through February) temperature (°C) across the FSA (Wang et al., 2016)
Non-auto access score	Sum of BC-normalized access indices for transit, cycling, and walking to various land uses (Statistics Canada, 2023)
Biking infrastructure density	A comfort- and population-weighted measure of the density of cycling infrastructure based on the Canadian Bikeway Comfort and Safety (Can-BICS) classification system in (weighted) km/km² (Statistics Canada, 2022b)
Average absolute road grade	Length-weighted average of absolute link grades in each FSA calculated by differencing the elevation range on each link and dividing by total link length (in 0.1 m/m); road network from OpenStreetMap (OpenStreetMap contributors, 2015) and 25 m raster elevation data from (GeoBC, 2024).
Season: Summer, Spring/Fall, or Winter	Season of observation: summer (Jun-Aug), spring/fall (Mar-May or Sep-Nov), or winter (Dec-Feb) (categorical)

# 1.3.5 Survey Weights

Survey weights for responses in each wave were constructed and applied in the analyses to account for differences between the observed sample and the study population (i.e., all BC Program rebate recipients). Wave 1 survey weights (Response weights) account for non-random recruitment from the study population into the Wave 1 study sample. Survey weights for Waves 2 and 3 combine the Response weights with Attribution weights, which account for non-random attrition from the study sample after Wave 1.

Survey weights were calculated by raking with iterative proportional fitting using the "survey" package in R (Lumley, 2019; R Core Team, 2025a). The objective of raking is to achieve target marginal distributions in variables of interest for the weighted survey sample. The variables of interest are selected as the attributes that are both relevant to the study objectives and for which the observed sample differs from the study population. To select raking variables for Response weights, attributes of the Wave 1 sample were compared to those of the BC Program rebate recipients for available variables. To select raking variables for Attrition weights, attributes of the Wave 3 sample were compared to those of the Wave 1 sample (using a regression model described below in Section 1.3.7.1).



# 1.3.6 Calculation of Impacts

#### 1.3.6.1 Purchases, Spending, and Revenues

Purchase-related program impacts are calculated from the reported pre-rebate e-bike price p, the rebate value r, and the self-reported purchase marginality  $^{14}$  m. Total cost of all incentivized e-bikes is  $C = \sum(p)$ , which can be decomposed into the total costs of marginal purchases  $C_m = \sum(pm)$  and non-marginal purchases  $C_{nm} = \sum(p(1-m))$ ,  $C = C_m + C_{nm}$ .

 $C_m$  is also the new retailer revenue generated by the program. This new revenue is composed of the rebates received by marginal purchasers  $R_m = \sum (rm)$  and the induced spending by those purchasers on marginal e-bikes,  $S_m = \sum ((p-r)m)$ . The remaining rebate value is the cost savings on non-marginal purchases,  $R_{nm} = \sum (r(1-m))$ . And finally, the portion of total e-bike costs is the unaffected purchaser spending on non-marginal e-bikes:  $S_{nm} = \sum ((p-r)(1-m))$  and  $C = R_m + S_m + R_{nm} + S_{nm}$ .

The price sensitivity of e-bike purchases can be represented by the point price elasticity of e-bike demand ( $\varepsilon$ ). As described in Bigazzi and Berjisian (2021), assuming a power demand function the purchase marginality is related to price elasticity as  $m=1-\left(1-\frac{r}{p}\right)^{-\varepsilon}$ . This relationship can be rearranged to infer price elasticity from marginality as:  $\varepsilon=\frac{-\ln(1-m)}{\ln\left(1-\frac{r}{p}\right)}$ .

# 1.3.6.2 Travel Behaviour Changes

Travel behaviour changes are evaluated in two ways: 1) using the reported alternative modes for the last two trips taken on the purchased e-bike (which isolates behaviour changes through modal shift), and 2) using changes in typical weekly travel habits by mode between waves (which encompasses a broader range of travel behaviour changes, including trip-making and destination choices).

For each reported e-bike trip (i), the survey instrument recorded the trip distance  $d_i$  in km, the likelihood (from 0 to 1) of making the trip by each alternative mode m if the e-bike had not been purchased,  $L_i^m$ , and the proportional distance of the trip by alternative mode m, relative to  $d_i$ ,  $\gamma_i^m$ . From these, we calculate mode shift as the net change in PKT by alternative mode m for each e-bike trip  $i \in I$  as:  $\Delta PKT_m = \frac{1}{I}\sum_{i \in I}[-d_iL_i^m\gamma_i^m]$ . For e-bike travel, the net mode shift calculation includes the observed trip:  $\Delta PKT_{eb} = \frac{1}{I}\sum_{i \in I}[-d_iL_i^m\gamma_i^m + d_i]$ .

In each survey wave w participants reported weekly travel habits as days per week using mode m at wave w,  $\omega_m^w$ , and average distance per day on days used,  $\delta_m^w$ . From these, we calculate

<sup>&</sup>lt;sup>14</sup> Likelihood they would not have purchased an e-bike without the rebate; see Section 3.1 in Part 1.

 $<sup>^{15}</sup>$  For example,  $\gamma_i^m=1.2$  would indicate a 20% longer trip if it were made by mode m.



weekly PKT for each mode and wave as  $PKT_m^w = \omega_m^w \delta_m^w$ . Mode shift is then calculated as the change in  $PKT_m^w$  between waves.

#### 1.3.6.3 Greenhouse Gas Emissions

The climate impacts of e-bike-induced mode shift were estimated from the PKT values described in the previous section multiplied by per-PKT lifecycle GHG emission rates from a recent study of the climate impacts of household travel in greater Vancouver, BC (Bigazzi et al., 2024a). The emission rates are given in Table 4 in grams of carbon dioxide equivalent emissions (g CO<sub>2</sub>eq) per PKT.<sup>16</sup> These are consequential emission rates, designed to reflect the net impact of individual travel behaviour on total transportation system GHG emissions (Bigazzi, 2025).

Table 4. Lifecycle greenhouse gas emission factors

Primary travel mode	g CO₂eq per PKT
Automobile	325.23
Public transit	39.69
E-bike	11.18
Conventional bicycle	10.72
Walking	0.00

The rates in Table 4 include operating (on-road) emissions, as well as lifecycle emissions for the fuel cycle (e.g., petroleum refining and electricity generation) and vehicle cycle (production, maintenance, and disposal); they do not include guideway lifecycle emissions (generated by infrastructure construction and maintenance). The rates are averaged by "primary" mode, and so include emissions from access and egress trip segments by other modes in multimodal trips (e.g., taking an automobile to a transit station). Automobile travel includes trips by private, shared, or hailed (taxi) vehicles, using a passenger vehicle fleet based on BC vehicle registration data (primarily gasoline passenger cars, but including passenger trucks and hybrid and fully electric vehicles). Public transit includes only bus and paratransit trips (i.e., excluding Vancouver's rail transit and Sea Bus), so that they are applicable to the entire province. Drawing from the Saanich e-bike incentive study, the e-bike emission rate includes 0.46 g CO<sub>2</sub>eq/km in use-phase electricity consumption (Bigazzi et al., 2025).<sup>17</sup>

The emission rates in Table 4 are representative of systemic modal differences in the GHG intensity of passenger travel in BC, but GHG rates for individual trips will vary substantially with a range of factors that were not feasible to collect in this study, particularly vehicle model and fuel type, vehicle occupancy, and driving style. The rates also do not reflect potential systemic

<sup>&</sup>lt;sup>16</sup> Carbon dioxide equivalents is a metric used to combine the climate impacts of various greenhouse gases, adjusted for global warming potential.

<sup>&</sup>lt;sup>17</sup> We do not treat food as a transportation fuel, and so exclude upstream GHG emissions attributable to production of food consumed by people who cycle. This is a topic of some debate, and there is currently mixed evidence on the marginal effects of active travel on food consumption (Elder and Roberts, 2007; Frank et al., 2022).



differences in the GHG intensity of travel by region of the province due to factors such as vehicle fleets and transit operations. Implications are discussed in Section 1.5.3.

#### 1.3.6.4 External Costs of Travel

In Part 1 of this report we estimate the *external* costs to society associated with overall weekly travel in each wave and the change in external travel cost per e-bike trip. In Part 2 we estimate the *internal* travel-related costs experienced by the e-bike users. Table 5 presents the assumed external travel cost rates per PKT, which were taken from Litman (2022)<sup>18</sup>. These external costs include the construction and maintenance of roadway and parking facilities, traffic congestion, transit and vehicle subsidies, crashes, noise and air pollution, barrier effects, and resource extraction.

Table 5. Assumed external travel cost rates by mode (in \$ per km)

	Walking	Biking	E-biking	Auto	Transit	Other <sup>1</sup>
External travel costs	\$0.01	\$0.09	\$0.12	\$0.48	\$0.09	\$0.16

<sup>&</sup>lt;sup>1</sup>Average of all other modes

# 1.3.7 Regression Analyses

Regression analysis was used to examine sample attrition in the panel between waves, and to investigate the factors influencing purchase marginality and travel mode shift after purchase (weekly PKT by e-bike and automobile). The independent variables (given above in Section 1.3.4) included attributes of the purchase (rebate, price), the purchaser (age, gender), their household (income, children), their travel circumstances (commuter, comfort cycling), and their home context (population density, climate). We also included potentially confounding time-varying factors (season, fuel price). Selection of independent variables was informed by the travel behaviour literature, the study scope and objectives, and data availability. A variety of variable definitions were examined during model specification (such as transformations of household income), with the final specification determined by model fit and theoretical consistency.

Missing data are challenging for regression analysis, and various approaches to handling missing data carry different vulnerabilities to bias in parameter estimates (Groenwold et al., 2012; Jones, 1996; Ranganathan and Hunsberger, 2024). We created flag indicator variables to identify missing responses for independent variables, and the missing data were assigned a sample mean value for model estimation. This practical approach allows us to retain observations and variables of interest with incomplete responses (e.g., someone who responded to all questions except

<sup>&</sup>lt;sup>18</sup> Currency conversion of CA\$1.35 = US\$1.00 was used as necessary



age). It is more appropriate than eliminating incomplete observations or variables when missing values are not random, <sup>19</sup> and avoids the challenges and uncertainties of data imputation.

Statistical tests use a default significance threshold p<0.05. This threshold is common but arbitrary and often misapprehended with respect to the evidence it provides for both "significant" and "null" effects (Nuzzo, 2014; Wasserstein and Lazar, 2016). We report simple p-values for each parameter, which do not adjust for multiple hypothesis testing, and should not be viewed as definitive arbiters of which factors do or do not influence the outcomes of interest.

#### 1.3.7.1 Panel Retention Model

Binary logit regression was used to investigate non-random attrition in the study participants between survey waves and to determine the variables to use for survey weighting (see Section 1.3.5 above). The dependent variable in the model was completion of Wave 3 (binary). The estimated model parameters for independent variables indicate if participants with certain attributes were more or less likely than others to remain in the study for all three waves. Variables with statistically significant parameters (p<0.05) were then used to calculate the Attrition survey weights for Wave 2 and Wave 3 observations (model results in Section 1.4.1.6 and survey weights in Section 1.4.1.7).

#### 1.3.7.2 Purchase Marginality Model

Dirichlet regression was used to investigate relationships between the independent variables and an individual's self-reported likelihood of alternative purchase behaviours if the rebate had not been available: 1) purchasing the same e-bike, 2) purchasing a different e-bike, and 3) not purchasing an e-bike. <sup>20</sup> The first alternative was the reference level, and so the parameter estimates represent the effects of each variable on the likelihoods of alternatives #2 and #3 relative to alternative #1. Dirichlet regression is used for compositional data (adding up to 1); it addresses the challenge of multicollinearity without assuming a single alternative is chosen, <sup>21</sup> and allows for independent effects of each variable for each alternative (Douma and Weedon, 2019; Maier, 2014). The estimated parameters for alternative #3 are the primary interest from this model because they represent the effects of independent variables on purchase marginality. The model was estimated in the statistical software R with the package 'DirichletReg' (Maier, 2014).

<sup>&</sup>lt;sup>19</sup> "Missing Not At Random" (MNAR) data; i.e., when the likelihood that participants chose not to respond to certain questions relates to the value they would have provided

<sup>&</sup>lt;sup>20</sup> The third alternative includes the likelihoods of not purchasing any bicycle and purchasing a conventional bicycle.

<sup>&</sup>lt;sup>21</sup> Such as is assumed in discrete choice modelling



#### 1.3.7.3 E-bike and Automobile PKT Models

Travel behaviour changes after purchase were investigated using negative binomial regression models of weekly PKT by e-bike and by automobile in each wave. The negative binomial model specification accounts for the non-normal distribution of these dependent variables (which are truncated at zero and have substantial positive skew). The specification also includes random effects for each participant to account for panel effects (intra-subject error correlation).<sup>22</sup> The models were estimated in the statistical software R with the package 'glmmTMB' (Brooks et al., 2017; R Core Team, 2025a).

An "After e-bike purchase" intervention dummy variable was included in the models to denote observations after e-bike purchase. The estimated parameters on this intervention variable indicate the change in each outcome associated with the e-bike purchase, after controlling for the independent variables and the participant's pre-purchase behaviour. The post-purchase intervention variable was also interacted with other independent variables to test for moderating effects on post-purchase behaviour changes (i.e., whether post-purchase e-bike or automobile use increased or decreased more in certain circumstances such as for purchasers living in hillier areas).

#### 1.4 Results

## 1.4.1 Study Sample

#### 1.4.1.1 Responses

As of October 2023, 2,856 rebates had been distributed by the BC Electric Bike Rebate Program and 2,278 rebate recipients (80%) consented to be contacted for study recruitment. Of those who were invited to participate, 1,004 complete and cleaned responses were received at Wave 1, representing a response rate of 44% (or 35% of all rebates distributed at that time). Figure 4 shows the sample progression over the study. The number of complete, cleaned responses for Waves 2 and 3 were 601 and 449, respectively, which translates to retention rates from Wave 1 of 60% and 45%. Most participants completing Wave 1 and Wave 2 (89% and 99%, respectively) consented to be contacted for the next wave.

<sup>&</sup>lt;sup>22</sup> Random effects were used rather than fixed effects to account for the panel data structure so that we could include time-invariant personal factors in the model and make inferences beyond the studied sample; this approach assumes that the few non-personal, time-varying independent variables in the model (fuel price, season) are uncorrelated with the individual error (Greene, 2008).



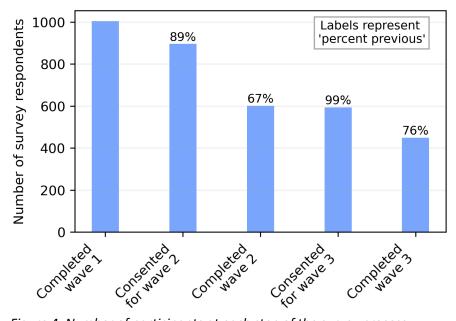


Figure 4. Number of participants at each step of the survey process

The complete and cleaned survey responses over time are shown in Figure 5. Most Wave 1 responses were collected in June and July 2023, coinciding with the launch of the BC e-bike rebate program, while the majority of Wave 2 responses were collected in September and October 2023 and the majority of Wave 3 responses were collected in June and July 2024. The number of responses at each step of the data cleaning process is given in Table 6.

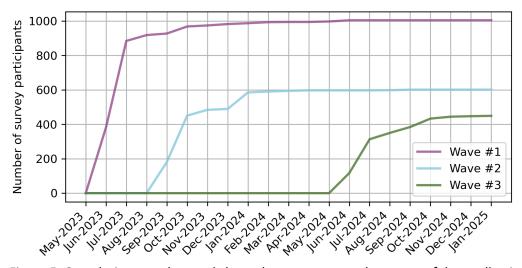


Figure 5. Cumulative complete and cleaned responses over the course of data collection



Table 6. Number of responses through data cleaning

Type of response	Wave 1	Wave 2	Wave 3	All responses
Raw (post-consent)	1,362	703	513	2,578
Complete (95%+)	1,072	614	457	2,143
Purchased e-bike with BC rebate	1,004	601	449	2,054

#### 1.4.1.2 Rebate Distribution

By July of 2024, 4,943 total rebates had been distributed by the BC e-bike rebate program, although no new study participants were recruited after October 2023. We use the full population of rebate recipients for comparison of sample attributes and weighting.

Figure 6 presents the rebate distributions for the Program recipients and the Wave 1 study sample. Most participants in the sample (80%) received the highest rebate value of \$1,400, while 14% received \$1,000 and 6% received \$350. An even larger portion of BC rebate recipients (86%) received \$1,400 rebates, while 10% received \$1,000 and 4% received \$350. The larger proportional representation of the lower-tier rebates is beneficial for analysis because it provides more observations for the less-common rebate values.



Figure 6. Distribution of rebate values for BC Program and study sample (at Wave 1)

Responses by rebate value and survey wave are shown in Figure 7. The \$350 rebate recipients had a slightly lower retention rate of 40%, compared to 46% for the \$1,000 rebate recipients and 45% for the \$1,400 rebate recipients. As a consequence, the distribution of Wave 3 responses across rebate tiers slightly more closely resembles the Program overall.



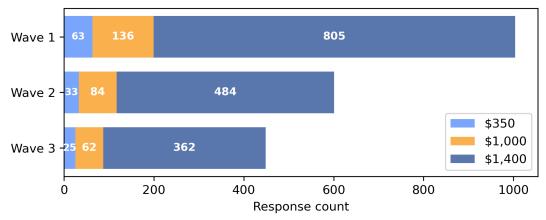


Figure 7. Number of complete and cleaned responses by rebate value category at each survey wave

#### 1.4.1.3 Sample Characteristics

Table 7 summarizes the study sample characteristics, with comparisons to the full set of BC rebate recipients, the Saanich e-bike incentive study sample (Bigazzi et al., 2025), and BC census data for the general population (Statistics Canada, 2022a). The sample percentages are calculated only for those who responded for each item. Most items had a response rate close to 100%, although only 87% of the sample reported household income. The BC study sample compares well to the study population (BC rebate recipients) overall, although it contains a higher proportion of people who identify as men, are aged 50 y or over, and are white. Reported weekly travel mode use is higher for all modes in the study sample than the study population (due to different phrasing of the prompts<sup>23</sup>), but the ordering across modes is the same (automobile >> conventional bicycle > transit > electric bicycle).

The BC study sample attributes are also largely similar to those of the previous study sample in Saanich, although the BC sample has a higher proportion of people aged 50 years or over and larger shares of people who reported using e-bikes and transit before the purchase. The household incomes for the BC and Saanich study samples are remarkably similar, both averaging \$67,600, despite differences in the income qualification criteria.

Household income for the study sample<sup>24</sup> is substantially lower than the province overall, due to the program's income criterion. Despite this difference in income, the study sample has similar educational attainment and motor vehicle ownership to the general BC population.

<sup>&</sup>lt;sup>23</sup> Study survey prompt: "In the month before you made this purchase, on average how many days per week did you use each of the following modes of travel" vs. BC Program prompt: "Which of the following do you usually use to travel at least one day per week"

<sup>&</sup>lt;sup>24</sup> Only personal (not household) income data are available for all the rebate recipients in the BC Program.



Table 7. Sample characteristics in Wave 1

Attribute	BC Wave 1	BC rebate	Saanich Wave	British
	sample	recipients	1 sample <sup>1</sup>	Columbia
Count (N)	1,004	4,943	164	5,000,880
Gender: man <sup>2</sup>	52%	46%	52%	49%
Age: 19-29 y	13%	20%	32%	20%
Age: 30-39 y	23%	22%	19%	17%
Age: 40-49 y	14%	15%	18%	15%
Age: 50-59 y	18%	14%	14%	16%
Age: 60-69 y	24%	20%	9%	16%
Age: 70+ y	9%	9%	7%	16%
Physical disability	5%	Unk <sup>3</sup>	7%	Unk
Indigenous	2%	Unk	3%	6%
Non-white	24%	27%	24%	34%
Has at least college certificate	81%	Unk	82%	82%
Has driver's license	94%	Unk	97%	Unk
Household size (mean)	2.72	Unk	2.50	2.40
Households with children	27%	Unk	31%	34%
Household motor vehicles (mean)	1.60	Unk	1.55	1.62
Household conventional adult bicycles (mean)	1.68	Unk	1.65	Unk
Household electric bicycles (mean)	1.26	Unk	1.05	Unk
Annual household income				
<\$25,000	18%	Unk	15%	9%
\$25,000 - \$50,000	30%	Unk	30%	17%
\$50,000 - \$75,000	16%	Unk	20%	17%
\$75,000 - \$100,000	14%	Unk	16%	15%
\$100,000 - \$150,000	14%	Unk	8%	20%
>\$150,000	8%	Unk	10%	21%
Travel habits: at least weekly trips by each mode	(pre-purchase)	5		
Walk	82%	Unk	83%	Unk
Conventional bicycle	41%	34%	40%	Unk
Electric bicycle	15%	8%	7%	Unk
Private automobile	91%	74%	94%	Unk
Public transit	32%	30%	19%	Unk

<sup>&</sup>lt;sup>1</sup>Saanich "study group" (incentive recipients) only; excludes the control group of non-incentivized purchasers

<sup>&</sup>lt;sup>2</sup> Participants who selected *Man* as their only gender identity for the program and sample data; the "Men +" category in the census data for British Columbia includes non-binary people

<sup>&</sup>lt;sup>3</sup> Unknown

<sup>&</sup>lt;sup>4</sup>Not applicable

<sup>&</sup>lt;sup>5</sup> Different prompts were used in the BC program and study surveys to measure this value.



# 1.4.1.4 Geographic Distribution

Figure 8 shows the number of survey participants by forward sortation area (FSA) and metropolitan region. FSA sizes are inversely related to population density, so the number of participants per FSA is moderate (<25) even in the densest parts of Vancouver.

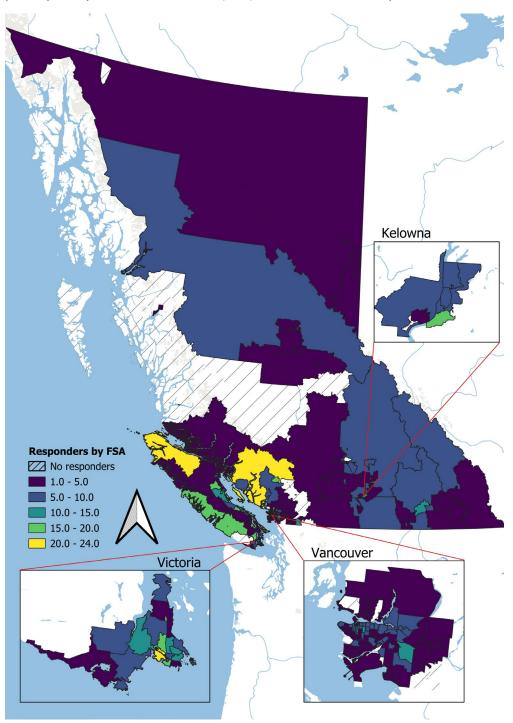


Figure 8. Spatial distribution of participants at Wave 1



Table 9 presents sample characteristics for Wave 1 participants by metropolitan region. Vancouver participants are younger, more likely to identify as men and be non-white, and have higher household incomes than participants in other regions. Weekly travel habits are relatively similar across regions; however, Vancouver participants use public transit more frequently and automobiles less frequently, compared to other regions.

Table 8. Sample demographics by metropolitan region

Attribute	Vancouver	Victoria	Kelowna	Elsewhere	Total sample	
Count (N)	436	176	55	337	1,004	
Man	59%	44%	44%	48%	52%	
Age: 19-29 y	18%	12%	9%	8%	13%	
Age: 30-39 y	27%	20%	20%	19%	23%	
Age: 40-49 y	16%	14%	9%	12%	14%	
Age: 50-59 y	17%	16%	20%	20%	18%	
Age: 60-69 y	18%	24%	28%	30%	24%	
Age: 70+ y	4%	14%	13%	11%	9%	
Physical disability	4%	6%	9%	5%	5%	
Indigenous	1%	2%	2%	4%	2%	
Non-white	40%	14%	9%	7%	24%	
Has college/university certificate/diploma	84%	86%	77%	74%	81%	
Household size (mean)	2.96	2.59	2.82	2.46	2.72	
Households with children	31%	24%	26%	24%	27%	
Household motor vehicles (mean)	1.46	1.52	2.33	1.71	1.60	
Household conventional adult bicycles (mean)	1.64	1.59	1.95	1.74	1.68	
Household electric bicycles (mean)	1.20	1.32	1.47	1.26	1.26	
Annual household income						
<\$25,000	17%	16%	18%	20%	18%	
\$25,000 - \$50,000	29%	28%	32%	32%	30%	
\$50,000 - \$75,000	13%	22%	11%	18%	16%	
\$75,000 - \$100,000	15%	18%	7%	13%	14%	
\$100,000 - \$150,000k	15%	12%	23%	11%	14%	
>\$150,000	11%	5%	9%	6%	8%	
Travel habits: at least weekly trips by each mode (pre-purchase)						
Walk	84%	82%	85%	79%	82%	
Conventional bicycle	40%	41%	42%	41%	41%	
Electric bicycle	16%	15%	9%	13%	15%	
Private automobile	85%	91%	98%	97%	91%	
Public transit	52%	26%	4%	14%	32%	



Table 8 presents the sample distribution across metropolitan regions with a comparison to the BC Program and BC population. A higher share of rebate recipients in the Victoria region and Elsewhere completed Wave 1 of the study, while a lower share in the Vancouver region completed Wave 1. The retention rate of Wave 1 participants at Wave 3 is similar for all regions, ranging from 43% to 48%. Compared to the general population, Program rebates were disproportionately distributed in the metropolitan regions of Victoria and Vancouver.

Table 9. Sample distribution across metropolitan regions

Region	BC Wave 1 sample	BC rebate recipients	BC population	Moved after Wave 1	Retained at Wave 3 from Wave 1 <sup>1</sup>
Vancouver	43%	55%	53%	1.1%	44%
Victoria	18%	13%	8%	2.3%	48%
Kelowna	5%	5%	5%	5.5%	45%
Elsewhere	34%	27%	34%	0.3%	43%

<sup>&</sup>lt;sup>1</sup> Excluding those who moved

#### 1.4.1.5 Summary of Model Variables

Table 10 presents a summary of the time-varying, observation-level variable values for all 2,038 observations with complete travel data (each observation is a response in a specific survey wave, with up to 3 observations per participant). These variables are used in the regression analysis to examine associations with purchase marginality and changes in e-bike and automobile use post-purchase, and to control for confounding factors. Table 11 presents a summary the person-level variable values for all 1,004 participants.

Table 10. Summary of time-varying (observation-level) variables used in analysis

Variable name	Units	Summary statistic <sup>1</sup>
Automobile PKT/week	km/wk	95.05 (93.55)
E-bike PKT/week	km/wk	26.98 (46.90)
Flag (imputed <sup>2</sup> automobile km/day)	None (binary)	2%
Flag (imputed <sup>2</sup> e-bike km/day)	None (binary)	2%
After e-bike purchase	None (binary)	51%
Experienced injury crash with new e-bike	None (binary)	2%
Fuel price	(\$/L)	1.83 (0.13)
Season	None (categorical)	
Summer		41%
Fall/Spring		53%
Winter		6%
·		

<sup>&</sup>lt;sup>1</sup>% true for binary and categorical variables; mean (standard deviation) for continuous variables; for 2,038 observations with complete travel data (up to 3 per participant)

<sup>&</sup>lt;sup>2</sup> Mean km/day for other people reporting the same days/week of use



Table 11. Summary of participant variables used in analysis

Category	Variable name	Units	Summary statistic
	Rebate value	\$100	12.8 (2.77)
	Purchase alternative: No purchase	None (likelihood)	0.58 (0.40)
	Purchase alternative: Other e-bike	None (likelihood)	0.20 (0.27)
Purchase	Purchase alternative: Same purchase	None (likelihood)	0.23 (0.31)
Fulchase	Flag (missing purchase alternative response)	None (binary)	4%
	E-bike price	\$100	31.87 (13.67)
	Flag (missing e-bike price response)	None (binary)	1%
	Share of expected e-bike use by purchaser	None (proportion)	0.88 (0.19)
	Man (exclusive) <sup>2</sup>	None (binary)	51%
	Age	10 y	4.92 (1.58)
	Flag (missing age response)	None (binary)	1%
Personal	College certificate <sup>2</sup>	None (binary)	81%
	Flag (missing education response)	None (binary)	2%
	Physical disability <sup>2</sup>	None (binary)	5%
	Non-white <sup>2</sup>	None (binary)	23%
	Natural log of income	Ln(\$10,000)	1.66 (0.76)
	Flag (missing income response)	None (binary)	13%
	3+ adults in household <sup>2</sup>	None (binary)	23%
	Children in household <sup>2</sup>	None (binary)	27%
	Motor vehicles per adult	Number/person	0.75 (0.47)
Household	Fewer cars than adults <sup>2</sup>	None (binary)	55%
	Conventional bikes per adult	Number/person	0.80 (0.69)
	Bike parking inside	None (binary)	59%
	Flag (missing bike parking response)	None (binary)	4%
	Detached or semi-detached dwelling <sup>2</sup>	None (binary)	75%
	Comfort riding on painted bike lanes	Ordinal (-2 to +2)	-0.16 (1.42)
	Comfort riding on local streets	Ordinal (-2 to +2)	1.34 (1.29)
Travel	Commuter <sup>2</sup>	None (binary)	44%
	Cycling pre-purchase	None (binary)	41%
	E-biking pre-purchase	None (binary)	15%
	Population density	100 people/km <sup>2</sup>	25.04 (36.26)
	Average annual precipitation	m	1.32 (0.61)
Context	Average winter temperature	°C	2.48 (3.40)
	Non-auto access score	Score	0.52 (0.58)
	Biking infrastructure density	Weighted km/km <sup>2</sup>	3.33 (3.86)

 $<sup>^1\%</sup>$  true for binary and categorical variables; mean (standard deviation) for continuous variables; for all 1,004 participants at Wave 1

<sup>&</sup>lt;sup>2</sup> The reference levels for these binary variables include "Prefer not to answer" and missing responses



#### 1.4.1.6 Panel Retention Model

As described in Section 1.3.7.1 above, we used a binary logit regression model of participant retention at Wave 3 to investigate the potential for bias introduced through non-random attrition of study participants. Table 12 presents the estimated model parameters as odds ratios for each variable. Odds ratios closer to one indicate less potential bias due to non-random attrition related to that factor. An odds ratio greater than one indicates a variable that increases the likelihood of retention in the panel to Wave 3, while an odds ratio less than one indicates a variable that decreases the likelihood of retention in the panel. P-values less than 0.05 in Table 12 indicate variables for which we have 95% confidence that the odds ratio is not 1 (i.e., variables of concern that relate to participant retention).

Four variable parameters in Table 12 are statistically significant (p<0.05): participant retention was higher for people who received larger rebates, live in households with higher income, and were conventional cycling pre-purchase, likely reflecting more motivated participants. In

Table 12. Estimated model of participant retention at Wave 3

Variable <sup>1</sup>	Odds ratio	P-value
Intercept	0.17	<0.01
Rebate value (\$100)	1.06	0.04
Man (exclusive)	1.08	0.58
Age (10 y)	1.07	0.12
Flag (missing age response)	0.24	0.20
College certificate	1.01	0.96
Flag (missing education response)	0.28	0.05
Physical disability	1.47	0.19
Non-white	0.88	0.46
Natural log of income (In(\$10,000))	1.30	0.01
Flag (missing income response)	0.97	0.88
3+ adults in household	0.83	0.27
Children in household	0.62	<0.01
Fewer cars than adults	0.85	0.29
Comfort riding on painted bike lanes	1.03	0.55
Cycling pre-purchase	1.58	<0.01
Metropolitan region: Vancouver <sup>2</sup>	1.11	0.73
Metropolitan region: Victoria <sup>2</sup>	1.21	0.26
Metropolitan region: Kelowna <sup>2</sup>	1.25	0.26
Automobile PKT/week (100 km/wk)	0.96	0.60
Flag (imputed automobile km/day) <sup>3</sup>	0.86	0.72

<sup>&</sup>lt;sup>1</sup>Variable values as reported at Wave 1

<sup>&</sup>lt;sup>2</sup> Reference level: "Elsewhere"

<sup>&</sup>lt;sup>3</sup> Mean km/day for other people reporting the same days/week of use



contrast, participant retention was lower for participants with children in their household, perhaps due to less time availability. Non-random sample attrition can introduce bias if it is associated with the outcomes of interest (such as travel mode shift and GHG changes). To mitigate this risk, we develop and apply attrition-related survey weights conditioned on rebate value, household income, having children in household, and cycling pre-purchase (described in the next section).

## 1.4.1.7 Survey Weights

Survey weights were developed to account for the sample non-representation issues described in the previous sections, both with respect to recruiting participants from the BC Program (Response weights) and retaining participants in subsequent waves (Attrition weights). Response weights were calculated by comparing the Wave 1 sample to the BC Program rebate recipients on the attributes of gender, age, non-white, metropolitan region, and rebate value. Attrition weights were calculated by comparing the Wave 2 and 3 samples to the Wave 1 sample on the attributes of household income, children in household, cycling before purchase, and rebate value. Survey weight values are summarized in Table 13. These weights are applied below in regression modelling and to calculate the total program impacts. Observations from Wave 1 are applied only the Response weights, while observations in Waves 2 and 3 are applied the product of the Response and Attrition weights.

Table 13. Summary of survey weight values

Weight type	Relevant sample	Minimum	Mean	Median	Maximum
Response	Wave 1	0.31	1.00	0.96	1.64
Attrition 2	Wave 2	0.81	1.00	1.05	1.50
Attrition 3	Wave 3	0.68	1.00	1.06	1.66

## 1.4.1.8 Summary: Study Sample Composition and Responses

A 35% response rate from recruited BC Program rebate recipients yielded a sample of 1,004 cleaned survey responses at Wave 1. Overall, the study sample compares well to the study population of BC Program rebate recipients, most (86%) of whom received the largest \$1,400 rebates. Compared to the BC Program, the study sample has higher proportions of people who identify as men (52% vs. 46%), are over 55 y (41% vs. 36%), and are white (76% vs. 73%).

The study participants come from households with lower income than the general BC population (averaging \$67,608 vs.  $$108,600^{25}$ ), in alignment with the Program design, but have similar levels of motor vehicle ownership (both averaging 1.6 motor vehicles per household). Geographically, the study sample and BC program rebate recipients are distributed across metropolitan similarly

<sup>&</sup>lt;sup>25</sup> Statistics Canada (2022a)



to the BC population. Metropolitan Victoria and Vancouver Island are overrepresented in both the study sample and the rebate recipients, while metropolitan Vancouver and Lower Mainland are under-represented in the study sample but not the rebate recipients.

Retention rates at Waves 2 and 3 were 60% and 45%, respectively, and generally consistent across most sample attributes. However, four attributes were statistically associated with the likelihood of participant retention to Wave 3: rebate value, household income, children in household, and cycling pre-purchase. Survey weights were developed to account for sample non-representation with respect to participants recruited from the BC Program (Response weights) and participants retained at Waves 2 and 3 (Attrition weights). These survey weights are applied in the regression and program impact analysis presented below.

For context, most studies of real-world e-bike incentive programs have sample sizes under 100 (Bjørnarå et al., 2019; Cairns et al., 2017; Fyhri and Fearnley, 2015; Goins et al., 2025) but some have recruited larger samples of up to 1,873 for a national program in Sweden (Anderson and Hong, 2022; Sundfør and Fyhri, 2022; Ton and Duives, 2021). Recruitment rates from incentive programs can range from 18% to as high as 89% when included in program requirements (Anderson and Hong, 2022; Goins et al., 2025; Johnson et al., 2023; Sundfør and Fyhri, 2022). Retention rates for multi-wave studies range from 21% to 45%, decreasing with time between waves (Bigazzi et al., 2025; Sundfør and Fyhri, 2022; Ton and Duives, 2021). In this context, a good response rate (35%) from a large incentive program (2,856 rebates at the time of recruitment) yielded a relatively large sample size (1,004), with good retention (45%) over a long time period (12 months).

## 1.4.2 E-Bike Purchases

#### 1.4.2.1 Overview of Bicycle Purchases

By the time rebate recipients completed Wave 1 of the survey, 95% of the participants had purchased an e-bike. The remainder purchased an e-bike between Waves 1 and 2 (4.9%), or between Waves 2 and 3 (0.2%). Twelve participants reported no longer owning the original e-bike in Waves 2 or 3; 7 participants had replaced it. The self-reported reasons for no longer owning the e-bike were theft, mechanical issues with the e-bike, feeling unsafe cycling, and bike parking becoming an obstacle (after moving). Out of the three e-bikes that had been stolen, one has been recovered by the police, but the owner sold it due to concern about damage incurred.

Figure 9 presents the distribution of the expected share of e-bike use by them versus others. Most participants (65%) reported 100% of the expected use to be by them; the average expected share in the sample was 88%.



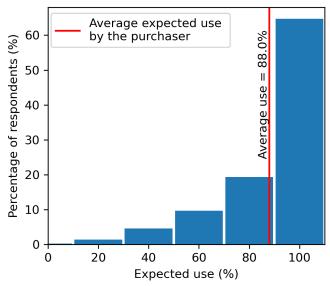


Figure 9. Share of expected e-bike use by the purchaser

The average purchased e-bike cost, after the rebate discount, was \$1,887, with a standard deviation of \$1,410 and a median value of \$1,555. No tax is included in this cost, as e-bikes are exempt from sales tax in BC. Figure 10 presents the e-bike cost by rebate value. People receiving larger, income-conditioned rebates purchased lower-price e-bikes on average, showing that the rebates were primarily used to decrease purchaser costs, rather than to obtain a higher-priced e-bike.

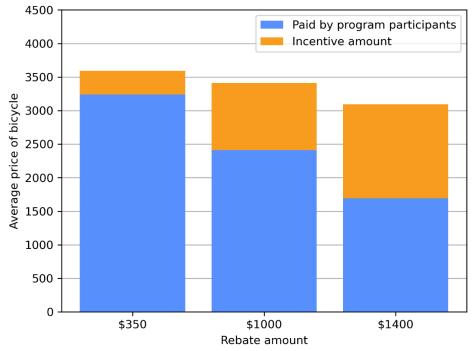


Figure 10. Reported e-bike costs by rebate value



Table 14 presents further cost information for each rebate tier. The purchase cost paid by the recipients of the \$350 rebate was approximately twice of that of the \$1,400 rebate recipients, while the total cost (before the rebate discount is applied) was 16% higher. Twenty-two participants reported receiving other incentives (such as employer benefits or retailer sales) with an average value of \$930 (standard deviation \$1,162).

Table 14. E-Bike cost<sup>1</sup> by rebate tiers

Cost variable	\$350 rebates	\$1,000 rebates	\$1,400 rebates	All rebates
Cost paid by the participant	\$3,241 (\$2,708)	\$2,410 (\$1,226)	\$1,692 (\$1,187)	\$1,887 (\$1,403)
Value of other incentives received <sup>2</sup>	\$35 (\$209)	\$45 (\$482)	\$15 (\$126)	\$20 (\$216)
Total e-bike price <sup>3</sup>	\$3,627 (\$2,684)	\$3,455 (\$1,380)	\$3,107 (\$1,193)	\$3,187 (\$1,367)

<sup>&</sup>lt;sup>1</sup> Mean (standard deviation)

Selected sample demographics by rebate tier are presented in Figure 11. At higher household income levels, an increasing share of participants received lower-value rebates. However, most rebate recipients in households with annual income over \$150,000 still received the \$1,400 rebates, due to the program's qualification criterion based on individual income, rather than household income. The relative share of \$1,400 rebates also decreases with age, although most participants received the \$1,400 rebates at all age levels.

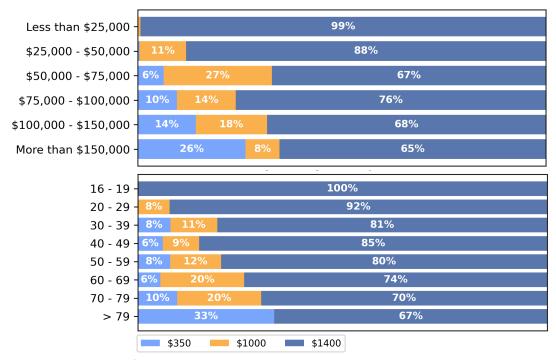


Figure 11. Distribution of rebate values with household income and recipient age

<sup>&</sup>lt;sup>2</sup> Reported by 1-3% of participants across rebate tiers; averaged across all rebate recipients

<sup>&</sup>lt;sup>3</sup> Includes other reported incentives; excludes Provincial sales tax (exemption available to all e-bike purchasers)



Participants were asked to rank the top three considerations for their bicycle purchase. Assigning 3 points to the first factor, 2 to the second factor, and 1 to the third factor, Figure 12 shows the mean points for each factor by rebate tier, in order of descending average points. The most important considerations overall are cost, physical effort of riding, the desire for mode substitution, riding distance, and fun of riding. Purchase cost, physical effort of riding, mode substitution, and fun of riding have the most variation in importance among different rebate levels. Recipients of larger rebates gave relatively more consideration to purchase cost and mode substitution, and less consideration to physical effort and fun of riding.

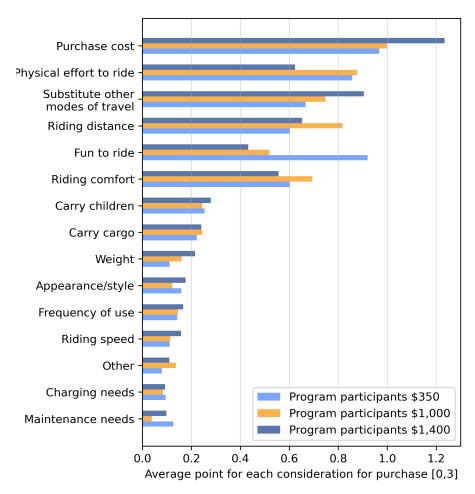


Figure 12. Main considerations in purchase by rebate value

#### 1.4.2.2 Marginal Purchases

As explained in Section 1.3.1 above, the concept of *marginality* is important for understanding the impacts of the program, as marginality indicates the effectiveness of the program in generating e-bike purchases that would not otherwise have happened. To quantify marginality of purchases, participants were asked the following question: "If the incentives described above were not available for this purchase, what is the likelihood each of the following would have



happened?" They were then provided response choices with sliders (ranging from 0% to 100%) for the following options: the same e-bike would have been purchased; a different e-bike would have been purchased; a conventional bicycle would have been purchased; no e-bike purchase would have occurred.

The mean likelihoods of each purchase alternative by rebate tier are presented in Figure 13. The combination of "no e-bike" and "conventional bicycle" likelihoods represents marginality, as in those instances, no e-bike purchase would have occurred. Figure 13 shows that mean marginality increases from 21% for \$350 rebates to 62% for \$1,400 rebates, which means that higher rebate values are more effective in stimulating new purchases that would not have happened without the rebate program.

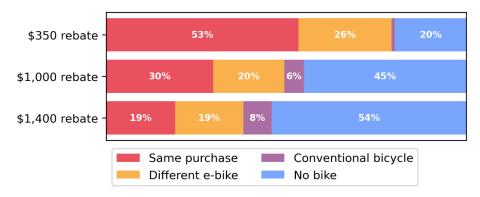


Figure 13. Mean self-reported likelihood of alternative purchase decision by rebate tier (if the rebate were not available)

Figure 14 presents the mean likelihoods of each purchase alternative by household income. Lower-income households report higher likelihood of the "no e-bike" alternative (i.e., higher marginality), which reflects the effects of both larger rebate values and higher expected price sensitivity.

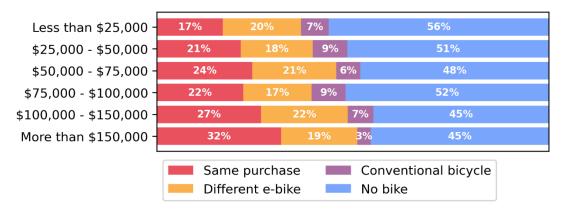


Figure 14. Mean self-reported likelihood of alternative purchase by household income



Inferred price elasticity of e-bike demand for each rebate tier are presented in Table 15. The elasticity ranges from -2.3 to -1.6, which means that a 10% decrease in e-bike cost increases e-bike demand by around 20%. These results align well with the suggested range of -1.0 to -3.0 based on limited previous literature in Bigazzi and Berjisian (2021), and are similar to the values estimated for the Saanich Incentive Program which ranged from -2.1 to -1.8 (Bigazzi et al., 2024b).

Table 15. Price elasticity of e-bike purchase demand

Variable	\$350 rebates	\$1,000 rebates	\$1,400 rebates	All rebates
Average marginality <sup>1</sup>	0.21	0.51	0.62	0.58
Pre-rebate price	\$3,591	\$3,410	\$3,092	\$3,166
Implied price elasticity	-2.30	-2.06	-1.60	-1.71

<sup>&</sup>lt;sup>1</sup> Likelihood of not making an e-bike purchase without the rebate

## 1.4.2.3 Regression Model of E-Bike Purchase Marginality

Weighted Dirichlet regression model results for the likelihood of alternative purchase behaviours (if rebates had not been available) are presented in Table 16. The model was specified with three alternative behaviours: purchasing the same e-bike (reference level), purchasing a different e-bike, and not purchasing an e-bike (i.e., being a marginal purchase). The model was estimated on 956 observations (excluding participants who did not answer the alternative purchase behaviour question). Table 16 summarizes the estimated model parameters as odds ratios for two alternatives: no purchase and other e-bike purchase, each in comparison to the reference alternative of making the same purchase. Odds ratios greater than one indicate variables that increase the likelihood of that alternative, relative to the reference of making the same purchase, while odds ratios less than one indicate variables that decrease the relative likelihood of that alternative. The primary alternative of interest is "No purchase", as it reflects the likelihood of the rebate generating a marginal purchase. P-values less than 0.05 in Table 16 indicate variables for which we have 95% confidence that the odds ratio is not 1 (i.e., variables that relate to the likelihood of alternative purchase behaviours).

Estimated model parameters in Table 16 indicate that receiving a higher rebate value, having at least a college certificate, being a commuter, and living in an area with warmer winter temperatures increase the likelihood of a purchase being marginal. The likelihood of a purchase being marginal decreases with e-bike price, purchaser age or household income, and if the purchaser reported cycling or e-biking pre-purchase. All aforementioned variables are statistically significant at p<0.05. Only rebate value is statistically significant (p<0.05) for the "Other e-bike" alternative, with higher rebate values increasing the likelihood of purchasing a different e-bike (rather than the same e-bike) if the rebate had not been available. The relative likelihood of the "Other e-bike" alternative decreases with rebate value relative to the likelihood of the "No purchase" alternative because the odds ratio on rebate value is smaller (closer to 1.0).



Table 16. Estimated Dirichlet model for likelihood of alternative<sup>1</sup> purchase behaviours (without rebate)

			native:	Alternative:		
Variable	Variable (unit, if applicable)	-	urchase		r e-bike	
category		Odds ratio	P-value	Odds ratio	P-value	
	Intercept	1.13	0.90	0.90	0.92	
Durchasa	Rebate value (\$100)	1.11	< 0.01	1.04	0.03	
Purchase	E-bike price (\$100)	0.99	< 0.01	1.00	0.41	
	Flag (missing e-bike price response)	0.58	0.20	0.97	0.94	
	Man (exclusive) <sup>2</sup>	1.14	0.15	1.08	0.42	
Personal	Age (10 y)	0.91	< 0.01	1.02	0.60	
	Flag (missing age response)	1.55	0.30	0.99	0.98	
	College certificate <sup>2</sup>	1.32	0.02	1.16	0.22	
	Flag (missing education response)	0.84	0.59	0.93	0.84	
	Physical disability <sup>2</sup>	0.81	0.28	0.78	0.24	
	Non-white <sup>2</sup>	1.16	0.16	1.14	0.25	
	Natural log of income (In(\$10,000))	0.87	0.03	0.94	0.35	
	Flag (missing income response)	1.06	0.66	1.00	1.00	
	3+ adults in household <sup>2</sup>	1.13	0.29	1.16	0.24	
	Children in household <sup>2</sup>	0.98	0.85	1.04	0.72	
Household	Fewer cars than adults <sup>2</sup>	1.01	0.94	1.09	0.40	
	Conventional bikes per adult	1.10	0.51	1.02	0.90	
	Detached or semi-detached dwelling <sup>2</sup>	1.10	0.42	0.87	0.26	
	Bike parking inside <sup>2</sup>	1.04	0.67	1.11	0.26	
	Flag (missing bike parking response)	0.81	0.40	0.90	0.70	
	Cycling pre-purchase	0.82	0.02	1.00	0.97	
	E-biking pre-purchase	0.73	0.02	0.91	0.46	
	Automobile PKT pre-purchase (100 km/wk)	1.03	0.47	1.01	0.85	
Travel	Flag (imputed automobile km/day) <sup>3</sup>	1.24	0.43	1.05	0.86	
	Comfort riding on local streets (from -2 to +2)	0.98	0.61	1.01	0.87	
	Share of expected e-bike use by the purchaser	0.75	0.21	0.84	0.49	
	Commuter <sup>2</sup>	1.25	0.02	1.09	0.39	
	Fuel price (\$/L)	0.88	0.79	0.65	0.41	
	Population density (100 people/km²)	1.00	0.33	1.00	0.58	
	Average annual precipitation (m)	0.96	0.62	1.01	0.92	
Context	Average winter temperature (°C)	1.04	0.03	1.04	0.09	
	Non-auto access score	0.82	0.25	0.90	0.55	
	Biking infrastructure density (weighted km/km²)	1.01	0.80	1.02	0.44	
	Average absolute road grade (0.01 m/m)	1.13	0.90	0.90	0.92	

<sup>&</sup>lt;sup>1</sup> Reference level: Same purchase

The model results for purchase marginality are illustrated in Figure 15 for two hypothetical purchasers with annual household incomes of \$50,000 and \$150,000, and other attributes at the sample mean. The lines show how the modelled likelihoods of each alternative purchase behaviour (without the rebate) vary with rebate value. As rebate value increases, the likelihood of a "No purchase" alternative (i.e., that the observed purchase was marginal) increases, and the

<sup>&</sup>lt;sup>2</sup> The reference levels for these binary variables include "Prefer not to answer" and missing responses

<sup>&</sup>lt;sup>3</sup> Mean km/day for other people reporting the same days/week of use



likelihood of making the same purchase decreases. The likelihood of purchasing a different e-bike is not greatly affected by rebate value, but decreases slightly. At all rebate levels, purchasers from lower income households are more likely to make a marginal purchase, compared to purchasers from higher income households.

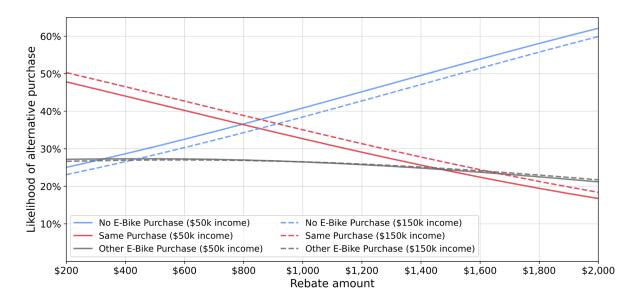


Figure 15. Illustration of modelled likelihood of alternative outcome without BC purchase rebate

Purchase model results show that larger rebates generate more marginal purchases, and also reveal varying sensitivity of different purchasers to the influence of rebates. Factors that increase marginality (i.e., odds ratios greater than 1 for the "No purchase" alternative in Table 16) reflect greater sensitivity of purchase decisions to rebates. We can expect that rebates are more effective when given to potential purchasers with these attributes because the rebate is more likely to generate a marginal purchase (one that would not have happened without the rebate). Varying marginality across purchasers can also be important for consequent program effects on mode shift if marginality relates systematically to how the e-bikes are used (which we examine in the usage analysis below).

At a given rebate value, the rebate tends to be less effective in generating marginal purchases when the (pre-rebate) e-bike price is higher, which is expected because the rebate represents a smaller portion of the total e-bike price. Older purchasers are less sensitive to rebates, while those with higher educational attainment are more sensitive. People in higher-income households are generally less sensitive to costs, which appears to apply to e-bike rebates as well. People who regularly commute are more sensitive to rebates, perhaps reflecting a more utilitarian approach to the e-bike purchase decision. In contrast, people who already cycle or e-bike are less sensitive to rebates, perhaps because non-cost aspects of cycling influence their decision more. Purchasers living in areas with colder winter climates are less sensitive to rebates, possibly for the same reason.



Table 17 presents select model variables in terms of the rebate dollar equivalent needed to offset the effect of that attribute on purchase marginality (all else being equal). For example, \$44 larger rebates are needed to achieve the same likelihood of a marginal purchase for people in a household with \$50,000 higher income. <sup>26</sup> Because people with at least a college certificate are more sensitive to rebates, a \$257 smaller rebate achieves the same marginality (or inversely, \$257 larger rebates are needed to induce the same behaviour change from people who do not have at least a college certificate). Rebates are more likely to generate marginal purchases when targeted toward lower-income households, purchases of lower-priced e-bikes, younger people with higher educational attainment who commute regularly but are not already cycling or e-biking, and people living in areas with warmer winter climates. Some of these relationships are potentially important for mode shift as well, because the induced (marginal) purchases are disproportionately made by people who regularly commute but were not previously cycling or e-biking.

Table 17. Dollar value of rebated needed to achieve the same marginality

Variable	Rebate value to offset modelled effect
Increase in bike price by \$100	+\$12
Increase in age by 10 years	+\$91
Having college certificate	-\$257
Increase in HH income by \$50k <sup>1</sup>	+\$44
Cycling before purchase at least once / week	+\$188
E-biking before purchase at least once / week	+\$286
Being a commuter	-\$208
Increase in average winter temperature by 10°C	-\$399

<sup>&</sup>lt;sup>1</sup> From mean value of \$68,000

#### 1.4.2.4 Summary: Rebate-Driven Purchases

Rebate recipients purchased e-bikes with an average price of \$3,187, paying an average of \$1,887 after the rebate. A small share (2.1%) of participants also reported receiving other supplementary incentives to purchase the e-bike, which averaged \$930. E-bike price was inversely related to rebate value, showing that the rebates were primarily used to decrease cost rather than acquire a more expensive e-bike. This inverse relationship also enhanced the relative effectiveness of higher-value rebates, because they covered an even larger share of the e-bike price. Although rebate value decreased with higher household income, most recipients in high-income households (over \$150,000 per year) were still able to qualify for the largest \$1,400 rebates due to low personal income. Rebate value also decreased with recipient age.

<sup>&</sup>lt;sup>26</sup> Compared to the average of \$68,000 in the modeling sample



A minority of participants (35%) expected to share use of the e-bike with others. The most important self-reported considerations for e-bike purchase decisions were cost, desire for mode substitution, physical effort to ride, and riding distance. Lower-income purchasers gave relatively more consideration to purchase cost, riding distance, and riding comfort, and relatively less consideration to physical effort, carrying children, and riding speed.

The program was effective in generating new (marginal) e-bike purchases, as the average self-reported likelihood of not purchasing an e-bike without the rebate in the sample was 58%, increasing from 21% to 62% with rebate value. At a given value, rebates were more likely to generate marginal purchases when used to purchase lower-priced e-bikes, and when received by younger people, in lower-income households, in milder winter climates, with higher educational attainment, who commute regularly, but who were not previously cycling or e-biking. These relationships are promising for mode shift potential because rebates disproportionately induce marginal purchases by people who regularly commute but are not already cycling or e-biking.

For context, the marginality of purchases in the Saanich e-bike incentive program were slightly higher, ranging from 24% to 75% with rebate values of \$350 to \$1,600<sup>27</sup> (Bigazzi et al., 2025). The difference in marginality may be due to differences in the income qualifications between the programs (primarily individual vs. household criteria), as well as demographic and geographic differences in the factors that can influence marginality such as educational attainment, previous cycling or e-biking, and annual precipitation. Overall, the price sensitivity of purchasers implied by the marginality values is consistent with expectations based on pre-program economic modelling (Bigazzi and Berjisian, 2021).

#### 1.4.3 E-Bike Usage

#### 1.4.3.1 Overall Experience

Figure 16 summarizes participant self-reported experience with their new e-bike at Waves 2 and 3 (i.e., after approximately 3 and 12 months of ownership), compared to their pre-purchase expectation. The mean response is positive for all categories. "Enjoyment/fun" and "Overall experience" exceeded expectations the most, and "Parking" the least. These results were consistent after a year of ownership. Participants reported using their e-bikes more frequently than expected, and with greater comfort and perception of safety.

<sup>&</sup>lt;sup>27</sup> Adjusting for inflation and rebate amount, the marginality for the Saanich program was larger by a factor of approximately 1.2 (Polikakhina et al., 2025).



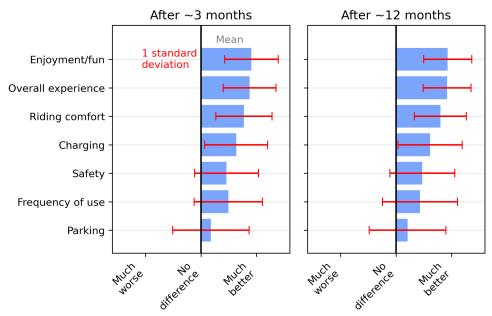


Figure 16. Reported experience with the new e-bike, compared to pre-purchase expectations.

## 1.4.3.2 Comfort cycling

Figure 17 presents self-reported levels of cycling comfort on various facility types in each wave. Comfort levels are steady across waves despite increasing cycling (described below). The same result was reported in a study of the Saanich incentive program (Bigazzi et al., 2025). This potentially surprising outcome may be due to e-biking experience on different facility types generally aligning with expectations and previous cycling experience.

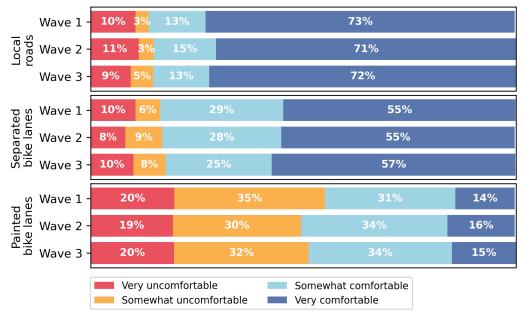


Figure 17. Cycling comfort by survey wave and facility type



In Wave 3 of the study, we also asked participants what category best describes their attitude towards cycling, sometimes referred to as Geller's "4 types of cyclists" (Geller, 2006). <sup>28</sup> This cycling attitude was reported approximately one year after e-bike purchase, although as shown above in Figure 17, cycling comfort did not change substantially over time. Figure 18 presents the weighted distribution of the self-reported cyclist types of rebate recipients. We find that most participants (66%) identify as "enthused and confident", with another 22% identifying as "interested but concerned" and the remaining 13% identifying as "strong and fearless".

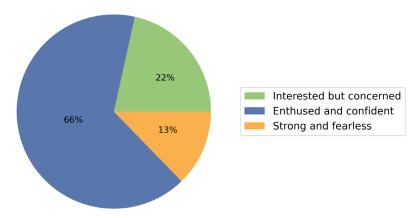


Figure 18. Self-identified attitude towards cycling

#### 1.4.3.3 Considerations for E-bike Use

Self-reported "main considerations in deciding whether to use [the] new e-bike versus another mode of travel" are shown in Figure 19 for each survey wave. On average, the highest-ranked consideration was "weather", followed by "fun", "physical exertion", and "travel distance". Surprisingly, "riding facilities" was not highly ranked, while "bike parking" was moderately ranked. Weather consideration increased the most across waves, with the highest ranking in Wave 2, which was primarily completed during the fall and winter months. Consideration of "cargo" also increased over time. Inversely, considerations of "travel distance", "bike parking", "accompanying travelers", "environmental impacts", and "riding facilities" decreased over time. These results align with Figure 16, indicating that relatively positive experiences assuaged some participant concerns about factors such as safety and parking. On the other hand, weather emerged as a primary factor that increased in importance over time, perhaps due to negative experiences e-biking in inclement weather. Although cycling infrastructure is generally a key factor for cycling participation, it is also a fairly static feature of the environment, and so participants may have considered it less for trip-level mode decisions than more dynamic factors like weather and trip distance.

<sup>&</sup>lt;sup>28</sup> We intentionally omitted the "no-way, no-how" option from the typology, as the survey sample consisted of e-bike purchasers



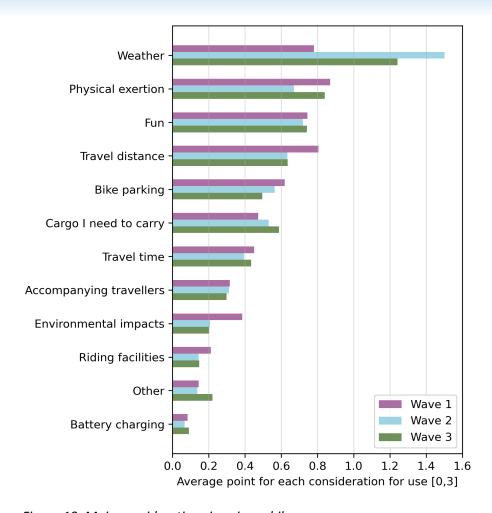


Figure 19. Main considerations in using e-bike across survey waves

## 1.4.3.4 Recent E-Bike Trips

Table 18 presents a summary of the 2 most recent return trips on the purchased e-bike reported in each wave (first averaged within persons, with 81% to 87% of participants reporting in each wave). Average return trip length and time between trips both increased slightly across waves.

Table 18. Summary of two most recent return trips on the purchased e-bike

Wave	Participants reporting trips	Trips reported	Average return trip length (km)	Average time between trips (days)
Wave 1	831	1,659	16.2	3.4
Wave 2	484	965	16.6	4.7
Wave 3	385	768	17.2	4.6
Overall	1,700	3,392	16.5	4.0

Figure 20 shows the distributions of trip purposes for reported e-bike trips across the three survey waves. The most common trip purposes are exercise/leisure (with no primary



destination), shopping/errands, commuting to work/school, and social/recreational/dining. Few trips (≤2%) are for work (other than commuting). The share of exercise/leisure trips decreased over time, while the shares of social/recreational/dining and escort/chauffeur trips increased.

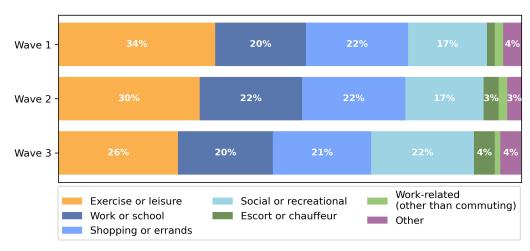


Figure 20. Distribution of e-bike trip purposes by wave

Figure 21 shows the distribution of trip purposes for reported e-bike trips (in any wave) by rebate value. Recipients of the \$350 rebates reported the highest share of exercise/leisure trips and the lowest share of shopping/errands trips. Recipients of the \$1,400 rebates reported the highest shares of utilitarian (commuting and shopping/errand) trips, and the lowest share of exercise/leisure trips.

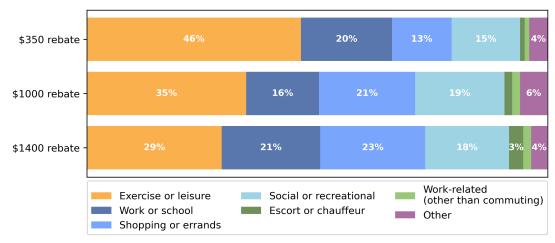


Figure 21. Distribution of e-bike trip purposes by rebate value

Figure 22 shows the distribution of trip purposes for reported e-bike trips (in any wave) by metropolitan region. Utilitarian trips are most common in the larger metropolitan areas of Vancouver and Victoria, whereas participants in the Kelowna area and Elsewhere in BC reported larger shares of exercise/leisure trips.



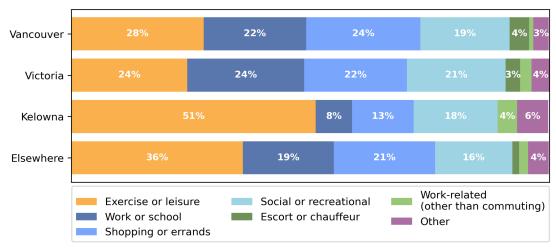


Figure 22. Distribution of e-bike trip purposes by metropolitan region

#### 1.4.3.5 E-Bike Mode Substitution

For each reported e-bike trip (described in the previous Section 1.4.3.4), participants were asked to report the likelihood of using other travel modes for the trip, if they had not purchased the incentivized e-bike (including options for using a different e-bike and not making the trip at all). Figure 23 presents distributions of those alternative travel modes for e-bike trips by rebate tier. The distribution of alternative modes is fairly consistent across rebate values, with automobile being the most likely substituted mode (35% to 39%) followed by conventional cycling (16% to 21%). The next most likely alternative was not making the trip, revealing that 15% to 18% of reported e-bike trips were new or induced. Transit mode substitution was higher for recipients of the \$1,400 rebates (at 10%) vs. others (at 6%).

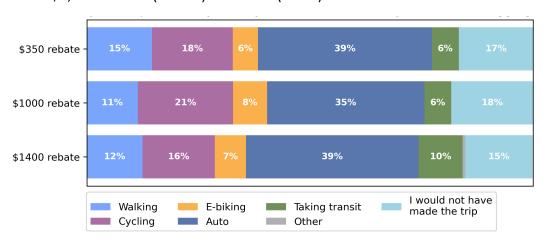


Figure 23. Distribution of travel modes replaced by the purchased e-bike across rebate values

Figure 24 shows the distributions of alternative travel modes by survey wave. The likelihood of new or induced trips (would not have made the trip without the purchased e-bike) decreased



over time, while the likelihood of e-biking on a different e-bike increased, perhaps reflecting a growing commitment to the mode.

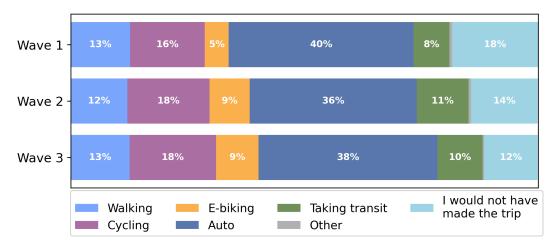


Figure 24. Distribution of travel modes replaced by the purchased e-bike across survey waves

Figure 25 presents the distributions of alternative travel modes by household income. Alternative mode distributions are surprisingly stable across income levels, and there are few clear upward or downward trends with income. Automobile mode substitution is highest at moderate to high income tiers while transit mode substitution is highest for the lowest income tier.

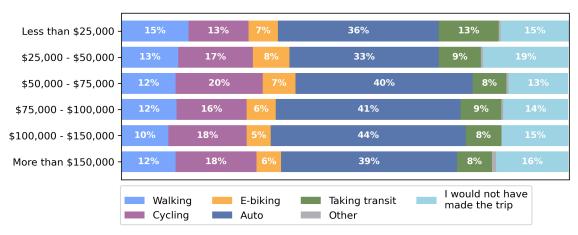


Figure 25. Distribution of travel modes replaced by the purchased e-bike across household income levels

Figure 26 presents the distributions of alternative travel modes by metropolitan region. Participants in Vancouver reported the highest likelihoods of replacing transit travel with e-bike trips, followed by participants in Victoria. Participants in Kelowna had the most distinct distribution of alternative travel modes, with more conventional cycling, other e-biking, and new or induced trips than other regions. The likelihoods of automobile mode substitution with e-bike trips were highest in the Victoria region and Elsewhere in BC. These distributions of alternative modes somewhat reflect pre-purchase travel differences by region (Table 9), except that the participants in Kelowna had the highest automobile use and lowest e-bike use pre-purchase.



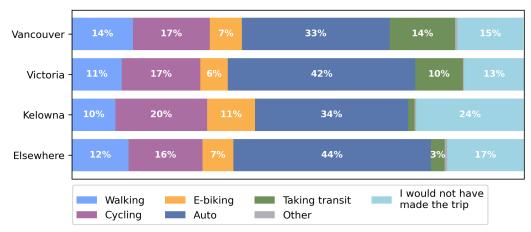


Figure 26. Distribution of travel modes replaced by the purchased e-bike across metropolitan regions

Figure 27 presents the distributions of alternative travel modes conditioned on whether the participant regularly cycled before the e-bike purchase.<sup>29</sup> The distributions are more distinct than comparisons across rebate value, survey wave, income, or region, with participants who cycled pre-purchase reporting much higher likelihoods of e-bike trips replacing conventional bicycle or other e-bike use, and lower likelihoods of all other alternatives.

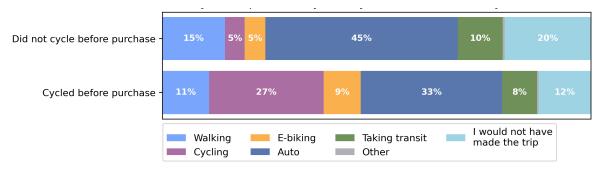


Figure 27. Distribution of travel modes replaced by the purchased e-bike across pre-purchase cycling habits

Figure 28 presents the distributions of alternative travel modes by self-reported attitude towards cycling (see Section 1.4.3.2). The least confident cyclist type in the survey ("interested but concerned") reported replacing the most walking, the least conventional cycling, and making the most new trips. The most confident cyclist type ("strong and fearless") reported the highest rates of replacing conventional cycling, and the lowest rates of replacing walking or making new trips. Interestingly, automobile mode substitution is consistent across all three groups of cyclists.

<sup>&</sup>lt;sup>29</sup> Defined as using a conventional bicycle or e-bike at least once a week at Wave 1.



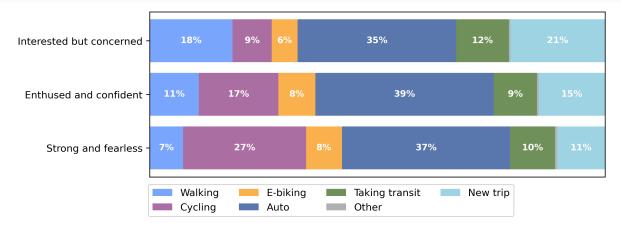


Figure 28. Distribution of average travel modes replaced by the purchased e-bike across self-reported cycling attitude

Table 19 shows the joint distribution of trip purpose and alternative travel mode for the 3,352 reported trips on the purchased e-bikes (without missing purpose or alternative mode responses). The three most common combinations (>10% of observed trips) were shopping or errand trips that would have been made by automobile, commuting trips that would have been made by automobile, and exercise or leisure trips that would not have been made at all (i.e., new or induced trips). Most of the new or induced trips are for exercise or leisure, which is also the most common trip purpose for trips that would have been made by walking, conventional bicycle, or another e-bike. In contrast, e-bike use that is substituting for automobile or transit modes is predominantly utilitarian (for commuting, shopping, or errands).

Table 19. Joint distribution of modes replaced and trip purpose for reported e-bike trips

		Conventional				New	All
Trip purpose	Walking	bicycle	E-bike	Automobile	Transit	trip	modes <sup>1</sup>
Exercise or leisure	6%	7%	3%	4%	1%	11%	31%
Commuting (work or school)	2%	3%	1%	11%	4%	0%	21%
Shopping or errands	3%	3%	1%	12%	2%	1%	22%
Social, recreational, or dining	2%	3%	1%	8%	2%	2%	18%
Escort or chauffeur	1%	0%	0%	1%	0%	0%	3%
Work-related (other than commuting)	0%	0%	0%	1%	0%	0%	2%
Other purpose	0%	1%	0%	1%	0%	1%	4%
All purposes	13%	17%	7%	38%	9%	16%	100%

<sup>&</sup>lt;sup>1</sup> "Other" mode not shown (<1%)

Participants were also asked whether the total trip length would have been different if they had used the alternative travel modes; 17% reported the trip length would increase (by an average of 33% or 5.5 km) and 27% reported trip length would decrease (by an average of -34% or -6.4 km). These changes in trip length were combined with the alternative travel mode likelihoods



and trip length for each e-bike trip to estimate net PKT changes for each mode resulting from e-bike usage (see Section 1.3.5 above). Table 20 presents the average net changes in PKT for each travel mode per reported e-bike trip. Each return trip on the purchased e-bike generates a 3.6 km increase in total travel, with 15.2 km of new e-bike use (which would not have occurred without the purchase) mostly displacing travel by other modes (predominantly 5.9 km of automobile use). New e-bike travel and displacement of other modes are highest for the \$350 rebate recipients due to longer reported e-bike trips.

Table 20. Average net changes in PKT due to each reported trip on purchased e-bike

			<u> </u>	
Travel mode	\$350 rebates	\$1,000 rebates	\$1,400 rebates	All rebates
Walking	-1.7	-1.2	-1.2	-1.3
Conventional bicycle	-3.9	-3.5	-2.5	-2.7
E-bike	19.2	16.6	14.6	15.2
Automobile	-7.0	-5.9	-5.8	-5.9
Transit	-1.4	-1.0	-1.7	-1.6
Other	-0.0	-0.0	-0.1	-0.1
Total	5.0	5.0	3.3	3.6

#### 1.4.3.6 Usage from Odometer Data

Most participants (85%) reported having an odometer on their purchased e-bike. Table 21 shows the number of respondents reporting their odometer readings in each wave, along with the mean and standard deviation of odometer readings (in km).

Table 21. Odometer data summary by study wave

	Wave 1	Wave 2	Wave 3
Number of observations	748	433	319
Odometer reading: mean (km)	127	548	1,490
Odometer reading: standard deviation (km)	218	536	1,758

Table 22 summarizes the changes in odometer readings between waves (for participants who reported readings in multiple waves). We computed the average weekly e-bike usage from the odometer data by differencing the odometer readings and dividing by the number of weeks between readings. Short-term usage over the first 3 months between Waves 1 and 2 averaged 32 km/wk, and long-term usage over the following 9 months between waves 2 and 3 averaged 24 km/wk. Waves 1 and 2 straddled good-weather months of June to September, while usage between Waves 2 and 3 included the winter season, which may explain lower usage, in addition to potential novelty effects in the short run.



Table 22. Summary of data from reported e-bike odometer readings

	Wave 1 to 2	Wave 2 to 3	Wave 1 to 3
Number of observations	362	283	256
Change in odometer reading (km) $^{\mathrm{1}}$	453 (452)	993 (1501)	1,451 (1,780)
Weeks between odometer readings <sup>1</sup>	14.9 (3.9)	39.8 (1.8)	54.4 (3.9)
Implied use (km/wk) <sup>1</sup>	31.5 (32.8)	24.1 (36.3)	26.7 (32.4)

<sup>&</sup>lt;sup>1</sup> Mean (standard deviation)

## 1.4.3.7 Safety Incidents Experienced

At Waves 2 and 3, 7.5% and 8.2% of participants, respectively, reported they had experienced "an incident where [they] fell to avoid contact, caused someone to fall, or made contact with another person or vehicle" while using their new e-bike. The Wave 3 survey did not specify a reporting time frame for safety incidents, so some events may have been reported in both Wave 2 and Wave 3. Figure 29 summarizes the highest severity of incident reported by each participant, separately for those reporting incidents with motor vehicles (40%) vs. others. While most participants reporting incidents (59%) suffered an injury of some kind, only 7% (6) went to hospital, and 2% (2) stayed overnight in hospital. Given the small number of serious injuries and potential for bias in incident reporting, we do not attempt to extrapolate crash or injury rates from these data. But they do provide context for the other results and analysis.

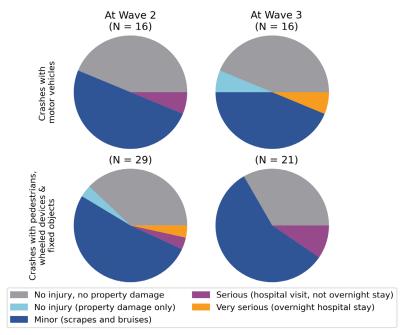


Figure 29. Severity distribution for participants reporting incidents in each wave, by incident type



#### 1.4.3.8 Summary: Use of Incentivized E-bikes

Overall, the study participants reported positive experiences with their purchased e-bikes which exceed expectations. Fun stood out as a particularly positive and important aspect of owning and using an e-bike. Weather also emerged as a primary consideration that increased in importance over time, perhaps due to negative experiences e-biking in inclement weather. Participants expressed concerns about the availability of safe places to ride and securing bike parking, and although it appears that relatively positive experiences with riding comfort, safety, and parking assuaged those concerns over time, general comfort cycling did not change over the year of e-bike usage. Safety incidents were reported by 8% of participants, with 5% reporting an injury of some kind (including scrapes/bruises) and <1% (6) involving a hospital visit.

Analysis of self-reported odometer data suggests long-term usage averaging 27 km/week.<sup>30</sup> The most common reported e-bike trip purposes were exercise/leisure (31%), shopping/errands (22%), commuting to work/school (21%), and social/recreational/dining (18%). The share of exercise/leisure trips decreased over time, while the shares of social/recreational/dining and escort/chauffeur trips increased. Recipients of the larger, income-conditioned rebates reported higher shares of utilitarian (commuting and shopping/errand) trips, and the lower shares of exercise/leisure trips. Utilitarian trips were also most common in the larger metropolitan areas of Vancouver and Victoria, whereas participants in the Kelowna area and Elsewhere in BC reported larger shares of exercise/leisure trips.

The likelihood of e-bike trips substituting for other travel modes was highest for automobile (38%), followed by conventional cycling (17%), walking (13%), and transit (9%). In addition, a large share of e-bike trips (16%) were new or induced (i.e., would not otherwise have been made). The most remarkable difference in mode substitution was that participants who cycled pre-purchase reported much higher likelihoods of e-bike trips replacing conventional bicycle or other e-bike use, and lower likelihoods of replacing automobile use and other alternative modes. The observed combinations of trip purpose and alternative travel mode are illustrated in Figure 30, showing that the most common alternatives were utilitarian trips (shopping, errands, or commuting) that would have been made by automobile and exercise or leisure trips that would not have been made at all.

<sup>&</sup>lt;sup>30</sup> Only for the subset of participants who reported odometer data in multiple survey waves.



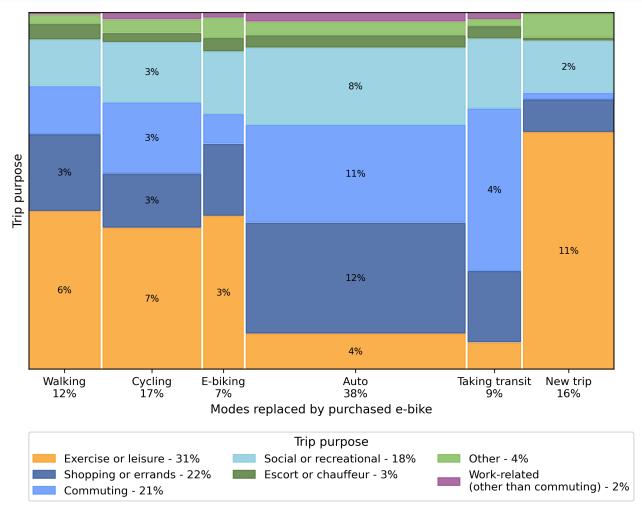


Figure 30. Reported trip purpose and modes replaced by trips on the purchased e-bike (only cells >2% are labelled; "other" alternative mode not shown)

The average changes in travel (PKT) attributable to the reported e-bike trips are illustrated in Figure 31, which combines mode substitution and alternative trip length data. Each return trip using the purchased e-bike generated 3.6 km net new travel on average, with 15.2 km of new e-biking displacing 5.9 km of travel by automobile and 5.7 km of travel by other modes.

These results generally align with other literature on e-bike usage and mode substitution, particularly in the North American context (Bigazzi and Berjisian, 2021, 2019; Bigazzi and Wong, 2020; Bucher et al., 2019; Cairns et al., 2017; Dekker, 2013; Hiselius and Svensson, 2017; Johnson et al., 2023; MacArthur et al., 2018a; Sundfør and Fyhri, 2022). The rate of automobile mode substitution overall is slightly lower than reported in the Saanich study of 40% to 44% (Bigazzi et al., 2025), however that rate aligns with 42% rate for participants in the Victoria region alone (Figure 26).



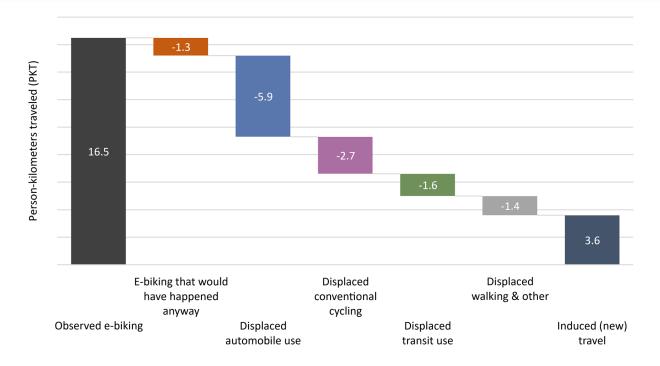


Figure 31. Illustration of average PKT changes attributable to the reported e-bike (return) trips

## 1.4.4 Travel Habits

# 1.4.4.1 Vehicle Ownership

Figure 32 shows household motor vehicle, bicycle, and e-bike ownership in each study wave (for participants who completed all 3 waves), regardless of household composition. Average motor

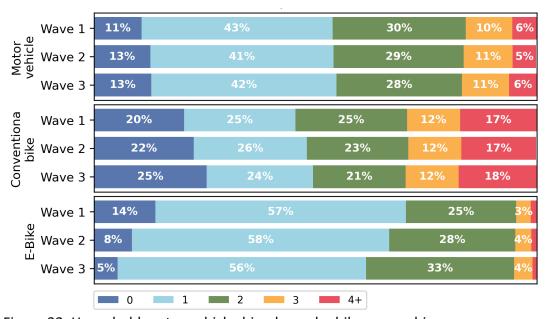


Figure 32. Household motor vehicle, bicycle, and e-bike ownership across survey waves



vehicle ownership fell slightly from 1.60 to 1.55 between Waves 1 and 3, while the share of "zero-car" households increased slightly from 11% to 13%. Concurrently, conventional bicycle ownership decreased while e-bike ownership increased through extra purchases beyond the incentivized e-bike.

#### 1.4.4.2 Commute Mode

Participants who reported regularly commuting to work or school were asked to rank their commute modes by frequency at each wave. <sup>31</sup> Assigning points to each rank (from 1 to 5 for least to most frequent, with 0 representing no rank), Figure 33 presents the average ranking of commute modes across waves for those who reported commuting at all waves. Results show increasing use of e-bikes to commute across all three study waves, accompanied by reductions in commuting by automobile, cycling, transit, and walking. Over time, e-biking became the mode with the highest average ranking, surpassing automobile. At Wave 1, 28% of commuting participants ranked e-biking as the primary commute mode and at Wave 3, 52% of the same participants did. For automobile, this share decreased from 36% to 32%.

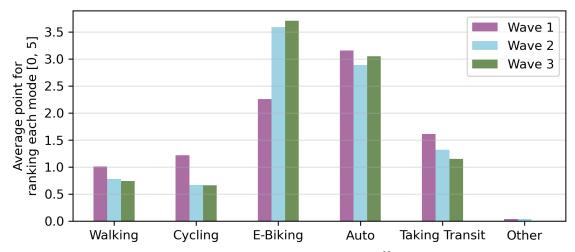


Figure 33. Average commute mode ranking across survey waves<sup>32</sup>

#### 1.4.4.3 Weekly Travel Habits

This section summarizes typical weekly travel habits for participants who purchased an e-bike prior to Wave 2 and still owned it at Waves 2 and 3. Wave 1 responses represent pre-purchase behaviour and responses in Waves 2 and 3 represent behaviour after 3 and 12 months of ownership, respectively (although not all changes are due to e-bike ownership). Figure 34 shows average weekly PKT by mode at each survey wave. The amount of e-biking increased substantially

<sup>&</sup>lt;sup>31</sup> Wave 1 commute responses were for the previous month, which was post-purchase for most participants.

 $<sup>^{32}</sup>$  For those who reported commuting at all waves, N = 139



after Wave 1 and then slightly more after Wave 2. Automobile PKT decreased after Wave 1 and then partially rebounded after Wave 2, but not at the expense of e-biking. A similar pattern is observed for conventional cycling and walking. Average total weekly PKT fell from 179 to 170 between Waves 1 and 2, and then rose to 184 in Wave 3.<sup>33</sup> A small net increase in average weekly travel is consistent with the (induced) e-bike trips reported above. On average, after a year of e-bike ownership, study participants reported a 42 km increase in weekly e-biking, a 19 km decrease in weekly travel by automobile, an 11 km decrease in weekly conventional cycling, a 5 km decrease in weekly transit use, and a 3 km decrease in weekly walking.

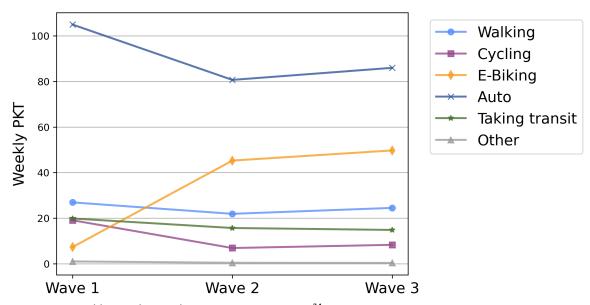


Figure 34. Weekly PKT by mode across survey waves<sup>34</sup>

Some of the changes in weekly PKT by travel mode in Figure 34 reflect net changes in weekly PKT over time (due to seasonality and other factors), and not only travel mode substitution related to e-bike ownership. Figure 35 presents the average weekly distribution of PKT across travel modes by survey wave. After e-bike purchase (in Waves 2 and 3), the share of weekly PKT by e-bike increased by a factor of 6, while the shares by all other modes decreased, particularly by conventional bicycle and automobile. Nearly identical mode shares at Waves 2 and 3 in Figure 35 indicate equivalent short-run and long-run impacts of e-bike purchase on weekly travel habits. Half of the increased share of e-biking (+24%pt<sup>35</sup>) replaced automobile travel (-12%pt), with most of the rest replacing conventional cycling (-7%pt).

<sup>&</sup>lt;sup>33</sup> Waves 1 and 3 were primarily completed in the summer and early fall, while Wave 2 was primarily completed in fall and winter; traffic volumes tend to be highest in summer and lowest in winter.

<sup>&</sup>lt;sup>34</sup> For those who took all three survey waves and owned an e-bike at Waves 2 & 3 (N=440)

<sup>35</sup> Percentage points



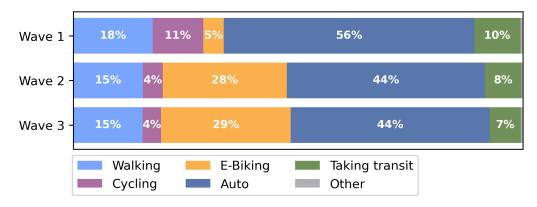


Figure 35. Distribution of weekly PKT across travel modes by survey wave<sup>34</sup>

Figure 36 shows the weekly PKT by mode for each rebate tier. The patterns are similar across the three rebates tiers, and without clear effects of increasing rebate value (i.e., the middle rebate tier may have the highest or the lowest value, rather than the values increasing or decreasing with rebate value). Any differences across rebate values should be interpreted with caution due to the small sample size (N=25) of \$350 rebate recipients completing all three survey waves.

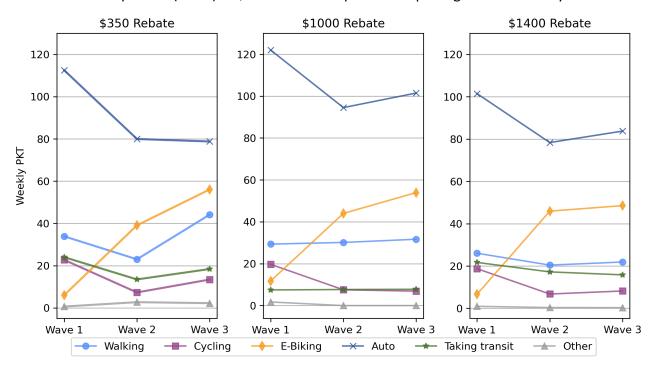


Figure 36. Weekly PKT by mode and rebate value<sup>34</sup>

Figure 37 separates weekly PKT by mode for participants who did and did not cycle pre-purchase. Both groups substantially increased their e-bike use in Wave 2 and further increased it in Wave 3, although the increase by those cycling pre-purchase was larger. That group's conventional cycling fell to a rate similar to their pre-purchase e-bike use, resulting in a large net increase in cycling overall. Weekly PKT by automobile was similar for both groups and initially fell more for



the group that did not cycle pre-purchase, but then also substantially rebounded for that group in Wave 3 (although still not at the expense of e-bike use).

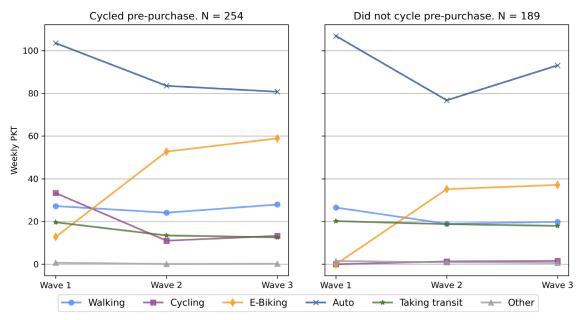


Figure 37. Weekly PKT by mode by pre-purchase cycling habits<sup>34</sup>

Figure 38 presents weekly PKT by mode at each wave by self-reported cyclist type categories. Those who were the least confident cycling ("interested but concerned") reported the smallest increase in e-biking and smallest reduction in automobile use. The most confident cyclists ("strong and fearless") reported the largest increase in e-biking as well as the greatest reductions in automobile use and conventional cycling. Moreover, their Wave 3 weekly e-bike PKT was greater than their weekly PKT by automobile. The overall weekly PKT (by any mode) for "strong and fearless" participants was the highest and most consistent across survey waves, reflective of proportionally more mode substitution and fewer induced trips from e-bike use (Figure 28Figure 38).



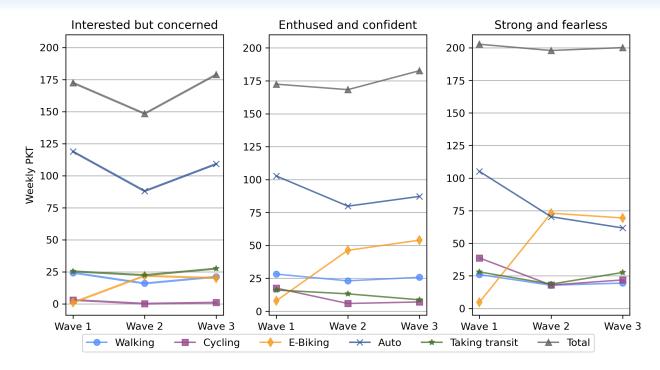


Figure 38. Weekly PKT by self-reported cycling attitude<sup>36</sup>

## 1.4.4.4 Long-Term Changes in Travel Habits

Figure 39 presents the change in PKT by each travel mode between survey Waves 1 and 3, segmented by rebate value. Recipients of the two larger rebates reported similar increases in e-

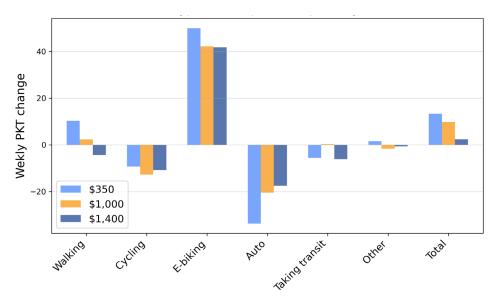


Figure 39. Average changes in weekly PKT by mode between Waves 1 and 3, by rebate value<sup>34</sup>

 $<sup>^{36}</sup>$  For those who took all three survey waves, owned an e-bike at Waves 2 & 3, and responded to the cycling attitude question (N=428)



biking of around 42 km/wk, and decreases in automobile and conventional bicycle use of around 19 and 12 km/wk, respectively. Recipients of the \$350 rebates reported a larger increase in ebiking of 50 km/wk and a larger decrease automobile use of 34 km/wk, although as above these results should be interpreted with caution due to the small sample size (N=25) of \$350 rebate recipients completing Wave 3.

Figure 40 shows the change in weekly PKT by each travel mode between Waves 1 and 3, segmented by household income. In general, lower income households reported larger increases in total travel and e-biking, and a smaller decrease in automobile usage, although the patterns do not follow a consistent upward or downward trend across income levels. Reductions in conventional cycling are similar across income categories, and a reduction in transit use is most pronounced for those with household income under \$25,000. E-bike ownership appears to be used to increase access more for lower-income households, and enable automobile mode shift more for higher-income households.

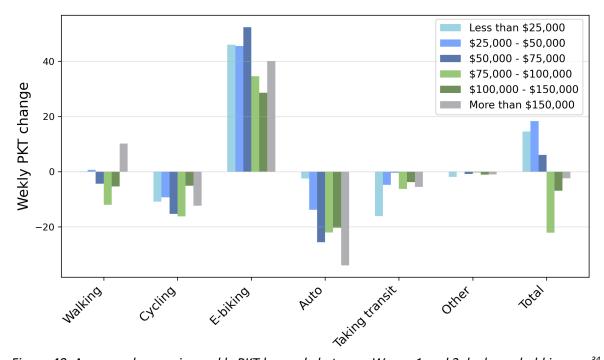


Figure 40. Average changes in weekly PKT by mode between Waves 1 and 3, by household income<sup>34</sup>

Figure 41 presents the change in weekly PKT by each travel mode between Waves 1 and 3, segmented by metropolitan region. Participants in the Victoria region reported the largest increase in e-biking and smallest decreases in automobile use and conventional cycling, leading to a large increase in total weekly travel. Consistent with the reported recent e-bike trips (Section 1.4.3 above), participants in the Kelowna region reported the most distinct travel behaviour, with the largest decreases in automobile use and conventional cycling, and an increase in transit use; these results should be interpreted with caution due to the small sample size (N=22) of Kelowna participants completing Wave 3.



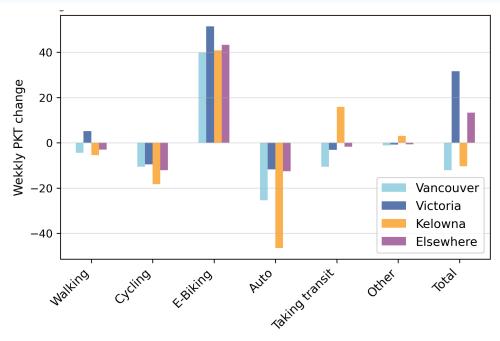


Figure 41. Average changes in weekly PKT by mode between Waves 1 and 3, by metropolitan region<sup>37</sup>

#### 1.4.4.5 Regression Model of Automobile and E-bike PKT across Waves

Table 23 presents estimation results for weighted negative binomial regression models <sup>38</sup> of weekly automobile and e-bike person-kilometers traveled (PKT) in each study wave (see model description in Section 1.3.7.3 above). The estimated model parameters are reported as the proportional change in weekly PKT associated with a one-unit increase in each independent variable. For examples, a proportional change of 0.04 for "Age (10 y)" in the automobile PKT model indicates that every 10-year increase in age is associated with 4% higher weekly PKT by automobile. In the e-bike PKT model, proportional changes of -0.17 for "Season: fall or spring" and -0.73 for "Season: winter" indicate that reported weekly PKT by e-bike is 17% lower in the fall or spring and 73% lower in winter, compared to summer. P-values less than 0.05 in Table 23 indicate variables for which we have 95% confidence that the proportional change is not 0 (i.e., variables that relate to the weekly PKT by automobile or e-bike).

The variable of primary interest in the PKT models is "After e-bike purchase", which represents the intervention effect of purchasing an incentivized e-bike on weekly PKT by automobile and e-bike, after controlling for all the other factors in Table 23. These estimated parameters for "After e-bike purchase" indicate that weekly PKT by automobile fell by 20% and weekly PKT by e-bike increased by a factor of 16 after purchase of the incentivized e-bike (both statistically significant at a 95% confidence level).

<sup>&</sup>lt;sup>37</sup> For those who took all three survey waves and owned an e-bike at Waves 2 & 3 and did not move metropolitan region between waves (N=433)

<sup>&</sup>lt;sup>38</sup> Overall all model fits were R<sup>2</sup>=0.48 for automobile PKT and R<sup>2</sup>=0.12 for e-bike PKT.



Table 23. Negative binomial mixed regression model results for weekly automobile and e-bike PKT

Variable		Automobile	PKT	E-bike Pl	<b>〈</b> T
category	Variable	Proportional	P-	Proportional	P-
category		change	value	change	value
	After e-bike purchase	-0.20	<0.01	15.71	< 0.01
Purchase	Rebate value (\$100)	0.01	0.37	-0.01	0.66
Purchase	Purchase marginality	0.23	< 0.01	-0.31	< 0.01
	Flag (missing marginality response)	0.18	0.09	0.44	0.01
	Man (exclusive) <sup>1</sup>	0.07	0.09	0.20	< 0.01
	Age (10 y)	0.04	< 0.01	0.08	< 0.01
	Flag (missing age response)	-0.23	0.34	-0.09	0.90
Personal	College certificate	0.19	< 0.01	-0.09	0.23
	Flag (missing education response)	-0.12	0.43	0.33	0.33
	Physical disability <sup>1</sup>	-0.06	0.52	0.09	0.55
	Non-white <sup>1</sup>	0.01	0.89	0.04	0.56
	Natural log of income (In(\$10,000))	0.15	< 0.01	-0.10	0.01
	Flag (missing income response)	0.12	0.06	-0.05	0.58
Household	3+ adults in household <sup>1</sup>	0.15	< 0.01	0.03	0.68
	Children in household <sup>1</sup>	0.23	< 0.01	0.01	0.86
	Motor vehicles per adult	0.86	< 0.01	-0.04	0.61
	Conventional bikes per adult	-0.02	0.55	-0.05	0.28
	Bike parking inside <sup>1</sup>	0.11	0.01	0.11	0.08
	Flag (missing bike parking response)	-0.11	0.32	-0.27	0.14
	Comfort riding on painted bike lanes (from -2 to +2)	0.01	0.53	0.02	0.34
	Commuter <sup>1</sup>	-0.04	0.43	0.67	< 0.01
Travel	Cycling pre-purchase	0.09	0.04	0.35	< 0.01
Havei	Experienced injury crash with new e-bike	-0.11	0.40	0.09	0.57
	Flag (imputed automobile km/day) <sup>2</sup>	0.21	0.11	N/A <sup>4</sup>	
	Flag (imputed e-bike km/day) <sup>2</sup>	N/A <sup>4</sup>		6.67	<0.01
	Fuel price (\$/L)	-0.30	0.10	1.10	0.01
	Population density (100 people/km²)	-0.01	0.03	0.00	0.51
	Season: fall or spring <sup>3</sup>	-0.03	0.46	-0.17	< 0.01
	Season: winter <sup>3</sup>	0.10	0.31	-0.73	< 0.01
Context	Annual precipitation (m)	-0.03	0.34	-0.10	0.08
	Average winter temperature (°C)	0.01	0.07	0.02	0.09
	Non-auto access score	-0.28	< 0.01	0.14	0.21
	Biking infrastructure density (weighted km/km²)	0.02	0.21	-0.04	0.05
	Average absolute road grade (0.01 m/m)	0.03	0.09	0.11	< 0.01

<sup>&</sup>lt;sup>1</sup> The reference levels for these binary variables include "Prefer not to answer" and missing responses

Other statistically significant parameters<sup>39</sup> in Table 23 indicate that (besides the effect of e-bike purchases) weekly PKT by automobile is higher for participants who are older, have at least a

<sup>&</sup>lt;sup>2</sup> Mean km/day for other people reporting the same days/week of use

<sup>&</sup>lt;sup>3</sup> Reference level – summer

<sup>&</sup>lt;sup>4</sup> Not applicable for this model

<sup>&</sup>lt;sup>39</sup> Statistical significance defined using a confidence interval of 95% (p<0.05).



college certificate, and live in larger households with children, more motor vehicle ownership, higher income, an ability to park bicycles inside their home, and in areas with higher population density but more limited non-automobile access to destinations (suggestive of suburban areas). Statistically significant parameters<sup>39</sup> indicate that weekly PKT by e-bike is higher in summer, when fuel prices are higher, and for participants who are men, older, commuters, were already conventional cycling pre-purchase, and live in households with lower income and in hillier areas with lower biking infrastructure density. The counterintuitive parameters for the last two factors of hills and biking infrastructure could reflect differences between conventional and electric bicycles, with greater relative utility for e-bikes in hillier and sparser cycling networks. <sup>40</sup> The parameters on the "Purchase marginality" variable indicate that people whose purchase decisions were more affected by the rebate (i.e., people who were less likely to have purchased the e-bike without the rebate) had more weekly PKT by automobile and less by e-bike (separate from the e-bike purchase effect).

We examined a selection of these control variables to see whether they affect (i.e., *moderate*) how much e-bike and automobile PKT change after the e-bike purchase (i.e., the *intervention*). For examples, we wanted to examine if factors like having a disability or living near more bike infrastructure were associated with larger or smaller changes in automobile travel or e-bike use after the purchase. Figure 42 shows how the effects of the e-bike purchase differ depending on these moderating factors (full model results are given in Appendix C, Table 45). <sup>41</sup> In the figure, the "reference" effect shows the estimated change in weekly PKT when the moderating factor is at its baseline value (either *False* for binary variables or *zero* for continuous variables). The "moderated" effect shows the change in weekly PKT when the factor is True or increased by 1 unit. When the two effects are similar (i.e., the bars are a similar size), that factor does not greatly influence how much travel behaviour changes after purchase. In contrast, large discrepancies in the bar sizes indicate factors that are contextually import for the magnitude of impacts from e-bike adoption.

The significant moderating effects at a 95% confidence level for change in automobile PKT post-purchase are being a commuter (post-purchase automobile PKT fell by -28% for commuters but only -14% for non-commuters) and household income (increasing household income from \$50,000 to \$136,000 is associated with larger post-purchase automobile PKT reduction from -20% to -28%). The significant moderating effects at a 95% confidence level for change in e-bike PKT post-purchase are conventional cycling pre-purchase (e-bike PKT increased by a factor

<sup>&</sup>lt;sup>40</sup> In other words, e-bikes "unlock" more latent demand for cycling in places that are less conducive to conventional cycling. Hills and a lack of biking infrastructure are both deterrents to cycling, but present less of a barrier for electric than conventional bicycle use. For example, some recent studies have reported that e-bikers are less sensitive to cycling infrastructure quality than people on conventional bicycles (Arning and Kaths, 2025; de Freitas et al., 2025; Meister et al., 2023).

<sup>&</sup>lt;sup>41</sup> Moderating effects were specified in the model as interacting variables with "After e-bike purchase"; each potential moderating variable was examined in a separate model estimation.



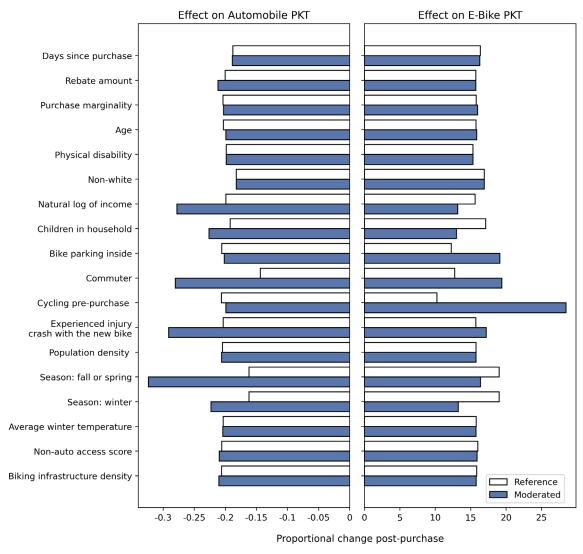


Figure 42. Moderators of the intervention (e-bike purchase) effect on automobile and e-bike PKT

of 10 for those not conventional cycling but by a factor of 28 for those previously cycling), being a commuter (e-bike PKT increased by a factor of 19 for commuters and by a factor of 13 for non-commuters), and using bike parking inside the home (e-bike PKT increased by a factor of 19 for those with inside bike parking, and by a factor of 12 for those without). No moderating effect was found for short- versus long-term travel behaviour changes ("Days since purchase" variable), after accounting for time-varying factors such as weather and fuel price. Rebate value and purchase marginality were also not significant moderators of the e-bike purchase effect.

Due to the non-linear regression model format, with a fixed proportional intervention effect, the variables in Table 23 that increase automobile or e-bike PKT will increase the absolute magnitude of the change in PKT post-purchase. For example, marginal purchasers had 23% higher automobile PKT than non-marginal purchasers overall, and so the -20% intervention effect



generates a 23% larger absolute reduction in automobile PKT post-purchase. Conversely, marginal purchasers had 31% lower e-bike PKT than non-marginal purchasers, and so the x16 intervention effect generates a 31% smaller absolute increase in e-bike PKT post-purchase.

Thus, in addition to the factors that significantly moderate the proportional changes post-purchase described above, the absolute automobile PKT reductions post-purchase are greater for people making more marginal purchases, purchasers who are older and have higher educational attainment, who live in larger, higher-income households with more motor vehicle ownership, who were conventional cycling pre-purchase and park their e-bike inside their home, and who live in higher-density areas but with more limited non-auto access to destinations. Similarly, the absolute e-bike PKT increases post-purchase are greater for people making less marginal purchases, purchasers who are men, older, and live in lower-income households, who regularly commute and were cycling pre-purchase, and who live in hillier areas.

#### 1.4.4.6 Comparison of e-bike usage data sources

Self-reported typical e-bike usage in the previous month at Waves 2 and 3 was compared to ebike usage implied by the odometer data (see Section 1.4.3.6 above). Table 24 gives results of a linear fit for the relationship between those two sources of e-bike km/week. Estimated ratios indicate that the e-bike usage implied by odometer data is 10% and 9% lower than the selfreported typical usage in the previous month at Waves 2 and 3, respectively. This is a relatively small and consistent offset, considering the differences between the measures, which are at distinct time scales (covering 3 or 9 months vs. 1 month) and have different scopes of usage (usage of one e-bike by anyone vs. usage of any e-bike by one participant). We generally expect atypical weeks to have less cycling than an average week due to vacation, injury, icy roads, etc., so long-term usage measured by an odometer will generally be less than usage on a typical week. Another potential influencing factor is that survey respondents often over-report participation in activities that they believe are beneficial or virtuous, due to social desirability bias. The relationship estimates yielded goodness-of-fit statistics of  $R^2 = 0.23$  and 0.24 for Wave 2 and Wave 3 usage, respectively, reflecting the imprecision in individual usage for the two measures.<sup>42</sup> Overall, however, it appears that while these measures of any one individual's e-bike usage are imprecise, the aggregate data reflect reasonably good agreement on the amount of e-bike use.

Table 24. Relationship between e-bike use from self-reported weekly travel habits vs. odometer data

	Wave 1 to 2	Wave 2 to 3
Number of observations	362	283
Linear fit ratio of km/wk from odometer vs. self-reported typical usage data	0.903	0.913
R <sup>2</sup> for linear fit	0.23	0.24

<sup>&</sup>lt;sup>42</sup> Manual inspection of the odometer data revealed errors such as decreases in value over time and imprecision such as rounding to one significant figure.



#### 1.4.4.7 Summary: Changes in Travel Behaviour

The e-bike use described in Section 1.4.3 in Part 1 was accompanied by broader changes in travel behaviour. E-biking became an increasingly common commute mode over the year of ownership, overtaking automobile use as the primary commute mode in the sample at Wave 2 and further increasing in Wave 3. We did not see large changes in household vehicle ownership between waves, <sup>43</sup> although increases in e-bike ownership were accompanied by small decreases in conventional bicycle and motor vehicle ownership in the sample. Most participants (87%) still had access to a private motor vehicle after the e-bike purchase, with an average of 0.75 household motor vehicles per adult.

E-bike use had increased dramatically by 3 months after purchase (by an average of +42 km/week), accompanied by a large reduction in automobile use (by an average of -19 km/week) and smaller reductions in PKT by other modes. Automobile use partially rebounded at the 12-month follow-up, but not at the expense of e-biking, which continued to rise.<sup>44</sup> The average mode shares of weekly PKT in the sample at Waves 2 and 3 were remarkably similar, indicating that automobile use fell from 56% of weekly PKT pre-purchase to 44% post-purchase, while e-biking increased from 5% to 29% and conventional cycling fell from 11% to 4%.

A regression model was used to control for a range of other factors that can influence e-biking and automobile use (e.g., season, fuel prices, socio-demographics), revealing estimated aggregate effects of the e-bike purchase of a 20% reduction in automobile use (PKT/week), and a factor of 16 increase in average weekly PKT by e-bike. Post-purchase changes in both automobile and e-bike PKT were greater for participants who commuted vs. those who did not commute. Automobile PKT reductions post-purchase were also greater for those living in households with higher income, while e-bike PKT increases post-purchase were greater for those who conventional cycled pre-purchase and used inside bike parking. Other moderating factors did not significantly affect the proportional PKT changes, but still amplified the absolute PKT changes post-purchase because they increased the pre-purchase PKT, including marginal purchases, higher household income, cycling pre-purchase, and living in areas that are denser but with more limited non-auto access for automobile PKT, and non-marginal purchases, lower household income, cycling pre-purchase, and living in hillier areas for e-bike PKT.

The weekly travel data and trip-level e-bike mode substitution data (Section 1.4.3.5 above) align in indicating that most travel on the purchased e-bikes (around 90%) is new e-biking, and most of that new e-biking (80% to 90%) is displacing travel by other modes: roughly half replacing automobile use and a quarter replacing conventional cycling (on a per-PKT basis).

For comparison, e-bike use around 40 km/wk and automobile displacement of around 20 km/wk or 20% is in line with past research on e-bike adoption in various contexts (Anderson and Hong,

<sup>&</sup>lt;sup>43</sup> We could not have observed any changes in vehicle ownership before the e-bike purchase.

<sup>&</sup>lt;sup>44</sup> Total weekly PKT increased between Waves 1 and 3.



2022; Andersson et al., 2021; Bigazzi and Wong, 2020; Bucher et al., 2019; Hiselius and Svensson, 2017; Johnson et al., 2023; Mason et al., 2015; McQueen et al., 2020; Sundfør and Fyhri, 2022). The Saanich incentive program study reported increases in e-bike use of 47 km/wk and 30 km/wk after 3 and 12 months, respectively, and decreases in automobile use of 56 and 49 km/wk after 3 and 12 months, respectively (Bigazzi et al., 2025). Applying similar methods to the BC e-bike rebate program we find larger increases in e-bike use but smaller reductions in automobile use, primarily due to lower pre-purchase automobile use by rebate recipients, which averaged 105 km/wk in this study but 128 km/wk in the Saanich study. Post-purchase automobile use is more similar at 86 km/wk in this study and 79 km/wk in the Saanich study. We also do not find that automobile PKT reductions are higher for the larger, more income-restricted rebate tiers, as was reported in the Saanich study. 45 Automobile use in this study most closely resembles that of the un-conditioned \$350 rebate recipients in Saanich, which averaged 110 km/wk pre-purchase and 87 km/wk after 12 months. Regression analysis results in the Saanich study reflect some of these differences, as they report a 36% reduction in automobile PKT after e-bike purchase, 46 whereas we find a smaller reduction effect of 20%. Neither program found a significant effect of rebate value on proportional reduction in PKT. Although the incentive program designs are similar, they had different rebate values and used different income qualification criteria; other key differences in the study context include geography, seasonality, and a maturing e-bike market.

#### 1.4.5 Greenhouse Gas Emissions

GHG impacts were estimated from PKT using the marginal lifecycle emission rates presented in Section 1.3.6.3 in Part 1. The PKT changes inferred from recent e-bike trips (see Section 1.4.3.5 above) translate to net reductions of 1.8 kg CO<sub>2</sub>eq per return e-bike trip or 119 g CO<sub>2</sub>eq per PKT by e-bike. These net changes are almost entirely the result of displaced automobile use. Each observed PKT by the purchased e-bike generates 10 g CO<sub>2</sub>eq of new emissions,<sup>47</sup> and displaces 123 g of emissions due to automobile use, 6 g due to transit use, and 2 g due to conventional bicycle use.

Table 25 gives GHG estimated from the weekly PKT by travel mode results (see Section 1.4.4.3 above), of which over 95% are generated by automobile use. Overall weekly GHG from travel fall by 22% between Wave 1 and Wave 2, and then partially rebound to a net 17% reduction in Wave 3. The net reduction is largest (11 kg  $CO_2eq/wk$ ) for the \$350 rebate recipients and smallest (6 kg  $CO_2eq/wk$ ) for the \$1,400 rebate recipients, primarily due to differences in automobile PKT. As stated above, comparisons across rebate values should be interpreted with caution due to the small number of \$350 rebate recipients completing all three survey waves (N=25).

<sup>&</sup>lt;sup>45</sup> Noting that the qualifying income criteria were different between the two programs

<sup>&</sup>lt;sup>46</sup> For the middle rebate tier of \$800

<sup>&</sup>lt;sup>47</sup> After accounting for the likelihood the trip would have happened by e-bike anyway, which discounts 1 g CO₂eq.



Table 25. GHG generated by reported weekly travel habits (kg CO₂eg/wk) 48

Study wave	\$350 rebates	\$1,000 rebates	\$1,400 rebates	All rebates
Wave 1	37.8	40.3	34.1	35.2
Wave 2	27.1	31.6	26.8	27.4
Wave 3	27.1	34.0	28.5	29.2

For comparison, average weekly GHG emissions of 35 kg CO<sub>2</sub>eq pre-purchase is somewhat lower than the estimate of 42 kg/wk for the Saanich study sample pre-purchase (Bigazzi et al., 2025) and closer to the 38 kg/wk<sup>49</sup> reported in a study of household GHG emission for the metropolitan Vancouver region (Bigazzi et al., 2024a). A GHG reduction of 17% (6 kg CO<sub>2</sub>eq/week) is smaller than the 38% previously reported in the Saanich study, primarily due to higher pre-purchase GHG in the Saanich study (average weekly GHG at Wave 3 in Saanich was 26 kg CO<sub>2</sub>eq/week, more similar to the 29 kg observed here). Other modelling studies have estimated that widespread ebike adoption could reduce GHG from passenger travel by 10 to 20% (Bucher et al., 2019; Hiselius and Svensson, 2017; Mason et al., 2015; McQueen et al., 2020), and studies of e-bike incentives in Sweden and the USA estimated reductions of 3 to 10 kg CO<sub>2</sub>eq per week (Anderson and Hong, 2022; Johnson et al., 2023).

#### 1.4.6 Aggregate BC Program Impacts

This section presents aggregate weighted results, with purchase-related outcomes based on the full study sample of 1,004 and net PKT and GHG changes between Waves 1 and 3 based on the 449 participants who completed all 3 survey waves. Long-term behaviour differences across rebate tiers should be interpreted with caution because only 25 participants who received a \$350 rebate completed all 3 survey waves. Some of the values differ from unweighted results for the study sample presented above because they are weighted to represent the attributes of all BC Program rebate recipients.

#### 1.4.6.1 Spending and Revenues for Incentivized E-bike Purchases

Table 26 summarizes the costs and revenues associated with incentivized e-bike purchases within the BC Program (see calculation methods in Section 1.3.6.1). The average cost of the purchased e-bikes was \$3,100 (after any other incentives or discounts), of which \$1,800 was paid by the purchaser. Accounting for the marginality of purchases, each rebate generated on average \$1,800 in new retailer revenue (i.e., revenue from e-bike purchases that would not have been made without the rebates). Across all rebates, an average of \$1,000 in new spending was induced

<sup>&</sup>lt;sup>48</sup> Limited to participants who completed all three survey waves and owned an e-bike in at Waves 2 and 3: 25 who received \$350 rebates, 61 who received \$1,000 rebates, and 357 who received \$1,400 rebates.

<sup>&</sup>lt;sup>49</sup> Scaling up from the reported 5.5 kg/day.



through marginal purchases, while \$500 was saved through rebates subsidizing non-marginal purchases.

Table 26. E-bike cost and retailer revenue per rebate

Impact	\$350	\$1,000	\$1,400	All
Impact	rebates	rebates	rebates	rebates
Pre-rebate e-bike cost <sup>1</sup>	\$3,484	\$3,401	\$3,039	\$3,093
Post-rebate e-bike cost <sup>1</sup>	\$3,134	\$2,401	\$1,639	\$1,773
New retailer revenue per rebate (due to marginal purchases)	\$688	\$1,675	\$1,818	\$1,762
Induced spending per rebate (on marginal purchases)	\$616	\$1,158	\$940	\$951
Reduced spending per rebate (on non-marginal purchases)	\$279	\$483	\$522	\$509

<sup>&</sup>lt;sup>1</sup> After applying any other reported incentives or discounts

#### 1.4.6.2 Travel Mode Shift and GHG Reduction

Table 27 summarizes the average long-term changes (from Wave 1 to Wave 3) in weekly travel behaviour and associated GHG emissions, weighted to represent all BC Program rebate recipients. The "marginal" values are scaled to only include the changes associated with additional e-bike purchases (i.e., those that would not have been made with the rebate). Although overall changes in e-biking, automobile travel, and GHG decrease with rebate value, the marginal changes have the opposite trend due to increasing marginality with rebate value. On average, e-bike purchasers increased their e-biking by 40 km/week (from 7 to 46 km/week), half of which would likely not have happened without the rebate program. E-bike purchasers reduced their weekly automobile use from 101 to 84 km/week and reduced their weekly GHG emissions from travel by 5.4 kg CO<sub>2</sub>eq on average (almost all from reduced automobile use); 3.9 kg of the reduction was associated with marginal purchases and the remaining 1.5 kg likely would have occurred without the rebate program.

Table 27. Changes in weekly travel and associated GHG between Waves 1 and 3, per rebate

Impact	\$350	\$1,000	\$1,400	All rebates
Impact	rebates	rebates	rebates	All repates
E-bike PKT increase (km/wk)	51.3	43.1	38.6	39.5
Marginal <sup>1</sup> e-bike PKT increase (km/wk)	8.1	18.5	20.3	19.6
Automobile PKT reduction (km/wk)	36.9	15.2	16.3	17.0
Marginal <sup>1</sup> automobile PKT reduction (km/wk)	9.3	6.6	12.7	12.0
GHG reduction (kg CO₂eq/wk)	11.8	4.6	5.3	5.4
Marginal¹ GHG reduction (kg CO₂eq/wk)	2.9	2.0	4.2	3.9

<sup>&</sup>lt;sup>1</sup> Weighted by marginality (likelihood of not purchasing an e-bike without the rebate)



#### 1.4.6.3 Cost Efficiency

Table 28 summarizes the overall cost efficiency of impacts associated with the incentivized purchases, based only on rebate costs to the program.<sup>50</sup> The lifespan impact calculations apply the weekly GHG changes from Section 1.4.6.2 above over an assumed 5-year e-bike use life (these assumptions are discussed below in Section 1.5.3 below). Rebate cost per additional (marginal) e-bike averaged \$2,200 and increased with rebate value. The increase is a consequence of cost per rebate increasing proportionally more than marginality across rebate tiers, which is consistent with past research (Bigazzi et al., 2025; Bigazzi and Berjisian, 2021; Jones et al., 2024). Each \$1 in rebates generated \$1.33 in new retailer revenue (\$0.72 from induced spending and \$0.61 from transfer through the rebate), and \$0.39 in reduced costs for non-marginal e-bike purchases. Average marginal and non-marginal GHG abatement costs are estimated at \$1,300 and \$930 per tonne CO₂eq, respectively. Although higher-value rebates had larger marginal impacts per rebate, the impacts per rebate-dollar mostly decreased with rebate value.

Table 28. Cost efficiency of BC Program impacts

Impacts normalized to rebate value	\$350	\$1,000	\$1,400	All rebates
impacts normalized to rebate value	rebates	rebates	rebates	All repates
Rebate cost per additional e-bike	\$1,715	\$1,934	\$2,233	\$2,199
New retailer revenue per rebate \$ (due to marginal purchases)	\$1.96	\$1.68	\$1.30	\$1.33
Induced spending per rebate \$ (on marginal purchases)	\$1.76	\$1.16	\$0.67	\$0.72
Reduced spending per rebate \$ (on non- marginal purchases)	\$0.80	\$0.48	\$0.37	\$0.39
Lifespan¹ GHG abatement cost (\$/tonne)	\$114	\$834	\$1,022	\$933
Lifespan marginal GHG abatement cost (\$/tonne)	\$459	\$1,950	\$1,286	\$1,301

<sup>&</sup>lt;sup>1</sup> Applies weekly reduction between Wave 1 and Wave 3 to an assumed a 5-year lifespan of the e-bike

#### 1.4.6.4 Total Program Impacts

Table 29 shows the aggregate program impacts estimated for all 4,943 rebates distributed as of July 2024. Most of the impacts are generated by the largest (\$1,400) rebates, because most (86%) of the distributed rebates were at that tier. Overall, \$6.5 million in rebates to almost 5,000 recipients generated almost 3,000 new e-bike purchases that would not have happened without the program, inducing \$4.7 million in new spending and \$8.7 million in new bike shop revenue. Rebates also reduced purchase costs by \$2.5 million for non-marginal purchasers. The lifespan estimates are a rough approximation based on extrapolation over a 5-year assumed use life, but suggest that the rebate program induced around 25 million new kilometres of e-bike use in BC. At the same time, these rebate-induced e-bike purchasers reduced their automobile travel by 15

<sup>&</sup>lt;sup>50</sup> This neglects administrative and transaction costs for the administrator, retailer, and purchaser.



million person-kilometres, leading to a reduction in GHG emissions over 5 years of 5,000 tonne CO<sub>2</sub>eq.

Table 29. Aggregate weighted impacts of all BC Program rebates

Variable Variable	\$350 rebates	\$1,000 rebates	\$1,400 rebates	All rebates
Number of rebates	180	516	4,247	4,943
Cost of rebates	\$63,000	\$516,000	\$5,946,000	\$6,525,000
Average marginality	0.20	0.52	0.63	0.60
Additional e-bikes (marginal purchases)	37	267	2,663	2,967
New retailer revenue (due to marginal purchases)	\$124,000	\$864,000	\$7,720,000	\$8,708,000
Induced spending (on marginal purchases)	\$111,000	\$598,000	\$3,992,000	\$4,700,000
Reduced spending (on non-marginal purchases)	\$50,000	\$249,000	\$2,217,000	\$2,517,000
Lifespan <sup>1</sup> e-bike PKT increase	2,400,000	5,777,000	42,586,000	50,796,000
Lifespan marginal e-bike PKT increase	378,000	2,479,000	22,406,000	25,239,000
Lifespan automobile PKT reduction	1,725,000	2,043,000	18,052,000	21,846,000
Lifespan automobile marginal PKT reduction	436,000	888,000	14,065,000	15,364,000
Lifespan GHG reduction (tonne CO₂eq)	551	619	5,819	6,996
Lifespan marginal GHG reduction (tonne CO₂eq)	137	265	4,622	5,014

<sup>&</sup>lt;sup>1</sup> Applies weekly change between Wave 1 and Wave 3 to an assumed a 5-year lifespan of the e-bike

Between Waves 1 and 3, participants reduced the external costs of their weekly travel by \$5 on average, leading to a reduction of approximately \$1.3 million annually in travel-related externalities for all rebate recipients. S1 Assuming a 5-year e-bike lifespan, the estimated total reduction in travel externalities approximately equals the total rebate costs of \$6.5 million. These external cost savings are only approximate, but indicate that the rebates can be justified by reductions in societal costs alone, without including the purchase and travel cost savings for the travellers themselves (which are examined further in Part 2). Further, these cost savings do not include the substantial benefits of increased physical activity, which past research has shown can dwarf the savings from changes in crashes or air pollution (de Nazelle and Nieuwenhuijsen, 2009; Grabow et al., 2010; Mueller et al., 2015; Rojas-Rueda et al., 2013). Further investigation of the multidimensional cost impacts is left for future work.

<sup>&</sup>lt;sup>51</sup> This estimate takes into account the additional external costs incurred by participants doing new e-biking; see cost factors in Section 1.3.6.4 above.



#### 1.4.6.5 Summary: Program Impacts on Travel and Greenhouse Gas Emissions

Figure 43 illustrates the aggregate costs of e-bikes purchased using rebates from the BC Program, for which \$6.5 million in rebates generated \$8.7 million in new retailer revenue. In addition to the \$4.0 million in rebates that induced marginal purchases, the remaining rebates reduced \$2.5 million of costs for non-marginal purchasers, almost all (98%) for people who met the Program's low-income criteria (including 88% for the lowest-income recipients).

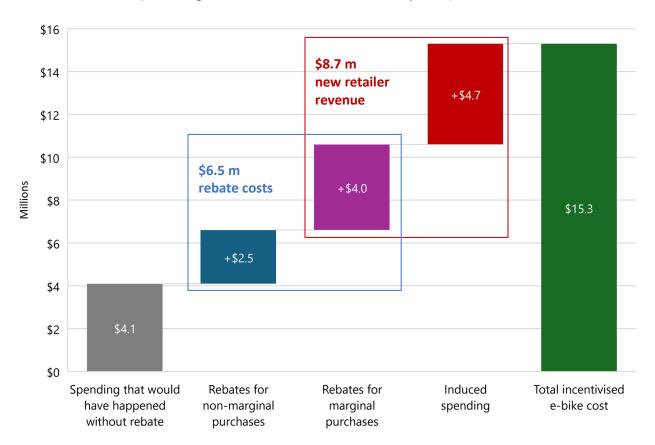


Figure 43. Illustration of aggregate e-bike costs and spending for the BC Program

One year after their e-bike purchase, BC Program rebate recipients had increased their e-bike use by 40 km/week and decreased their automobile use by 17 km/week on average, which reduced their weekly GHG from travel by 5.4 kg CO<sub>2</sub>eq/week. Approximately 60% of these changes are associated with marginal e-bike purchases. If we extrapolate these 1-year changes out to an assumed 5-year e-bike use life, the rebate program induced new e-bike purchases that will be used for 25 million km of travel by e-bike, and associated with 15 million fewer km travelled by automobile and 5,000 tonnes less CO<sub>2</sub>eq emissions from travel.

Normalizing to rebate value, the BC Program provided approximately \$2,200 in rebates for each induced e-bike purchase. Each \$1 in rebates generated \$0.72 in new spending on e-bikes by marginal purchasers and \$0.39 in reduced costs for non-marginal purchasers. The implied GHG



abatement costs (qualified with major assumptions – see Section 1.5.3 below) are \$1,300 or \$900 per tonne  $CO_2$ eq using marginal or non-marginal accounting methods. <sup>52</sup> In comparison, adjusting to a 5-year lifespan assumption, other studies have estimated (using a widely different methods) GHG abatement costs of e-bike incentives ranging from \$600 to \$1,300 (Anderson and Hong, 2022; City and County of Denver et al., 2022; Johnson et al., 2023). The more similar Saanich study estimated lower marginal GHG abatement costs of \$700 per tonne, due primarily to higher pre-purchase automobile use (see discussion in Section 1.5.2 below).

To contextualize these abatement costs, the social cost of  $CO_2$ eq emissions in Canada for 2024 was estimated at \$266 per tonne (Environment and Climate Change Canada, 2023), while the market price was \$80 per tonne in BC (Ministry of Environment and Climate Change Strategy, 2024) and \$107<sup>53</sup> per tonne in Europe (CarbonCredits.com, 2024). In contrast, abatement costs for transportation interventions such as electric vehicle purchase and vehicle scrappage subsidies have been reported<sup>54</sup> in the range of \$300 to \$1,100 per tonne  $CO_2$ e (Azarafshar and Vermeulen, 2020; Chandra et al., 2010; Gillingham and Stock, 2018; Kok et al., 2011). The BC incentives for battery-electric and plug-in hybrid vehicle purchases were estimated to have abatement costs of \$600 and \$1,000 per tonne, respectively, in 2016<sup>55</sup> (Azarafshar and Vermeulen, 2020). A study by Tian et al. (2023) estimated that electrifying bus fleets in major Canadian cities by 2030 would yield abatement costs ranging from \$2,900 to \$4,350 per tonne  $CO_2$ e. Hence, the BC e-bike rebates were cost-competitive for GHG reduction with vehicle electrification strategies, but not with the general carbon markets.

Comparison of impacts across rebate values is challenging due to the strong skew in the rebate value distribution (only 25 people who completed Wave 3 received \$350 rebates, which is the rebate tier with the most distinct travel habits). The general patterns are that the larger, more income-restricted rebates were more likely to generate marginal purchases but were less costefficient in doing so (i.e., required more rebate dollars per additional e-bike). In addition, recipients of the larger, income-conditioned rebates exhibited smaller changes in e-bike and automobile use one year after purchase, but more change that could be attributed to the rebate program. Combining these effects, marginal GHG abatement costs were similar for the \$1,000 and \$1,400 rebate tiers, but much lower for the \$350 tier. These results are largely in line with expectations and the literature (Bigazzi et al., 2025; Bigazzi and Berjisian, 2021; Jones et al., 2024). One notable contrast is that the Saanich study found that marginal GHG abatement costs

<sup>&</sup>lt;sup>52</sup> We believe the marginal accounting method is more appropriate, but provide both for comparison to other reported estimates that use non-marginal methods.

<sup>&</sup>lt;sup>53</sup> Using a rate of €1 = CA\$1.55

<sup>&</sup>lt;sup>54</sup> Critically, vehicle incentive impacts are usually calculated with the assumption that rebates incentivize shifts in the type of vehicle purchased, but do not affect the total amount of vehicles purchased (i.e., they do not account for induced vehicle ownership).

<sup>&</sup>lt;sup>55</sup> Around \$800 and \$1200, respectively, after adjusting for inflation to 2024.



fell with rebate value, due to increasing GHG reductions resulting from higher pre-purchase automobile use (Bigazzi et al., 2025).

#### 1.5 Conclusions: Part 1

#### 1.5.1 Program Impacts

Part 1 of this report aimed to characterize the e-bike purchase decisions of rebate recipients from the BC e-bike rebate program, as well as their subsequent e-bike usage and accompanying travel behaviour changes. Overall, the BC Program was successful in achieving its aims of spurring new e-bike adoption and subsequent GHG reductions. Lower-income households received larger shares of high-value rebates, although most high-income households also received the largest rebate value (\$1,400).

Approximately 3 out 5 rebates induced a new (marginal) purchase that would not have happened without the rebate. This rate was largely determined by the rebate value, but rebates were also more likely to generate new (marginal) purchases when they were received by people in lower-income households, who regularly commuted, and who were not already cycling or e-biking. Commuting and pre-purchase cycling were also two of the main factors affecting post-purchase travel behaviour changes, as those who commuted and cycled pre-purchase used their e-bikes more.

The incentivized e-bikes were used regularly for a variety of utilitarian, exercise, and leisure trips, and a large portion of the e-bike use displaced automobile travel, which led to lower GHG emissions from travel by rebate recipients. The most common e-bike trip types were utilitarian trips (commuting, shopping, or errands) that would have been made by automobile and exercise or leisure trips that would not have been made without the e-bike. The changes in travel patterns were similar at the +3 and +12 month survey waves, which is promising for long-term impacts. In addition to practical considerations such as weather, travel distance, and exertion, "fun" was a key factor motivating sustained e-bike use.

Most rebates were distributed at the \$1,400 tier, which made it difficult to compare long-term impacts across rebate values. Generally, larger rebate values generate greater impact per rebate but smaller impact per rebate-dollar. Lower-income purchasers tended to use their e-bikes more, but displace less automobile travel due to lower pre-purchase automobile use. There were also some regional differences in travel behaviour, particularly pre-purchase travel habits reflecting differences among metropolitan areas (e.g., high transit use in the Vancouver region). Purchasers in the Vancouver and Victoria regions were more likely to use the e-bikes for utilitarian trips, whereas Kelowna and Elsewhere residents were more likely to make new exercise or leisure e-bike trips, possibly due to differences in cycling access to destinations.



Table 30 summarizes some of the factors shown in this study to influence the key determinants of e-bike rebate program outcomes. For example, commuters who receive rebates are more likely to make marginal purchases, and subsequently increase their e-bike use and decrease their automobile use more than non-commuters. Rebates distributed in more moderate winter climates are similarly beneficial for all three mechanisms. In contrast, some factors have trade-offs, such as higher recipient age and recipients conventional cycling prepurchase, which lead to less marginal purchases, but greater use of the purchased e-bikes and more displaced automobile use. Rebate recipients living in lower-income households are more likely to make marginal purchases and use their e-bike more, but have less automobile use to displace with e-biking. Additionally, we find that more marginal purchasers used their new e-bikes less, but reduced their automobile use more.

Table 30. Summary of factors affecting three key determinants of e-bike rebate program outcomes

Influencing factor	More marginal e-bike purchases <sup>1</sup>	Potential for new e-biking <sup>2</sup>	Potential for automobile mode substitution <sup>2</sup>
Being a marginal purchaser		<b>V</b>	
Rebate value		•	•
E-bike price	<b>V</b>	•	•
Men	•		*
Age	<b>V</b>		
Educational attainment		•	
Household income	<b>V</b>	<b>V</b>	
Larger households (with children)	•	•	
Motor vehicles per person	•	•	
Cycling pre-purchase	<b>V</b>		
Regular commuting			
Bike parking inside home	•		
Population density	•	•	
Non-auto access to destinations	•	•	<b>V</b>
Higher annual precipitation	•	*	•
Moderate winter temperatures		*	*
Cycling infrastructure density	•	*	•
Hillier areas	•		*

<sup>+</sup> Enhances benefits; - Reduces benefits; O Uncertain or mixed effects

<sup>\*</sup> Effects observed in the models at a 90% (rather than 95%) confidence level

<sup>&</sup>lt;sup>1</sup> Per rebate, not per rebate-dollar

<sup>&</sup>lt;sup>2</sup> Includes effects that moderate either the proportion or absolute magnitude of PKT changes

<sup>&</sup>lt;sup>56</sup> Not including equity considerations, which are examined in Part 2 of this report.



# 1.5.2 Comparison to Saanich Program

The study results are largely consistent with the limited past empirical research on e-bike adoption and incentive programs, and with pre-program modelling (Anderson and Hong, 2022; Bigazzi and Berjisian, 2021; Bigazzi and Wong, 2020; City and County of Denver et al., 2022; Johnson et al., 2023; Sundfør and Fyhri, 2022). A more detailed comparison to the Saanich E-bike Incentive Program is useful because it provided similar rebates, and was evaluated using similar methods (Bigazzi et al., 2025). The Saanich rebates were only available to residents of Saanich, BC, whereas the BC rebates were available to everyone in the province, covering a much wider range of climates, topographies, socio-demographics, transportation services, street networks, and built environments. Other key differences between the programs that may affect the program outcomes are that the Saanich program: 1) provided different values for the incomeconditioned rebates, 2) conditioned the rebates on household rather than personal income, 3) limited the number of rebates at each tier, so they were more evenly distributed across tiers, and 4) took place 2 years earlier, which covered a period of rapid growth in e-bike use generally (Hassanpour and Bigazzi, 2024), substantial consumer price inflation, and late-stage COVID recovery. In addition, survey Waves 1 and 3 were mostly completed in the summer months in the BC study and in the winter and shoulder months in the Saanich study and (due to the rebate distribution timing).

One difference between the program outcomes is illustrated in Figure 44, showing that the Saanich rebate values were strongly differentiated by household income, whereas most BC rebate recipients received the highest-value (\$1,400) rebates due to low personal income, even in high-income households. This difference is a consequence of both the income criteria and the limited number of highest-value rebates in Saanich. The weak relationship between rebate value and household income in the BC Program enabled us to distinguish income from rebate value

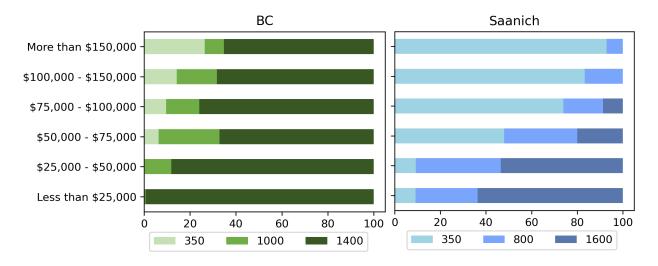


Figure 44. Distribution of rebate values by household income in each program



effects in the regression analysis (which was not possible in the Saanich evaluation), revealing that while both household income and rebate value influence purchase marginality, only household income was significantly related to subsequent travel behaviour changes.

Figure 45 illustrates the estimated rebate cost per marginal e-bike purchase for both programs, as well as from pre-program economic modelling (using a pre-rebate e-bike price of \$3,100 and price elasticity of e-bike demand of -2.0) (Bigazzi and Berjisian, 2021). This measure of cost efficiency is based on the relationship between rebate value and purchase marginality, and shows remarkable agreement among both studies and the model. The BC rebates, particularly at the \$1,400 level, were slightly less cost efficient, which can be expected from the factors shown in Section 1.4.2.3 above to reduce purchase marginality: higher e-bike prices, and rebate recipients that have higher income, more pre-purchase e-bike use, and live in areas with colder winters.

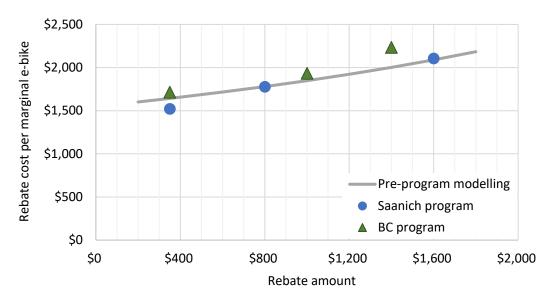


Figure 45. Rebate cost per marginal purchase from BC and Saanich program evaluations and pre-program modeling (assuming a \$3,100 pre-rebate e-bike price and -2.0 price elasticity of e-bike demand)

Reported e-bike usage was similar between the BC and Saanich programs, with return trips averaging 16.5 and 16.2 km, respectively: 31% (BC) and 25% (Saanich) for exercise or leisure, and 38% (BC) and 44% (Saanich) replacing automobile use. The BC study participants from the Victoria region were even more similar, with 24% of e-bike trips for exercise or leisure and 42% replacing automobile use (Section 1.4.3 above), suggesting that the broader differences are likely due to geographic factors such as climate, topography, land use, and transportation infrastructure. Average weekly e-bike PKT 12 months after purchase increased more for BC (+40 km/wk) than for Saanich (+31 km/wk), likely due to the Wave 1 and 3 surveys being completed in different seasons (predominantly summer months for BC and non-summer months for Saanich). 57

<sup>&</sup>lt;sup>57</sup> As shown in Section 4.4.5 of Part 1, new e-bike use was greatest in summer and least in winter.



The changes in automobile use 12 months after purchase were more distinct: they were approximately one third as large for BC (-17 km/wk) as for Saanich (-48 km/wk). This difference in displaced automobile travel led to about one third as large GHG reductions per rebate for BC as Saanich (-5.4 vs. -15.5 kg CO<sub>2</sub>eq/wk) and also almost twice the estimated marginal GHG abatement costs for the BC program (\$1,300 vs. \$720 per tonne). As with the changes in e-bike use between Waves 1 and 3, one influencing factor could be the season of survey completions, as we observed (Section 1.4.4.5 in Part 1) that automobile PKT reductions were smaller in the summer (when most BC Wave 1 and 3 surveys were completed) than in the winter and shoulder seasons (when most Saanich Wave 1 and 3 surveys were completed).<sup>58</sup>

However, the bigger factor appears to be particularly high pre-purchase automobile use by recipients of the income-conditioned Saanich rebates. The Saanich study observed that this result was "counterintuitive, because higher income is generally associated with higher automobile PKT," and speculated that it could reflect less ability of lower-income households to actualize preferences for less automobile reliance (Bigazzi et al., 2025). This phenomenon was not observed in the BC study results, and regression analysis (Section 1.4.4.5 in Part 1) confirmed that BC rebate recipients living in higher-income households had more automobile use prepurchase, leading to greater automobile PKT reductions post-purchase. We also do not observe particularly large reductions in automobile use for BC rebate recipients living in metropolitan Victoria (Section 1.4.4.4 in Part 1), and neither study found a significant effect of rebate value on reductions in automobile PKT. The Saanich sample was younger than the BC sample (Table 7), but automobile PKT reduction increased with age in our regression analysis (Section 1.4.4.5 in Part 1).

Ultimately, it is unclear why the study participants who received income-conditioned Saanich rebates had higher pre-purchase automobile use than the other participant groups in either study. Pre-purchase e-bike use was twice as common in the BC program as the Saanich program, which may support the idea that latent demand to reduce automobile dependence was particularly high for low-income households receiving Saanich rebates in 2021, and has eased with the growing availability of e-bikes province-wide in the intervening 2 years. The Saanich study had a small number of rebate recipients completing all 3 survey waves (24 for the two income-conditioned tiers combined), and so we are more confident generalizing from the BC study results, given the larger sample and more diverse contexts. The BC results for automobile mode shift to e-bike are also closer to estimates from other studies.

<sup>&</sup>lt;sup>58</sup> However, the seasonality effect was not statistically significant at p<0.05.

of the unconstrained \$350 rebate recipients in the Saanich study (which fell from 105 to 86 km/wk on average) most closely resembled that of the unconstrained \$350 rebate recipients in the Saanich study (which fell from 110 to 87 km/wk on average). The post-purchase automobile use of these groups was slightly higher than both the pre- and post-purchase automobile use of the non-incentivized e-bike purchasers in the Saanich study control group (83 and 80 km/wk, respectively). Post-purchase automobile use was also roughly similar for the income-conditioned rebate recipients in the Saanich study, but their pre-purchase automobile use was much higher (up to 150 km/wk for the \$1,600 rebate recipients).



#### 1.5.3 Limitations

There are range of challenges and limitations to consider when interpreting these results and planning future evaluations. The first concern is sample bias, as not all rebate recipients completed our study but we aimed to estimate the total program impacts. We used survey weights to partially account for non-random responses (to the extent that they related to observable factors). People who were not using their e-bikes would have been less likely to respond, although we did receive responses from people who no longer owned or were not using their e-bikes at all. In addition, we do not know the extent of potential fraud or non-compliance with program criteria by rebate recipients, which could erode program effectiveness.

The second concern is response bias, as most data were self-reported by participants making them vulnerable to social desirability and recall biases. We also asked participants to respond to hypothetical counterfactuals about what they would have done without the rebate or without the e-bike, and we do not know how reliable those response are. Three sources of information on e-bike use (about the last two trips, typical weekly travel, and odometer readings) helped to triangulate and provide some confidence in the results. In addition, the use of panel data provides relatively robust "within-subject" repeated measures to evaluate travel behaviour changes. We generally expect the reliability of individual observations to be low, but the aggregate estimates to represent the overall program impacts.

A third limitation is causal inference from the associations reported here. In some cases we indirectly asked participants to report causality using hypothetical prompts ("What would you have done..."). For others we used a panel study design and controlled for potential confounding factors such as seasonality and fuel prices. A control sample was not feasible in this study since the rebates were available to all residents of BC, and non-BC residents were insufficiently comparable. A "gold standard" approach would be to randomize which participants get the rebates and follow both groups over time, but this was not compatible with the program design. The study population is people who applied for and received an e-bike rebate, in contrast to the general population. We can describe this group as the "potential e-bike market", and a major challenge for a priori program evaluation is estimating the size of this population sub-group.

The survey design involved consideration of various trade-offs related to internal and external validity, particularly response burden and selection bias versus measurement precision and privacy protection. We only required the first three digits of home postal codes, which is not personally identifiable, but provides poor spatial resolution for contextual variables in rural areas. We also chose not to use location-tracking technology (i.e., smartphone apps) to reduce selection bias, particularly for low-income rebate recipients. In addition, only opt-in information was communicated between the program administrators and study team, which prevented tracking of personal information between the program and the study.



GHG estimates used fixed modal GHG emission factors from other research, which neglects a variety of factors that can moderate an individual's "carbon footprint" from travel. In particular, we did not collect information of vehicle type, fuel type, or driving style. We also did not attempt to apply time-varying emission rates to account for evolution of the motor vehicle fleet or space-varying emissions rates to account for regional differences in vehicle fleets or transit operations. If motor vehicle GHG emission rates decrease over time, it will diminish the GHG benefits of automobile mode substitution and by extension e-bike adoption. In addition, the GHG impact estimates neglect possibly unique characteristics of e-bike adopters with respect to the general population. For example, if e-bike adopters systematically owned lower-emitting automobiles than others, or were more likely to share rides, we would overestimate the GHG impacts of e-bike mode substitution (and vice versa).

The lifespan impact estimates in Section 1.4.6 in Part 1 have high uncertainty due to their sensitivity to the assumption of a 5-year e-bike lifespan. Incentivized e-bikes might not last that long or may be used for a longer time. We also have not accounted for the benefits of potential future e-bike purchases by rebate recipients or their family. The lifespan impact estimates also apply the changes between 2 discontinuous months 1 year apart to the whole year, which neglects seasonality. Because most Wave 1 and Wave 3 observations were in the summer months (Figure 5), the regression results (Section 1.4.4.5 in Part 1) indicate that assumption could be conservative for reductions in automobile use (which were smallest in summer) but not for increases in e-bike use (which were largest in summer). Supporting this, comparison of e-bike use from odometer readings versus weekly travel data in each wave suggest that continuous usage is around 10% lower than implied by point-to-point before/after comparisons. The lifespan estimates also extrapolate the 1-year changes out to 5 years, which relies on the prepurchase behaviour as the reference case out to 2028. The similarity of the +3 and +12-month travel behaviour is promising, but long-term evaluation of outcomes is needed (and has not yet been undertaken to out knowledge).

Finally, e-bike adoption can have important impacts that were not closely examined in this study. E-bike use that displaces automobile travel can also reduce crashes, traffic congestion, local air pollution, and other externalities associated with automobility (Delucchi, 2000; Mason et al., 2015). We also did not examine the potential for social network effects where incentivized e-bike adoption indirectly spurs e-bike uptake by others in their community. In addition, the cost efficiency calculations only included rebate costs, not administrative or transaction costs for the program, purchaser, or retailer.

<sup>&</sup>lt;sup>60</sup> Although season was not statistically significant (p<0.05) in either model.

<sup>&</sup>lt;sup>61</sup> Acknowledging that, as noted above, they do not measure the exact same thing: the odometer indicates use of one e-bike by anyone and the weekly travel data represent use of any e-bike by one person.

<sup>&</sup>lt;sup>62</sup> Our Wave 3 survey asked for permission to re-contact for follow-up after 5 years, and most participants consented.



#### 1.5.4 Recommendations

E-bike rebate programs continue to be highly popular and effective at increasing e-bike adoption, which can advance a range of goals related to public health, affordability, accessibility, equity, livability, and climate change. The results of this study support the core assumptions of e-bike rebate programs and provide insights to inform future e-bike rebate program designs to further enhance their benefits. In general, aggregate program benefits increase when the rebates generate more marginal e-bike purchases, when the marginal e-bikes are used more, and when more of that new e-bike use displaces automobile travel. However, there can be trade-offs among these objectives.

Rebate program designers should consider these potential trade-offs among the program objectives when selecting program criteria to prioritize rebate cost efficiency, new e-bike use, or automobile mode substitution. For example, new (induced) exercise or leisure e-bike trips provide a range of benefits, but do not reduce greenhouse gas emissions. Prioritizing new e-bike use (with income restrictions, for example) emphasizes benefits for physical activity, health, and access, whereas prioritizing automobile mode substitution (with rebates in suburban areas, for example) emphasizes benefits for travel costs, livability, and the environment. Prioritizing marginality (with an e-bike price cap, for example) emphasizes cost efficiency of the rebate program (and indirectly automobile mode substitution). In addition to these factors that influence aggregate outcomes, there are important considerations of fairness and equity in both access to rebates and e-bike benefits that should also be accounted for in program design (which we address in Part 2 of this report).

We recommend continuing the BC Program, and considering a change to a household income criterion in order to increase the program's effectiveness in generating marginal e-bike purchases and induced e-bike use. Restricting the high-value rebates to be available only to low-income households would increase the number of additional (marginal) purchases generated by the high-value rebates, and also shift rebate demand from middle- and high-income households toward the lower-value rebates, allowing a greater number of rebates to be distributed from a fixed program budget. In this way, higher-income household would receive the more cost-efficient lower-value rebates.

Other strategies to increase the number of rebates are to restrict the total number of rebates available at the higher-value tiers, or reduce the rebate values. Rebate values need to be sufficient to warrant the administrative and transaction costs, and to make e-bikes feasible for low-income households. Larger rebates induce more marginal purchases, which indirectly increases automobile mode shift, but are still less cost-efficient per rebate-dollar. The current BC program tiers provided 10% to 44% of the pre-rebate e-bike costs, which is in line with rebate programs worldwide. The ideal rebate value is contextual, and depends on the attributes of the recipients, the e-bike market, and program priorities.



Given the positive effects of being a commuter on program impacts, a rebate program design that prioritizes or segments regular commuters (possibly in partnership with employers) may be a promising approach to conditioning rebates on attributes other than income. Employer-based programs have been implemented in the past, but typically on small scales as pilots or to advance the priorities of the employer (MacArthur et al., 2017; Ton and Duives, 2021).

Geographic context is another potential consideration for rebate program design, although most contextual factors were not significant in our analysis. Regional travel habits (i.e., pre-rebate mode shares) are likely the most important contextual factors for program impacts. Regions with good transit systems (Vancouver) will see less automobile mode substitution, for example. Areas that are hillier and with sparser cycling infrastructure tended to see more growth in e-bike use, likely because they are not conducive to conventional cycling but present less of a barrier for e-bike use. Reduction in automobile use was greater in areas that are relatively dense but with poor non-auto (walking, bike, transit) access, which implies suburban contexts. These results show that e-bike rebates are effective even in places without currently high levels of "bikeability".

Consistent with past work, we find that the GHG abatement from e-bike rebates is cost-competitive with other electric vehicle strategies, although e-bike rebates cannot compete on international carbon markets. Their attractiveness purely as a GHG reduction strategy is thus contextual, and depends on the acceptance of carbon off-setting as an effective and ethical alternative to actually reducing emissions from transportation systems (Hyams and Fawcett, 2013; Probst et al., 2023). E-bike rebates also generate a range of other benefits related health, safety, travel costs, and air pollution through automobile mode substitution and physical activity. Thus, while GHG mitigation is an important and significant benefit of e-bike rebate programs, e-bike rebates need not (and likely should not) be justified solely through climate action.

This last point is emphasized if we look ahead to the prospective for e-bike rebate programs in the future, assuming current trends continue. As emission rates of the passenger vehicle fleet decline, the GHG benefits of automobile mode substitution diminish. The marginal impacts of incentivizing e-bike purchases will decline as baseline e-bike use goes up, which will also reduce the potential automobile mode substitution. Assuming these beneficent trends continue, the effectiveness of e-bike rebates will diminish over time. In fact, by accelerating e-bike adoption (directly and indirectly), e-bike rebate programs may eventually make themselves obsolete. We are a long way from that point, but it bears considering that e-bike rebates are most effective as a transition strategy to accelerate uptake of this accessible and sustainable travel mode.

In closing, e-bike rebates can spur active travel and mode shift, but questions remain over the most effective incentive program designs. In addition, the full benefits of incentivized e-bike purchases (including travel costs, physical activity, and safety) require further investigation. As interest in e-bike incentive programs continues to expand, we look forward to further investigations on the effectiveness of these programs in various scales and settings.

# Final Report Part 2: Personal and Equity Effects of Incentivized E-bike Adoption





#### 2.1 Introduction

This is Part 2 of our report on the impacts of the "British Columbia E-Bike Rebate Program." Part 1 of the report examines how the rebates impacted e-bike purchases, travel behaviour, and greenhouse gas emissions. Part 2 provides an analysis of the personal and equity impacts of the program on rebate recipients. See Part 1 above for information on the rebate program, including its structure and implementation, and the broader study design.

Transportation is core to supporting health and well-being. Understanding the equity impacts of transportation policies and programs is especially important in the context of transportation poverty, which affects nearly 1 million Canadians (Allen and Farber, 2019). Transport poverty refers to limited access to opportunities due to inadequate, unaffordable, or unsafe travel options. These barriers hinder people's access to essential destinations like jobs, education, healthcare, and social activities, and are often more pronounced for those with mobility challenges, including people with disabilities (Park et al., 2023). Transport poverty is an issue that results from longstanding inequitable planning and practices in transportation systems.

Transportation equity is about seeking fairness in transportation systems. It encompasses the fair distribution of transportation resources, inclusive participation in decision-making processes, and recognition of the prevailing injustices that shape different levels of need and power within transportation systems (Williams et al., 2023). Equity questions often focus on population groups that are underrepresented in active transportation or face greater transportation-related barriers, such as women, older adults, people with disabilities, and racialized populations.

One aim of the BC Electric Bike Rebate Program was to make transportation more affordable for lower-income households, recognizing that for many people the cost of e-bike purchases is the main barrier to accessing them for travel. This analysis examines the experiences of people from structurally marginalized population groups, relative to others in the program, with the goal to understand if and how the rebate program made an impact on their lives. In particular, we evaluate whether the program made it easier for them to purchase an e-bike, how they used the new e-bike, whether they gained additional mobility or access to destinations, whether their overall cost of travel increased or decreased, and whether they increased or decreased their overall physical activity during travel. In addition to income, we look at equity with respect to personal factors such as age, gender, race, and educational attainment, as well as contextual factors such as rural areas and economic regions.

#### 2.2 Literature review

Research on the impact of e-bike ownership on travel behavior among equity-deserving groups in North America remains scarce. One study by Johnson et al. (2023) examined three e-bike rebate programs in northern California, USA and found that higher-income individuals were less likely to replace car trips, although the relationship was not consistent across all income levels.



Rates of substitution for daily car trips were lowest for those in households earning between US\$75,000 and US\$100,000, and highest for those in households earning over US\$150,000. Additionally, men and younger participants were more likely to substitute car travel than their counterparts.

Other studies have highlighted how different population groups use e-bikes in distinct ways. MacArthur et al. (2018b) found that men in the USA reported a slightly higher share of personal errands and entertainment trips than woman, while seniors and people with physical limitations were more likely to use e-bikes for recreational purposes. A New Zealand study (Wild et al., 2021) found that e-bikes increased confidence cycling for women. For mothers in particular, e-biking helped them better balance responsibilities and resume cycling after pregnancy. Together, these studies suggest that while e-bike usage patterns differ by demographic group, they offer significant mobility and lifestyle benefits across population subgroups.

#### 2.3 Methods

For information on the study framework, data collection, and data processing please refer to Part 1 of the report.

# 2.3.1 Equity-Related Variables

Table 31 presents a set of equity-related variables used for analysis throughout this report. The equity-related variables include a set of personal characteristics, three measures of household income and wealth, as well as two contextual geographic variables. The contextual variables were assigned to participants based on their home location.<sup>63</sup>

Table 32 presents the household income thresholds used to define the "Low income" variable based on geography and household size. The thresholds are based on 160% of the federal low-income cut-off (LICO) to align with thresholds used for income qualification in BC meant to reflect "modest means" rather than poverty (Saanich Sustainability Division, 2024). See Appendix D.1 for the threshold development.

<sup>&</sup>lt;sup>63</sup> Recorded in the survey as Forward Sortation Area (FSA) or other available location identifier – see Section 1.3.3 in Part 1 of this report.



Table 31. Equity-related variables

Variable name <sup>1</sup>	Description
Personal	
Non-man	Reported any gender identity besides (or in addition to) "man", or did not report gender (binary)
Senior	Reported age of at least 60 years (binary)
No college	Reported not receiving at least a college certificate or diploma, or did not report education (binary)
Physical disability	Reported "difficulty walking, using stairs, or doing other physical activities" at least "often" (binary)
Non-white	Reported any racial identity besides (or in addition to) "white" (binary)
Household	
Low income	Households with annual income less than 160% of the federal low-income cut- off (LICO) based on geography and household size per Table 32 (binary)
LICO multiplier	Ratio of the annual household income to the federal low-income cut-off based on geography and household size (continuous) <sup>2</sup>
Satisfaction with household income	Response to the question "To what extent does your annual household income satisfy your household's needs?", as: very well, well, not well, or not at all, which were re-labeled as high, medium, low, or very low <sup>3</sup>
Contextual	
Rural area	Households in an FSA <sup>4</sup> with a population less than 1,000 and population density less than 400 people per km <sup>2</sup> (Government of Canada, 2011)
Economic region	Seven economic regions of BC, adapted from Statistics Canada to align with FSA boundaries (Government of Canada, 2013)

<sup>&</sup>lt;sup>1</sup>The reference levels for binary variables include "Prefer not to answer" and missing responses, unless stated otherwise.

Table 32. Household income thresholds for the "Low income" variable

Household size	Vancouver	Kelowna, Victoria, and Elsewhere
1 person	< \$50,000	< \$50,000
2 persons	< \$50,000	< \$50,000
3 persons	< \$75,000	< \$50,000
4 persons	< \$75,000	< \$75,000
5 persons	< \$100,000	< \$75,000
6 persons	< \$100,000	< \$100,000
7 persons or more	< \$150,000	< \$100,000

<sup>&</sup>lt;sup>2</sup> See Appendix D.1 for low income cut-off (LICO) thresholds

<sup>&</sup>lt;sup>3</sup>This question was only available for participants who completed survey Wave 3.

<sup>&</sup>lt;sup>4</sup> Forward Sortation Area (first three digits of home postal code)



Figure 46 shows a map of rural and urban areas in BC based on the definition above; all areas not shown on the map are rural. Figure 47 presents a map of the economic regions defined above.

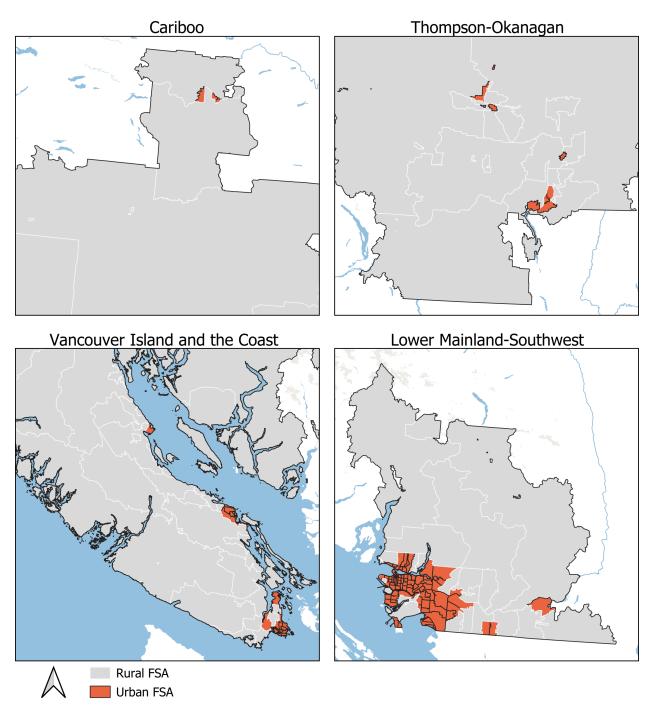


Figure 46. FSA classifications as Urban or Rural based on definition above (all FSA not shown are Rural)





Figure 47. Economic regions of BC based on the definition above

# 2.3.2 Survey Weights

As described in Part 1 of this report (Section 1.3.5), survey weights were applied to each response to account for differences between the observed sample and the study population (i.e., all BC Program rebate recipients). The survey weights account for sample demographic bias in each wave of the survey due to non-responses and attrition.



## 2.3.3 Impact Estimation

#### 2.3.3.1 Mobility

The gained mobility for rebate recipients is defined as the net new travel completed using the purchased e-bike: i.e., e-bike use that represents increased mobility rather than substitution of other travel modes. *Net new mobility* for each participant is calculated as the product of their average post-purchase weekly travel by e-bike (km/wk) and their average reported likelihood that they "would not have made [this] trip" without the e-bike (rather than making the trip using an alternative travel mode) for reported e-bike trips. Trip purpose for reported e-bike trips is also used to partition net new mobility between exercise versus travel for access.<sup>64</sup>

#### 2.3.3.2 Affordability

In Part 1 of this report we estimated the *external* travel costs for society, and in Part 2 we estimate the *internal* travel costs for e-bike users. Table 33 presents the rates used for these internal travel cost estimates, which were partly taken from Litman (2022) with updates and modifications to better align with the study context. <sup>65</sup> The internal rate for cycling and e-biking includes the costs of purchase and maintenance, as well as the cost of charging. Internal costs for automobile travel include vehicle purchase, fuel, maintenance, parking, licensing, and insurance. Internal costs for travel by transit only includes fares. The rate for "other" modes is computed as the average of all modes. See Appendix D.2 for details on travel cost assumptions.

Table 33. Assumed travel cost rate by mode (in \$ per km)

		Walking	Biking	E-biking	Auto	Transit	Other <sup>1</sup>
	Vehicle purchase	\$0.00	\$0.06	\$0.08	\$0.24	\$0.00	-
	Maintenance	\$0.00	\$0.06	\$0.07	\$0.08	\$0.00	-
	Fuel	\$0.00	\$0.00	\$0.00	\$0.14	\$0.00	-
Internal	Fare	\$0.00	\$0.00	\$0.00	\$0.00	\$0.23	-
travel costs	License/fees	\$0.00	\$0.00	\$0.00	\$0.01	\$0.00	-
	Insurance	\$0.00	\$0.00	\$0.00	\$0.15	\$0.00	-
	Parking	\$0.00	\$0.00	\$0.00	\$0.15	\$0.00	-
	Total internal travel costs	\$0.00	\$0.12	\$0.14	\$0.77	\$0.23	\$0.25

<sup>&</sup>lt;sup>1</sup>Average of all other modes

#### 2.3.3.3 Physical Activity

Physical activity during weekly travel is estimated using a representative activity intensity level called Metabolic Equivalent Task (MET). MET rates represent the approximate physical intensity

 $<sup>^{64}</sup>$  Using the person-average joint probability of exercise trip purpose (versus all others) and not making the trip without the e-bike

<sup>&</sup>lt;sup>65</sup> Currency conversion of CA\$1.35 = US\$1.00 was used as necessary



of an activity in terms of energy expenditure relative to being at rest. For example, someone doing an activity at a MET of 3 is expending energy at 3 times the rate they would if they were simply lying down. The MET values applied to the travel modes in this study are given in Table 34, based on relevant literature (Ainsworth et al., 2011; Bourne et al., 2018; Castro et al., 2019a; Gojanovic et al., 2011; Mageau-Béland and Morency, 2021). The second row in Table 34 presents the marginal (or non-sedentary) MET increment, which is a measure of the additional physical activity experienced during travel by that mode, relative to sedentary time (or being at rest) which has a MET of 1. Additionally, Table 34 presents the assumed pace used for each mode, to convert travel distance into travel time. The average pace for each mode was estimated from the Saanich E-Bike Incentive Study data (Bigazzi et al., 2024b) which collected information on both the length and duration of travel. These modal parameters are used for an approximate comparison across modes, recognizing that energy expenditure and the pace of travel vary greatly across individuals and trips due to factors such as terrain, infrastructure, physical fitness, trip purpose, and equipment.

Table 34. Assumed physical activity rate and pace by mode

	Walking	Cycling	E-biking	Auto	Transit	Other
MET	3	7	5	1.3	2	2
Marginal MET increment	2	6	4	0.3	1	1
Pace (min/km)	10	3.2	2.8	2.0	2.8	2.0

# 2.3.4 Open-Text Comments Analysis

Open-text comments from the survey were analyzed to examine the impacts of e-bike ownership and the rebate program. Open-text data can complement the other analysis in this report with a less constrained, more nuanced reflection of user experiences and priorities. All three survey waves contained an optional open-text response area allowing participants to include detail or make qualifications of their other responses. In Wave 1 and 2, the open-text prompt was generic: "Do you have any comments or clarifications about the information you provided in this survey?" In the Wave 3 questionnaire, the open-text prompt was revised to direct participants to reflect on their e-bike ownership: "Reflecting on your past year of e-bike ownership, is there anything else you would like to share about the benefits of owning an e-bike or the obstacles you encountered using it?" Open-text responses from all three survey Waves were reviewed and included in the text analysis.

All comments were first reviewed to determine whether they included a reflection about e-bike ownership, excluding those that only provided administrative or irrelevant information. All included comments were then manually labelled with the topics addressed in that comment. Table 35 gives a list of the topic labels, which were iteratively developed by the research team through manual review of the included comments. The table also identifies a sentiment



associated with each topic, indicating whether the comments generally addressed the topic in a positive or negative way.

Table 35. Topic definitions for labelling of open-text comments

Topic name	General sentiment	Topic description
Size	_	Size or weight of the e-bike
Maintenance	_	Cost or challenge of e-bike maintenance or repair
Distance	+	Relationship between e-bike use and travel or trip distance
Exertion	+	Relationship between e-bike use and exertion, or exertion as a barrier to cycling
Hills Weather	+	Influence of hills or topography on e-bike use or experience Influence of weather on riding likelihood or experience (including factors
	0	such as precipitation, temperature, wind, daylight, or smoke/air quality)
Riding facilities	-	Requests for greater availability or quality of cycling facilities such as bike lanes or paths
Parking facilities	_	Availability or quality of facilities for parking or charging e-bikes
Roadway interactions	_	Interactions with other road users or vehicles (including pedestrians, cyclists, or motorists)
Theft	_	Concerns about e-bike theft
Utility	+	Utility of the e-bike for purposes such as to commute, shop, or run errands
New access	+	E-bike use to make new trips that would not have been made otherwise
Mode shift	+	E-bike use to replace other modes of transportation
Co-riding	+	Cycling with others (adults, children, or pets) on the same or separate bicycles
Travel costs	+	Effects of e-bike use on travel costs
Health effects	+	Effects of e-bike use on mental or physical health
Enjoyment	+	Fun or enjoyment associated with the act of e-biking or cycling in general
Novelty	_	Challenge or need of learning about e-bikes (for e-bike users or other road users)

Indicates negative sentiment and + indicates positive sentiment; o indicates neutral or mixed sentiment

The topic labels from all survey waves were combined to create a list of person-level binary topic variables, indicating whether each person commented on a given topic in any wave (regardless of how many times the person commented on that topic). Correlations among topics were calculated using these person-level topic variables. The correlation coefficients were then visualized as a correlation network diagram using the 'igraph' package for the statistical software R (Csardi and Nepusz, 2006; R Core Team, 2025b).



## 2.4 Results

# 2.4.1 Study Sample

Table 36 provides a summary of the equity-related personal and household variables for the study sample. Comparisons to the study population (all BC rebate recipients) in the Part 1 report indicate generally good representation for gender, age, and race (the only variables with data available for study population). Approximately half of the sample is below our household income threshold of 1.6 x LICO, with a mean LICO multiplier of 1.8. A larger portion of the sample (three quarters) is satisfied with their household income, indicating that it meets their needs well or very well.

Table 36. Summary of equity-related personal and household variables in the study sample

Variable name	Summary statistic <sup>1</sup>		
Personal			
Non-man	51%		
Senior (age 60+)	32%		
No college	19%		
Physical disability	5%		
Non-white	23%		
<u>Household</u>			
Low-income	52%		
LICO multiplier	1.77 (1.22)		
Satisfaction with household income			
Very low	3%		
Low	23%		
Medium	52%		
High	23%		

<sup>&</sup>lt;sup>1</sup>% true for binary and categorical variables; mean (standard deviation) for continuous variable; summary includes all 1,004 participants at Wave 1 for all variables except Income satisfaction, which was only available in Wave 3 (N=431)



Figure 48 shows satisfaction with household income for each household income category. Income satisfaction generally increases with household income, although we observe both low and high levels of satisfaction at all income levels. Differences between these two distinct measures of financial capacity can reflect both varying financial demands across households and non-income sources of financial capacity (existing assets for retirees, for example).

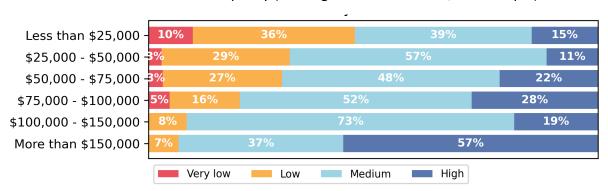


Figure 48. Distribution of income satisfaction by household income

Figure 49 shows satisfaction with household income by LICO multiplier, which normalizes household income to household size and geographic context. Similar to its relationship with household income, income satisfaction also generally increases with LICO multiplier, but we see both high and low levels of satisfaction at all LICO levels.

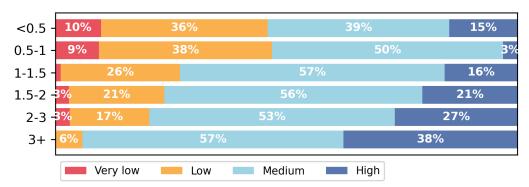


Figure 49. Distribution of income satisfaction by LICO multiplier

The Part 1 of this report focused on the distribution of the study sample among major metropolitan areas of British Columbia. Part 2 expands on this by examining the geographic equity of the sample in two ways: first, by analyzing representation across the province's seven economic regions, and second by comparing rural and urban areas.



Table 37 presents the sample, program, and general BC population distributions across BC geographies. Overall, the rebate distribution across economic regions generally reflected the population distribution. The Vancouver Island and Coast region is overrepresented, likely because the District of Saanich provided funding for additional rebates for its residents.

Table 37. Sample distribution across geographies, with program and population comparisons

		Number at wave 1	Proportion of Wave 1 sample	Proportion of BC rebate recipients	Proportion of BC population
Economic regions	Cariboo	7	1%	1%	3%
	Kootenay	39	4%	3%	4%
	Lower MainlandSouthwest	489	49%	60%	60%
	Nechako/North Coast	8	1%	1%	2%
	Northeast	4	<1%	<1%	1%
	ThompsonOkanagan	127	13%	10%	12%
	Vancouver Island and Coast	329	33%	25%	18%
Area status	Rural areas	345	34%	28%	34%¹
	Urban areas	659	66%	72%	66%

<sup>&</sup>lt;sup>1</sup>According to the definition of rural areas established above. Government of Canada (2022) uses a different, more localized measure of rural areas, which sets the share of rural residents in BC at 13%.



# 2.4.2 Mobility

#### 2.4.2.1 E-Bike Use

This section summarizes how key travel impacts of e-bike adoption vary with the equity-related variables described above. Figure 50 and Figure 51 present e-bike trip purpose versus household income and satisfaction with household income. Trip purposes are similar for high- and low-income households, with a small shift from commuting to shopping shares for low-income households. Differences in trip purpose are larger across income satisfaction levels, as participants with lower income satisfaction used their e-bikes much more for commuting and much less for exercise or leisure.

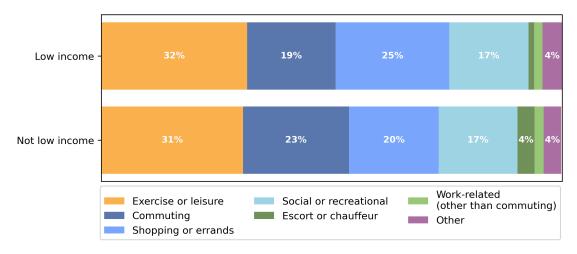


Figure 50. Average e-bike trip purpose by household income

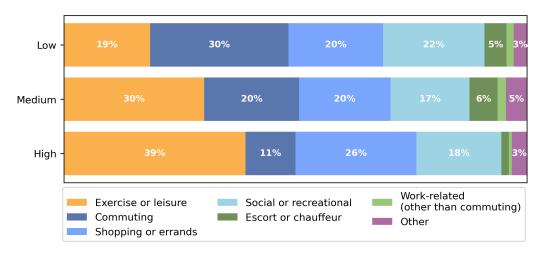


Figure 51. Average e-bike trip purpose by satisfaction with household income



Table 38 presents a summary of how e-bike trip purpose compares for equity-related subgroups in comparison to everyone else; the corresponding figures are presented in Appendix E.1.1. The table presents graphical indicators of whether certain population groups did more or less of that type of travel than other groups. <sup>66</sup> People with disabilities, those without college degrees, seniors, and residents of rural places reported a higher share of exercise or leisure trips. As shown in Figure 73 in Appendix E.1.1, people with disabilities reported that 52% of their e-bike trips were for exercise or leisure, which is the only group of people who reported more than half for of their travel to be of one purpose.

Table 38. Variation in e-bike trip purpose shares for equity-deserving groups

	Exercise or leisure	Commuting	Shopping or errands	Social or recreational	Escort or chauffeur	Work- related
Low household income	•	•	A	•	V	•
Low satisfaction with household income	•	<b>A</b>	•	•	•	•
Non-man	•	•	•	•	*	•
Non-white	•	*	•	•	•	•
Disability		<b>V</b>	*	•	•	•
No college		•	•	•	<b>V</b>	•
Senior		<b>V</b>	•	•	<b>V</b>	•
Rural		<b>V</b>	•	•	<b>V</b>	•
Economic regions <sup>1</sup> :						
Lower MainlandSouthwest	•	*	•	•	•	<b>V</b>
Vancouver Island and Coast	<b>V</b>	•	*	•	•	+*
Southeast <sup>2</sup>		<b>V</b>	•	•	•	•

<sup>▲</sup> indicates greater share and ▼indicates smaller share for these participants than for others; • indicates no significant difference in the share between these participants and others

<sup>\*</sup> Statistically significant differences at a 90% confidence level; other indicated differences at 95% confidence level

<sup>&</sup>lt;sup>1</sup> Only regions with at least 10 participants included

<sup>&</sup>lt;sup>2</sup> Thompson--Okanagan or Kootenay regions

<sup>&</sup>lt;sup>66</sup> T-tests were used to determine statistical significance of differences



Figure 52 and Figure 53 present mode substitution for e-bike trips versus household income and satisfaction with household income. As mentioned above, these are related but distinct measures of financial capacity (Figure 48). Participants from low-income households were less likely to replace automobile trips than those from higher-income households. In contrast, participants with lower income satisfaction were more likely to replace automobile and transit trips, and less likely to use the e-bike to make new trips, than those with higher income satisfaction. We find that the highest automobile mode substitution rate (44%) is reported by participants from high-income households with low income satisfaction (possibly due to high expenses constraining financial capacity). Conversely, the lowest automobile mode substitution rate (35%) is reported by participants from low-income households but medium or high satisfaction with household income (possibly due to non-income financial capacity). As with trip purposes, these results provide contrasting information about the relationship between household income and travel mode substitution.

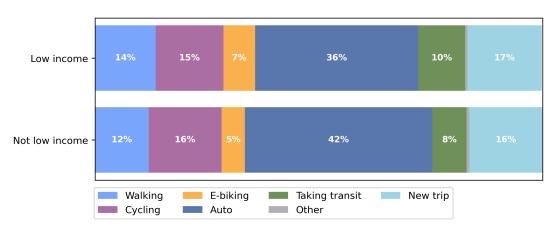


Figure 52. Distribution of travel modes replaced by purchased e-bike at different household income levels

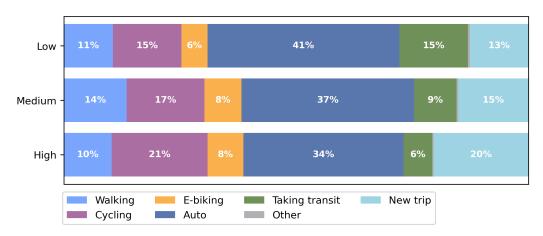


Figure 53. Distribution of travel modes replaced by purchased e-bike at different levels of satisfaction with household income



Table 39 presents a summary of how e-bike mode substitution compares for equity-related groups in comparison to everyone else; the corresponding figures are presented in Appendix E.1.1. Rates of automobile mode substitution were higher for people in rural areas, and lower for those with disabilities, without a college degree, and seniors. Non-white e-bike purchasers were more likely than others to replace walking and transit trips.

Table 39. Variation in e-bike mode substitution for equity-related groups

Category	Walking	Cycling	E-biking	Auto	Taking transit	New trip
Low household income	•	•		_		•
Low satisfaction with household income	•	•	•	•		•
Non-man		•	<b>V</b>	•	•	•
Non-white	*	<b>V</b>	•	•		<b>V</b>
Disability	•	•	•	*	•	
No college	•	•	*	*	•	•
Senior	•	•		<b>V</b>	<b>V</b>	
Rural	•	•	•		<b>V</b>	
Economic regions <sup>1</sup>	•	•	•	•	•	•
Lower MainlandSouthwest	•	•	•	<b>V</b>		•
Vancouver Island and Coast	•	•	<b>V</b>		<b>V</b>	•
Southeast <sup>2</sup>	<b>V</b>	•	•	•	<b>V</b>	

<sup>▲</sup> indicates greater share and ▼indicates smaller share for these participants than for others; • indicates no significant difference in the share between these participants and others

## 2.4.2.2 Changes in Travel Habits

This section summarizes how long-term changes in travel habits one year after purchase<sup>67</sup> vary with the set of equity-related variables. Figure 54 presents average weekly PKT by mode at each wave and Figure 55 summarizes the average long-term change in weekly PKT by different levels of the LICO multiplier, which is a measure of household income with respect to the poverty level based on household size and home location.<sup>68</sup> Pre-purchase automobile use at Wave 1 was highest for households with LICO multiplier greater than 1, as was total PKT in all waves. Increases

<sup>\*</sup> Statistically significant differences at a 90% confidence level; other indicated differences at 95% confidence level

<sup>&</sup>lt;sup>1</sup> Regions with at least 10 participants included

<sup>&</sup>lt;sup>2</sup> Thompson--Okanagan or Kootenay regions

<sup>&</sup>lt;sup>67</sup> Between pre-purchase behaviour at Wave 1 and behaviour in Wave 3 approximately 12 months later

<sup>&</sup>lt;sup>68</sup> For additional details, Figure 41 in Part 1 presents average change in weekly PKT across income categories and Figure 78 in Appendix E.1.2 presents the change in share of long-term weekly PKT by LICO multiplier.



in e-biking were generally higher for those in households with incomes below 2x LICO, and reductions in automobile use were greater for those in households with incomes above 1x LICO, although the trends are not consistent across all LICO multiplier tiers for any mode.<sup>69</sup>

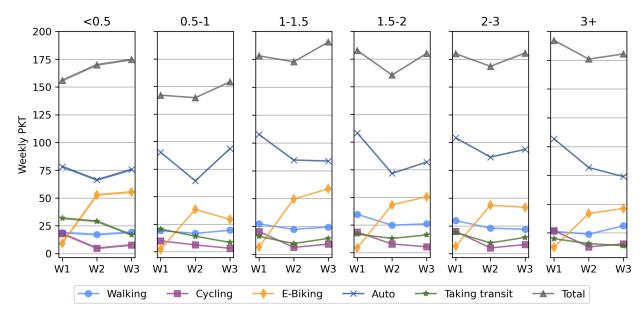


Figure 54. Average weekly PKT at each wave by LICO multiplier

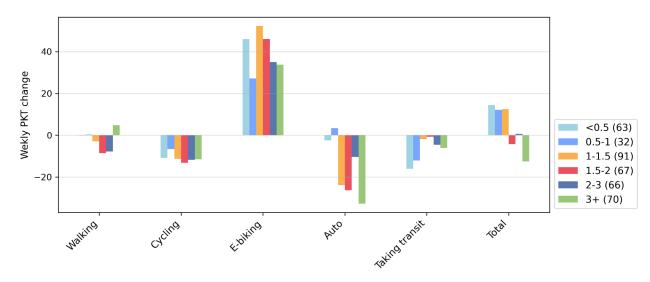


Figure 55. Average change in weekly PKT by mode between Waves 1 and 3, segmented by household LICO  $multiplier^{70}$ 

<sup>&</sup>lt;sup>69</sup> A study from the USA that examined the relationship between income and e-bike mode substitution found that while higher-income responders less frequently replaced automobile travel in general, the trend was not consistent across all income levels (Johnson et al., 2023).

<sup>70 &</sup>quot;Other" mode is omitted



Figure 56 presents the average PKT by mode at each of the three survey waves by satisfaction with household income. Persons from households with lower income satisfaction reported larger increases in e-biking. They also reported smaller pre-purchase automobile PKT and greater decreases in automobile travel, on average. Participants from households with the lowest income satisfaction also reduced their transit use by the largest amount.

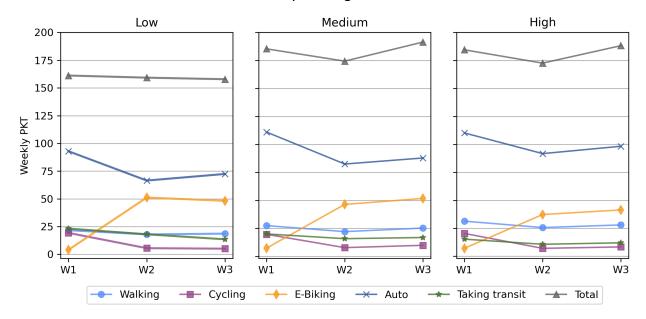


Figure 56. Average weekly PKT at each wave by satisfaction with household income<sup>70</sup>

Additional results on changes in weekly travel habits are presented in Appendix E.1.2. Non-men and non-white participants increased their weekly e-biking by a smaller amount than others, while seniors and people with disabilities or no college degree increased their weekly e-biking by a greater amount than others. Non-white participants and persons with disabilities or no college degree also decreased their automobile travel by a greater amount than others.

## 2.4.2.3 New Mobility and Access

This section examines the new mobility and access gained through e-bike adoption, by focussing on the e-bike trips that would not have been made without the e-bike purchase (i.e., those not substituting for other travel modes). On average, from 44 km/wk of e-bike use participants gained 5.8 km of new mobility, including 3.6 km/wk of new travel for exercise and 2.2 km/wk of new travel for access (utilitarian purposes). The mobility gains were greater for members of low-income households, persons with disabilities, seniors, and those living in rural areas, and smaller for non-man and non-white e-bike purchasers. People with disabilities experienced the largest net increase in mobility of 13 km/wk.



Table 40 summarizes how the new mobility varies with equity-related factors, separately for exercise/leisure and utilitarian travel. The table presents graphical indicators of whether certain population groups disproportionately gained new mobility. More detailed results are presented in Appendix E.1.3.

Table 40. Variation in new mobility and access for equity-related groups

	Net new mobility	Net new travel for exercise	Net new travel for access
Average for all recipients	5.8 km/wk	3.6 km/wk	2.2 km/wk
Low household income			*
Low satisfaction with household income	•	•	•
Non-man	*	*	•
Non-white	▼	<b>V</b>	•
Disability			•
No college	•	•	•
Seniors			*
Rural			•
Economic region <sup>1</sup> :			
Lower Mainland-Southwest	•	•	•
Vancouver Island and Coast	•	•	•
Southeast <sup>2</sup>		*	•

<sup>▲</sup> indicates more new net travel and ▼indicates less net new travel for these participants than for others; • indicates no significant difference in the amount of net new travel between these participants and others

On average, from 44 km/wk of e-bike use participants gained 5.8 km of new mobility, including 3.6 km/wk of new travel for exercise and 2.2 km/wk of new travel for access (utilitarian purposes). The mobility gains were greater for members of low-income households, persons with disabilities, seniors, and those living in rural areas, and smaller for non-man and non-white e-bike purchasers. People with disabilities experienced the largest net increase in mobility of 13 km/wk.

# 2.4.3 Affordability

Table 41 presents cost-related outcomes of rebate value, post-rebate e-bike cost, and post-purchase travel cost savings from e-bike use for the sample overall, along with graphical indicators for whether subgroups with certain equity-deserving attributes experienced disproportionately positive or negative impacts on affordability. Detailed results are provided in Appendix E.2. The travel cost savings are calculated using representative travel cost rates per PKT by mode, as described in Section 2.3.3.2 above. On average, participants received \$1,320 in rebates and paid an additional \$1,771 for the e-bike purchase. At Wave 1 (pre-purchase), the average cost of weekly travel was \$82.66, which reduced to \$73.59 at Wave 3 approximately a

<sup>\*</sup> Statistically significant differences at a 90% confidence level; other indicated differences at 95% confidence level

<sup>&</sup>lt;sup>1</sup> Regions with at least 10 participants

<sup>&</sup>lt;sup>2</sup> Thompson--Okanagan or Kootenay regions



year later, representing an overall reduction in travel costs of approximately 12%. Calculating travel cost savings due to mode substitution for each reported e-bike trip yields an average savings of \$2.53 per trip.

Table 41. Variation in affordability impacts for equity-related groups

	Rebate value	E-bike purchase cost <sup>1</sup>	Savings in weekly travel costs <sup>2</sup>	Travel cost savings per e- bike trip
Average for all recipients	\$1,320	\$1,771	-\$9.07	-\$2.53
Low household income	<b>A</b>		•	•
Low satisfaction with household income				•
Non-man	•	•	•	<b>V</b>
Non-white			•	•
Disability	•	•	•	•
No college	*		•	•
Senior	<b>V</b>	▼	•	▼
Rural	•	▼	•	•
Economic regions <sup>3</sup> :				
Lower Mainland-Southwest	•		•	•
Vancouver Island and Coast	•	•	•	*
Southeast <sup>4</sup>		<b>V</b>		_

<sup>▲</sup> Indicates greater benefit (larger rebate, lower cost, greater reduction in travel cost) and ▼indicates smaller benefit for these participants than for others; • indicates no significant difference in benefits between these participants and others

Participants from low-income households and with low household income satisfaction benefited from significantly larger rebates (a goal of the program design), leading to lower purchase costs. Non-white participants and those without a college degree also benefitted from larger rebates and lower purchase costs, whereas seniors received smaller rebates, and purchase costs were higher in rural areas (although rebate values were not smaller in rural areas). Participants with low income satisfaction gained greater weekly travel cost savings than others. Per-trip cost savings for non-men and seniors were smaller than others, because their e-bike trips displaced automobile use at lower rates.

Applying the average weekly travel cost reduction of \$9 per participant to all 4,943 distributed rebates and throughout the year, the program resulted in approximately \$2.3 million in annual travel cost savings for all participants combined, which extrapolates to \$11.7 million in savings over an assumed 5-year life span of an e-bike. These aggregate travel cost estimates are only indicative, and do not account for important factors such as seasonality and intra-modal variation

<sup>\*</sup> Statistically significant differences at a 90% confidence level; other indicated differences at 95% confidence level

<sup>&</sup>lt;sup>1</sup> Price paid by participants after rebate applied

<sup>&</sup>lt;sup>2</sup> Only available for those who completed survey wave 3

<sup>&</sup>lt;sup>3</sup> Regions with at least 10 participants

<sup>&</sup>lt;sup>4</sup> Thompson--Okanagan or Kootenay regions



in travel costs (between electric and gasoline automobile use, for example). A more detailed investigation of travel costs is outside the scope of this analysis, and an important direction for future work.

# 2.4.4 Physical Activity

Table 42 presents changes in physical activity during travel in terms of Marginal MET Minutes (MMM, see Section 2.3.3.3 above); detailed results are presented in Appendix E.3. On average, participants increased their total weekly physical activity during travel from 1,077 MMM prepurchase to 1,230 MMM approximately a year after purchase (from 670 to 752 MMM per 100 km), representing an increase of approximately 13%. Calculating physical activity from mode substitution for reported e-bike trips, each e-bike trip generated an average net increase of 84 MMM. Participants from households with low household income satisfaction experienced a significantly larger increase in physical activity levels, while non-men experienced a smaller increase. As with the travel cost estimates in the previous section, MMM calculations use fixed rates by mode and so neglect a range of factors that can moderate an individual's physical activity level during travel. These results are indicative of a general net increase in total physical activity during travel following e-bike adoption, but this is an area warranting further, detailed research and examination.

Table 42. Variation in physical activity during travel for equity-related groups

	Net change in weekly MMM after 1 year¹	Net change in MMM for each e-bike trip
Average for all recipients	+153	+84
Low household income	•	•
Low satisfaction with household income	<b>A</b>	•
Non-man	<b>*</b>	•
Non-white	•	•
Disability	•	•
No college	•	•
Senior	•	•
Rural	•	•
Economic regions <sup>2</sup> :		
Lower Mainland-Southwest	•	•
Vancouver Island and Coast	▼	•
Southeast <sup>3</sup>	•	*

<sup>▲</sup> Indicates a larger increase and ▼ indicates a smaller increase in MMM for these participants than for others; • indicates no significant difference in gained MMM between these participants and others

<sup>\*</sup> Statistically significant differences at a 90% confidence level; other indicated differences at 95% confidence level

<sup>&</sup>lt;sup>1</sup> Only available for those who completed survey wave 3

<sup>&</sup>lt;sup>2</sup> Regions with at least 10 participants

<sup>&</sup>lt;sup>3</sup> Thompson--Okanagan or Kootenay regions



# 2.4.5 Reflections on E-Bike Adoption

## 2.4.5.1 Summary of Comments and Topics

Study participants left a total of 709 comments across all three waves. After filtering based on inclusion criteria (see Section 2.3.4 above), 422 comments (59%) were included in the reflection-specific analysis; the number of unique participants who left a comment in any wave was 322.

Table 43 presents exemplar comments for each of the labelled topics, along with the total number and percentage<sup>71</sup> of comments including that topic, and average word count for those comments. Table 35 above identifies whether each topic was generally positive or negative. Most comments address more than one topic (an average of 1.9 topics per comment), as is reflected in the example comments. The most frequently mentioned topics are riding facilities, theft, parking facilities, and mode shift. Maintenance had the most average words per comment, while distance and enjoyment had the fewest.

In addition to these comments on the impacts of e-bike adoption, some participants left feedback on the BC rebate program design or administration. Many expressed general appreciation for the availability of the rebates or the execution of the program. Others raised issues including concerns that the program caused e-bike prices to rise, <sup>72</sup> difficulty covering the remaining purchase cost due to the minimum e-bike price, and a preference for rebate applicability to e-bike conversion kits.

<sup>&</sup>lt;sup>71</sup> Percentages do not sum to 100% because most comments included multiple topics.

<sup>&</sup>lt;sup>72</sup> Regarding the concern about an incomplete "pass-through effect" of the rebate program (i.e., the extent to which vendors captured the rebate value by raising prices), past research on a larger Swedish national e-bike rebate program found that price impacts of the rebates were negligible, and so purchasers received the full value of the rebates (A. Anderson et al., 2022). The relatively small number of BC rebates compared to total e-bike sales in the province makes complete rebate pass-through even more likely for the BC program. Finally, general consumer price inflation was high during the rebate program period, which is a more likely explanation for observed increases in e-bike prices.



Table 43. Topics in reflection comments and representative quotes

Topic	Number (%) of comments	Mean words	Example comments
Riding facilities	92 (22%)	29	"I would use my ebike MUCH more frequently if we had better infrastructure. There are far too many painted lanes where there's an assumption of safety but the reality is that just a rock can cause the rider to fall of a bike or swerve in to incoming traffic."
Theft	85 (20%)	26	"Ebikes are great and I'd highly recommend them to almost anyone. They are, however, nerve racking to park in quite a lot of the areas I might otherwise want to go with them. It's hard to run errands in downtown Vancouver without feeling like it will be stolen."
Enjoyment	67 (16%)	18	"The time spent riding to and from work has become a very important part of my day. Being outside, getting light exercise, and having a transition time by myself has been great for my mood and health."
Parking facilities	66 (16%)	22	"Love my ebike but have to be selective where I shop as most places do not have good secure bike parking. No infrastructure here for safely locking my bike up."
Utility	66 (16%)	22	"My wife mostly uses the ebike. I ride a conventional bike twice weekly if not raining. My wife used to bus 5 days/week to work, now she happily rides her ebike. I drive in 2 days/week to work"
Mode shift	64 (15%)	25	"I was thinking about getting an ebike just for fun but it seemed too extravagant. But then the rebate was announced and I decided to get a good ebike, and I love it! I work from home, but now I'm commuting my 2 yr old daughter to daycare and back every day on the bike (would have been driving my car) and it's great."
Roadway interactions	48 (11%)	29	"Drivers general attitude towards cyclists can be very scary at times. Many times when riding the shoulder of a road with no cycling provisions, drivers have intentionally driven close to cyclists to scare us off the road."
Weather	47 (11%)	28	"Weather is a bigger factor than I expected when it comes to choosing the e-bike over a conventional bike. The e-bike has become the preferred choice in extreme conditions of rain, wind, cold, heat and poor air quality."
Exertion	47 (11%)	23	"Due to how my body has been negatively affected during recovery from long covid having the e-bike has allowed me to be more active and participate in family biking outings with little pain and little aftereffects"
Health effects	36 (9%)	22	"E-bike changed my life. I bike everyday, down 100lbs since getting the e-bike. I can walk again without stick, honestly changed my whole life"
Co-riding	33 (8%)	25	"I can transport 2 kids on the ebike, so can travel longer distance and in shorter time than walking/stroller. We moved from Vancouver to Victoria and find having the ebike (combined with modo car share) means we still don't need to buy a car."
Size	33 (8%)	26	"It's not possible to take transit with our e-bike, because of its length and weight, so I can't combine their use for longer trips. It's also very very heavy, so it's difficult to pick it up for maneuvering in tight spots. It's more like a motorcycle than a bicycle.
New access	30 (7%)	20	"My e-bike has changed how I interact with my local community. Community facilities such as the outdoor pools and community centre in my neighbourhood are now within reach. My cycle time to work is significantly faster than driving or public transit."
Hills	28 (7%)	26	"We are living in a very hilly neighbourhood and haven't taken our conventional bikes out for 7 years because of all the hills. The e-bike makes such a difference! Game changer!"
Maintenance	23 (5%)	23	"The biggest obstacle is parts supply and maintenance cost. A ebike requires maintenance more than a regular bike A person with zero skills is most likely to abandon a ebike fearing the cost of a simple repair."
Distance	19 (5%)	18	"having the ebike has us going places and distances we would not have been able to ride."
Novelty	13 (3%)	24	"As I am an older rider and not a very experienced cycler, it might be helpful to be part of a small group with a leader to go through safety dos and don'ts when riding in traffic."
Travel costs	12 (3%)	20	"We take our child to school everyday on it. I commute to work every day on it. Both of those distances are struggles with conventional bike for us. It saves us so much time and money."



Figure 57 presents a correlation network diagram of which topics tend to be raised by the same person. Larger circles represent more frequently mentioned topics, and thicker lines connect topics that are more likely to be raised by the same person. The strongest correlation (0.50) occurs between **parking facilities and theft**: concerns about poor parking infrastructure are discussed in relation to concerns about theft, sometimes citing the high cost of e-bikes and their likelihood to be targeted for theft. These topics are also two of the four most mentioned ones overall (Table 43). Similarly, the next strongest correlation (0.44) is between **riding facilities and roadway interactions**, with a focus on drivers and motor vehicles. Concerns about riding infrastructure are discussed along with concerns about driver behaviour, particularly facility

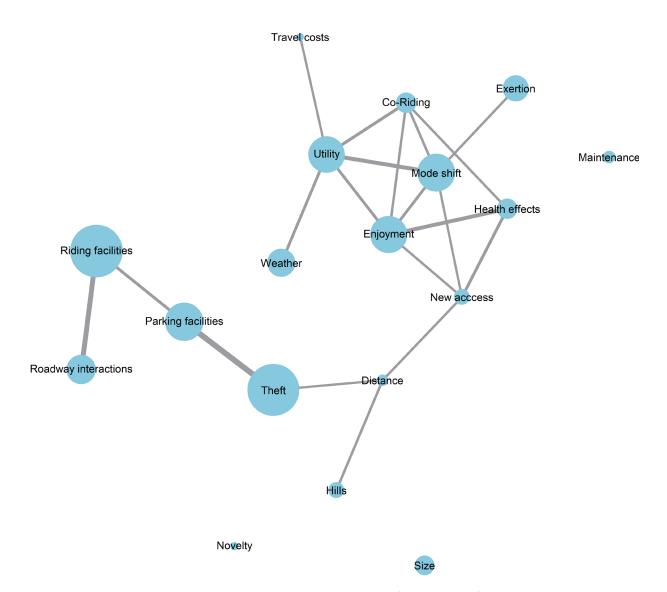


Figure 57. Correlations among topics addressed in each person's comments (lines indicate correlation coefficients >0.2; line thickness indicates correlation strength and circle size indicates overall topic frequency)



types that create cyclist vulnerability by exposing them to greater risk of being struck by a careless or aggressive motorist. There is also a smaller correlation (0.25) between parking and riding facilities.

After these two clusters of concerns about riding and parking facilities and their related risks, the next strongest correlations are among topics related to the benefits of e-bike use, particularly between **utility and mode shift** (0.36) and between **enjoyment and health effects** (0.35). Many comments about commuting or shopping with an e-bike also mentioned shifting away from another mode of travel for that trip (most commonly a motor vehicle). Mental and physical health benefits also tended to be mentioned together, sometimes with an explicit causal connection between them. In contrast, several topics tended to be mentioned as isolated concerns, including e-bike maintenance, size, and novelty.

## 2.4.5.2 Comment Topics from Different Groups

The figures in this section show how the shares of people mentioning each topic can vary with equity-related variables. Figure 58 gives the percentage of participants mentioning each topic within household income satisfaction tiers. Those with low income satisfaction disproportionately express concerns about theft and parking facilities, roadway interactions and riding facilities, and maintenance. They were also more likely to discuss utilitarian use, mode

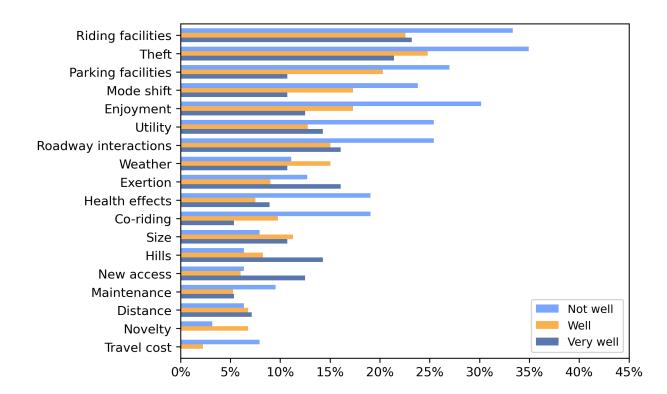


Figure 58. Topic mentions by household income satisfaction



shift, and co-riding, as well as enjoyment and health effects. In contrast, those with higher income satisfaction were more focussed on topography, e-bike size, and making new types of trips.

Figure 59 shows shares of seniors versus non-seniors mentioning each topic. Seniors are disproportionately focussed on riding facilities versus roadway interactions, but also more focussed on theft than parking facilities. Utilitarian use and mode shift are less discussed by seniors, whereas exertion, distance, hills, and health effects are greater focuses of concern. There are some similarities with the topic frequencies for people with physical disabilities versus those without, which also tend to focus on exertion, health, and topography (in even greater proportions), although in contrast to senior those with a disability were also more likely to mention enjoyment and new access (see Appendix E.4).

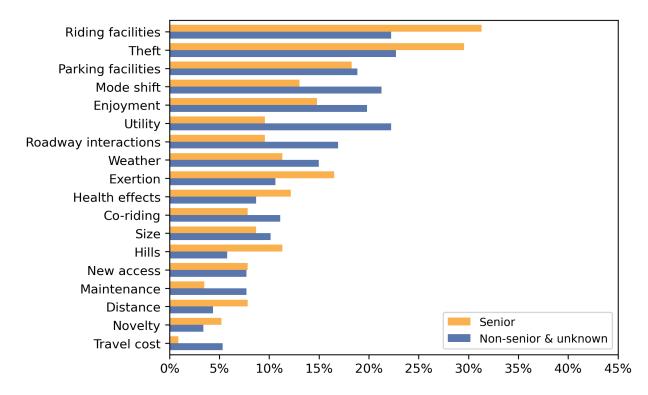


Figure 59. Topic mentions by age group

Figure 60 shows shares of people living in rural versus urban areas mentioning each topic. Theft, parking facilities, and roadway interactions stand out as disproportionately urban concerns, whereas exertion, weather, enjoyment, and riding facilities were a greater focus for rural respondents. The patterns were similar when comparing topic mentions by geographic area (see Appendix E.4).

Regarding other equity-related variables (see Appendix E.4), non-men were more likely to discuss co-riding and utilitarian e-bike use, enjoyment, and e-bike size, and non-white participants were more likely to mention theft, maintenance, and cost.



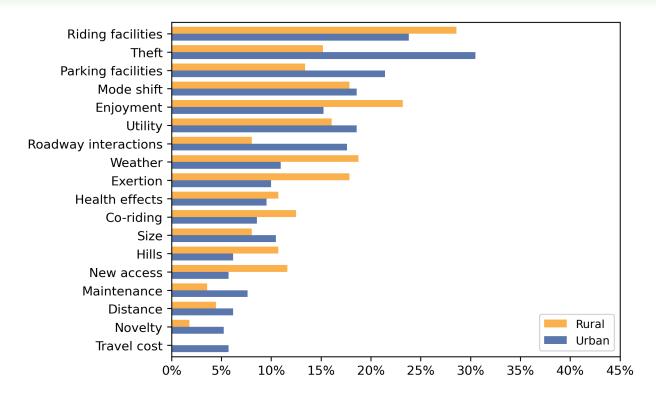


Figure 60. Topic mentions by rural/urban areas

## 2.4.5.3 Transformative Impacts

During manual review, some comments were flagged as describing particularly transformative life impacts as a result of the e-bike purchase and subsequent use. Select quotes from those comments are presented in Table 44 to illustrate the potential for new access to an e-bike (along with other supports) to lead to major impacts on people's lives. We believe these comments complement the rest of the results in this report, which focus on aggregate changes in travel behaviour and greenhouse gas emissions, by illuminating the more diverse impacts of the rebate program. More transformative impact comments are presented in Table 53 in Appendix E.4.

Comments on transformative impacts frequently described the benefits of greater options for those with limited travel capacity (due to poverty, infirmity, or other constraints). This includes individuals with limited access to a motor vehicle or inconsistent or nonexistent transit service. Others commented on substantial improvements in physical and mental health from use of the e-bike, as well as communities formed through shared enjoyment. The expressed health benefits ranged from chronic conditions to daily mood and general sense of well-being. Some also articulated the pivotal role the rebate played in enabling e-bike access that would not have been otherwise possible.



Table 44. Select comments on transformative impacts

Topic	Example comment
New access with physical disability	"Owning an ebike has had a huge impact on my daily quality of life. I have a physical disability which impacts my feet and it greatly reduces my ability to walk for any significant period of time. Previously I would have had to use my car to travel even short distances. Owning an ebike has allowed me to replace the majority of these short trips with cycling. It's been incredibly liberating for me and I really enjoy moving around my town by bicycle."
Enjoyment of commute	"I had planned to use the e-bike to commute to work, but have not been able to access it because my partner is using it to take kiddo to and from school. Kiddo suffers from severe school anxiety, and the bike ride to and from (on a trail-a-bike setup) is having tremendous mental health benefits. It's wonderful!"
Purchase cost	" I would have never been able to afford e-bike without the rebate, $$2000$ just not in this mums budget. So I'm forever grateful that I was lucky enough to get the rebate thank you."
Community	"I started up an activity group of women aged 47 to 75. It was the ebike that was the catalyst for doing this. I loved my bike but wasn't riding enough without having others to ride with but soon found like minded women. When I saw how enthusiastic the group was I decided to find other activities to ensure we'd still get out and exercise regardless of weather. We now hike, ebike, kayak, snowshoe, ski, Zumba, go to the climbing gym etc because our group has coalesced around being active. It took the bike to get us started and the group grew organically as we invited friends of friends to join in."

## 2.5 Conclusions: Part 2

# 2.5.1 Summary

## 2.5.1.1 User Impacts

Part 1 of this report examined the travel behaviour and associated greenhouse gas impacts of ebike adoption, which was the primary quantitative goal of the study. In Part 2 we characterized additional impacts on users through travel affordability and physical activity during travel, along with more qualitative dimensions of program impacts through analysis of open comments.

Regarding **affordability**, the rebates directly reduced e-bike purchase costs by 43% on average. We further find that e-bike adoption led to a net decrease in weekly travel costs of around 12% (including the costs of purchasing, maintaining, and fueling vehicles). The cost savings are largely through displacement of automobile use, and come despite an overall increase in weekly PKT (i.e., participants were spending less to travel more). These travel cost savings aggregate up to around \$2.3 million annually for all rebates distributed by program.



Despite the cost benefits, travel cost savings (besides the rebate itself) were not a primary focus of the participant reflections, which tended to focus more on other benefits such as mobility and health. To some extent, cost may be an implicit component in participant discussions of travel mode shift, which was a common topic. In addition, many travel costs such as motor vehicle maintenance are not salient for travellers (Andor et al., 2020; Gössling et al., 2022), and so adopters may not be aware of the extent of their travel cost savings.

We find that e-bike adoption led to a net increase in **travel-related physical activity**, averaging 13% based on the combined intensity and duration of activity. The large increase in e-biking (which occurs at a moderate intensity level) more than offset smaller reductions in walking and conventional cycling. Even those participants who reported using conventional bicycles at least once a week in the month before e-bike purchase still increased their total travel-related physical activity on average. While conventional cycling is a more vigorous activity than e-biking, individuals who acquired an e-bike tended to subsequently cycle more frequently and for longer durations, leading to an overall increase in physical activity. This finding is consistent with our previous study in Saanich (Bigazzi et al., 2025) and past research (Castro et al., 2019b; Sundfør and Fyhri, 2017), reaffirming the potential net physical activity benefits of wider adoption of motorized bicycles.

Benefits of e-bike adoption for mental and physical health also emerged as an important topic in the participant reflections. One in nine participants who left a comment reflected on improvements in their health, such as losing weight, improved physical mobility, increased exercise, and overall feeling happier. Many comments made an explicit connection between mental and physical health benefits, attributing enhanced mood and well-being to increased physical activity during travel (especially commuting). Post-adoption improvements in health state following e-bike adoption have also been reported elsewhere (C. C. Anderson et al., 2022; Jones et al., 2016).

Another important set of topics in the participant comments related to gaining new access and mobility, as well as shifting travel away from other, less desired modes. A key theme in the comments describing transformative impacts is that people struggling with general health-related physical limitations or those recovering from injuries benefited from increased mobility through the purchased e-bikes. As one participant said: "Freedom, flexibility, and independence is increased". Comments about commuting or shopping with an e-bike often also mentioned shifting away from another mode of travel for that trip (most commonly a motor vehicle). In addition to the travel utility of e-bike trips, participants mentioned benefits through reduced travel costs and enhanced social connections while riding with others. Consistent with some of the quantitative findings in Part 1 of this report, enjoyment was the most-mentioned benefit of e-bike adoption in the open text comments.



The most commonly mentioned topics overall, however focussed on barriers to cycling, primarily concerns about e-bike theft (and parking facilities), and concerns about the safety of available facilities for riding the e-bike (and interactions with other road users). These concerns about theft and traffic safety created not just anxiety for the participants, but were explicitly connected to limiting e-bike use (i.e., people claimed they would e-bike more if these issues were addressed). Unsafe riding facilities were often connected to general avoidance, whereas unsecure parking facilities were often connected with not using the e-bike for certain trips or in certain areas perceived to be riskier. Less commonly mentioned barriers were the challenges of e-bike maintenance and inclement weather (although some preferred the e-bike over a conventional bicycle in adverse weather conditions).

#### 2.5.1.2 Variations with income

Income is a commonly used indicator for equity analyses, but has the limitations of not reflecting wealth (financial capacity from existing assets) nor varying financial demands (due to factors such as household size or existing debts). Part 1 of this report examined travel behaviour relationships with household income; in Part 2, we examine two additional measures of financial capacity. The first is LICO-normalized household income (LICO multiplier), which sets a reference income to account for varying financial demand due to household size and geographic context. The second is a self-reported household income satisfaction measure, which reflects the perceived financial capacity of the participant's particular household situation. Although these two measures are positively related, there is wide variation in income satisfaction across all income levels (Figure 48 and Figure 49), reflecting nuanced financial situations.

We find some different results when comparing e-bike use based on LICO multiplier vs. household income satisfaction. For example, the share of commute trips is higher for high-income households, but also higher for those with lower income satisfaction. Similarly, both automobile mode substitution rates and long-term reduction in automobile use are higher in high-income households, and also higher for those with lower income satisfaction. These patterns could reflect high rates of automobile mode substitution in households that have insufficient but not necessarily low income: those with the means to do a large share of travel by automobile, but operating within financial constraints that make mode shift more attractive.

We find that the program benefits were equitably distributed with regard to household income using these measures. Rebate recipients in lower-income households or with lower household income satisfaction received larger rebates and paid less for their e-bikes. Due to the differences in automobile mode substitution noted above, those with low household income also had larger benefits through new mobility (for both exercise and access), while those with low income satisfaction had larger benefits through travel cost savings and increased physical activity during travel (largely driven by automobile mode substitution). Those with low income or income satisfaction were more likely to discuss enjoyment and health effects, although they also disproportionately express concerns about theft and riding facilities.



Regarding long-term changes in weekly travel behaviour, e-biking increased most for those in households with income below 2x LICO, while automobile use decreased most for those in households with income above 1x LICO. Hence, household income of 1x to 2x LICO appears to be a range that enhances program goals to both increase active travel and reduce automobile dependence. In contrast, both e-bike use and automobile displacement were high for those with moderate to low household income satisfaction. Targeting rebate recipients who have low income satisfaction would likely produce larger benefits, but constraining income (e.g., 1x to 2x LICO) would be more practical for rebate conditioning.

# 2.5.1.3 Variations with other demographics

Regarding the distribution of benefits for other equity-deserving groups, we find mixed results. E-bike purchase cost savings were greater for non-white recipients and those without a college degree, whereas the savings were smaller for seniors and those living in rural areas. Those with a disability, seniors, and living in rural areas experienced disproportional benefits through new mobility, while non-men and non-white purchasers had smaller benefits than others. Travel cost and physical activity benefits were mostly equally distributed with respect to equity-related factors other than income. Seniors expressed disproportionate concerns about riding facilities and theft, and theft was also an outsized focus of comments from those who were non-white, had a disability, or lived in urban areas.

The disproportionally high net increase in mobility for people with disabilities (averaging 13 km/week) is an important program outcome. According to a systematic review of 115 peer-reviewed studies by Park et al. (2023), the travel choices of persons with disabilities are often constrained by limited access to suitable transportation options, leading to 10% to 30% fewer trips than those without mobility challenges, particularly for non-commuting purposes. In this context, the substantial mobility gains observed among participants with disabilities represent a substantial equity benefit toward mobility justice.

## 2.5.2 Limitations

The estimation of indirect impacts of travel behaviour changes on travel costs and physical activity in this analysis relies on fixed cost and physical activity parameters by travel mode. This approach allows us to evaluate the aggregate impacts of travel mode substitution from e-bike adoption, but neglects a range of influencing factors that moderate travel costs and physical activity for individuals. The calculations also rely on the travel behaviour inputs, and so are subject to all of the uncertainty of travel surveys discussed in Part 1. As such, the results should be viewed as indicative of aggregate trends and applied with caution, recognizing that individual impacts can vary greatly. More detailed investigation of the cost and health impacts of e-bike adoption is left for other work. We were particularly struck at the lack of reliable cost parameters to quantify typical travel costs in BC or Canada, given the major role of transportation in household budgets.



Regarding equity, this analysis only examined the distribution of benefits across equity-related variables. We did not examine the effects of intersecting multiple factors, nor other types of equity or justice such as procedural, structural, or restorative. The analysis of open text comments allowed us to examine individual experiences in more detail than the rest of the closed-format survey, but the depth of exploration is limited given there was only one open-ended question.

## 2.5.3 Recommendations

In addition to the primary recommendations in the Part 1 report, the findings in Part 2 provide some additional insights to inform future implementations of e-bike purchase rebate programs. Firstly, the findings of substantial travel cost (-12%) and physical activity (+13%) net benefits further strengthens the case for e-bike rebates to advance goals related to affordability and health, in addition to climate mitigation. While not as easily quantified, enjoyment and well-being are an additional important benefit and likely motivator of continued e-bike use, which participants connected to increased physical activity and reduced automobile dependence. As shown in some of the comments, e-bike adoption can be part of a transformative life change that goes beyond the utilitarian benefits of a new travel mode option typically quantified in transportation analyses (i.e., reduced travel time or cost). Future evaluations of the case for e-bike rebates should endeavor to weigh these benefits along with the climate impacts against the financial costs of the program.

While e-bike rebates are effective in generating new e-bike use and automobile mode shift, there are persistent perceived barriers limiting use, particularly concerns about theft (especially in urban areas) and poor riding facilities (especially in rural areas). Rebates cannot be the full extent of efforts to facilitate e-bike adoption, as continued effort is also required to improve cycling networks and mitigate bike theft (which will also enhance use of non-incentivized e-bikes and conventional bicycles).

This analysis revealed that the relationship between income and e-bike use is complex, and should not be simplified to a linear trend. The twin objectives of increased e-bike use and decreased automobile use were most realized by households with moderate or low satisfaction with income – but not necessarily low-income households (which had lower rates of automobile substitution). Future analysis and program designs must consider what measure of income best reflects the financial capacity they wish to capture.

In Part 1 of this report we recommended changing to a household-based income criterion. We extend that recommendation to set LICO-based thresholds, because LICO accounts for household size and geographic context, reflecting more of the balance between income and expenses. We believe a threshold of around 2x LICO will prioritize income-constrained households (advancing affordability, equity, and rebate effectiveness) while also capturing households with the potential



for substantial automobile mode substitution (and related benefits for affordability, health, and climate).

Regarding other potential qualifying criteria, we find that those living in non-urban areas had higher purchase costs but disproportionately large internal and external benefits from e-bike adoption, likely because they were living in the most auto-dependent areas. Hence, we recommend continuing to offer the rebates province-wide, and considering geographic distribution if revising the allocation method to a lottery-based system as recommended in Part 1 of this report.



# References

- Ainsworth, B.E., Haskell, W.L., Herrmann, S.D., Meckes, N., Bassett, D.R., Tudor-Locke, C., Greer, J.L., Vezina, J., Whitt-Glover, M.C., Leon, A.S., 2011. 2011 compendium of physical activities: a second update of codes and MET values. Medicine and Science in Sports and Exercise 43, 1575–1581.
- Allen, J., Farber, S., 2019. Sizing up transport poverty: A national scale accounting of low-income households suffering from inaccessibility in Canada, and what to do about it. Transport Policy 74, 214–223. https://doi.org/10.1016/j.tranpol.2018.11.018
- Anderson, A., Hong, H., 2022. Welfare Implications of Electric-Bike Subsidies: Evidence from Sweden (No. w29913). National Bureau of Economic Research. https://doi.org/10.3386/w29913
- Anderson, A., Hong, H., Jacobs, E., 2022. Are E-Bike Subsidies Cost Effective in Mitigating Carbon Emissions? (Working Paper No. 29913), Working Paper Series. National Bureau of Economic Research. https://doi.org/10.3386/w29913
- Anderson, C.C., Clarkson, D.E., Howie, V.A., Withyman, C.J., Vandelanotte, C., 2022. Health and well-being benefits of e-bike commuting for inactive, overweight people living in regional Australia. Health Promot J Austr 33, 349–357. https://doi.org/10.1002/hpja.590
- Andersson, A., Adell, E., Hiselius, L.W., 2021. What is the substitution effect of e-bikes? A randomised controlled trial. Transportation Research Part D: Transport and Environment 90, 102648. https://doi.org/10.1016/j.trd.2020.102648
- Andor, M.A., Gerster, A., Gillingham, K.T., Horvath, M., 2020. Running a car costs much more than people think stalling the uptake of green travel. Nature 580, 453–455. https://doi.org/10.1038/d41586-020-01118-w
- Aono, S., Bigazzi, A.Y., 2019. Industry Stakeholder Perspectives on the Adoption of Electric Bicycles in British Columbia. Transportation Research Record: Journal of the Transportation Research Board 2673, 1–11. https://doi.org/10.1177/0361198119837158
- Aono, S., Bigazzi, A.Y., Berjisian, E., 2019. Development of an Electric Bicycle Incentive Program for Victoria. (Prepared for City of Victoria). University of British Columbia.
- Arning, L., Kaths, H., 2025. Further, steeper, greener: Implications from an electric bicycle mode choice model. International Journal of Sustainable Transportation 0, 1–16. https://doi.org/10.1080/15568318.2025.2533307
- Azarafshar, R., Vermeulen, W.N., 2020. Electric vehicle incentive policies in Canadian provinces. Energy Economics 91, 104902. https://doi.org/10.1016/j.eneco.2020.104902
- Bigazzi, A., 2025. A consequential framework to quantify the climate impacts of passenger travel. Environment and Planning B 23998083251325925. https://doi.org/10.1177/23998083251325925
- Bigazzi, A., Berjisian, E., 2021. Modeling the impacts of electric bicycle purchase incentive program designs. Transportation Planning and Technology 44, 679–694. https://doi.org/10.1080/03081060.2021.1956806



- Bigazzi, A., Frank, L., Dummer, T., Berjisian, E., White, K., 2024a. Transportation Emissions Estimates for Integrated Environment-Health Modelling (Final Report), Prepared for TransLink. University of British Columbia, Vancouver, BC, Canada.
- Bigazzi, A., Hassanpour, A., Bardutz, E., 2025. Travel behaviour and greenhouse gas impacts of income-conditioned e-bike purchase incentives. Transportation Research Part D: Transport and Environment 138, 104519. https://doi.org/10.1016/j.trd.2024.104519
- Bigazzi, A., Hassanpour, A., Bardutz, E., 2024b. Travel Behaviour and Greenhouse Gas Impacts of the Saanich E-Bike Incentive Program Final Report. Prepared for District of Saanich.
- Bigazzi, A., Wong, K., 2020. Electric bicycle mode substitution for driving, public transit, conventional cycling, and walking. Transportation Research Part D: Transport and Environment 85, 102412. https://doi.org/10.1016/j.trd.2020.102412
- Bigazzi, A.Y., Berjisian, E., 2019. Electric bicycles: Can they reduce driving and emissions in Canada? Plan Canada Fall 2019, 39–42.
- Bjørnarå, H.B., Berntsen, S., Velde, S.J. te, Fyhri, A., Deforche, B., Andersen, L.B., Bere, E., 2019. From cars to bikes The effect of an intervention providing access to different bike types: A randomized controlled trial. PLOS ONE 14, e0219304. https://doi.org/10.1371/journal.pone.0219304
- Bourne, J.E., Sauchelli, S., Perry, R., Page, A., Leary, S., England, C., Cooper, A.R., 2018. Health benefits of electrically-assisted cycling: a systematic review. International Journal of Behavioral Nutrition and Physical Activity 15, 116. https://doi.org/10.1186/s12966-018-0751-8
- Brooks, M.E., Kristensen, K., Benthem, K.J. van, Magnusson, A., Berg, C.W., Nielsen, A., Skaug, H.J., Mächler, M., Bolker, B.M., 2017. glmmTMB Balances Speed and Flexibility Among Packages for Zero-inflated Generalized Linear Mixed Modeling. The R Journal 9, 378–400.
- Bucher, D., Buffat, R., Froemelt, A., Raubal, M., 2019. Energy and greenhouse gas emission reduction potentials resulting from different commuter electric bicycle adoption scenarios in Switzerland. Renewable and Sustainable Energy Reviews 114, 109298. https://doi.org/10.1016/j.rser.2019.109298
- Cairns, S., Behrendt, F., Raffo, D., Beaumont, C., Kiefer, C., 2017. Electrically-assisted bikes: Potential impacts on travel behaviour. Transportation Research Part A: Policy and Practice 103, 327–342. https://doi.org/10.1016/j.tra.2017.03.007
- CarbonCredits.com, 2024. Carbon Prices Today. Carbon Credits. URL https://carboncredits.com/carbon-prices-today/
- Castro, A., Gaupp-Berghausen, M., Dons, E., Standaert, A., Laeremans, M., Clark, A., Anaya-Boig, E., Cole-Hunter, T., Avila-Palencia, I., Rojas-Rueda, D., Nieuwenhuijsen, M., Gerike, R., Panis, L.I., de Nazelle, A., Brand, C., Raser, E., Kahlmeier, S., Götschi, T., 2019a. 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, 100017. https://doi.org/10.1016/j.trip.2019.100017
- Castro, A., Gaupp-Berghausen, M., Dons, E., Standaert, A., Laeremans, M., Clark, A., Anaya-Boig, E., Cole-Hunter, T., Avila-Palencia, I., Rojas-Rueda, D., Nieuwenhuijsen, M., Gerike, R.,



- Panis, L.I., de Nazelle, A., Brand, C., Raser, E., Kahlmeier, S., Götschi, T., 2019b. 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, 100017. https://doi.org/10.1016/j.trip.2019.100017
- Chandra, A., Gulati, S., Kandlikar, M., 2010. Green drivers or free riders? An analysis of tax rebates for hybrid vehicles. Journal of Environmental Economics and Management 60, 78–93. https://doi.org/10.1016/j.jeem.2010.04.003
- City and County of Denver, People for Bikes, Bicycle Colorado, Ride Report, Rocky Mountain Institute, 2022. Denver's 2022 Ebike Incentive Program: Results and Recommendations. Denver, USA.
- Csardi, G., Nepusz, T., 2006. The igraph software package for complex network research. InterJournal Complex Systems, 1695.
- de Freitas, L.M., Bekhor, S., Axhausen, K.W., 2025. Mode-choice modelling of a sustainable mobility transition considering different bicycle types. Transportation Research Part A: Policy and Practice 200, 104628. https://doi.org/10.1016/j.tra.2025.104628
- de Kruijf, J., Ettema, D., Kamphuis, C.B.M., Dijst, M., 2018. Evaluation of an incentive program to stimulate the shift from car commuting to e-cycling in the Netherlands. Journal of Transport & Health 10, 74–83. https://doi.org/10.1016/j.jth.2018.06.003
- de Kruijf, J., van Lierop, D., Ettema, D., Kroesen, M., Dijst, M., 2024. E-cycling intention versus behavioral change: Investigating longitudinal changes in e-cycling intention and actual behavior change in daily commuting. Journal of Cycling and Micromobility Research 2, 100009. https://doi.org/10.1016/j.jcmr.2023.100009
- de Nazelle, A., Nieuwenhuijsen, M., 2009. Integrated health impact assessment of cycling. British Medical Journal.
- Dekker, P., 2013. Electrification of road transport—An analysis of the economic performance of electric two-wheelers (Master's Thesis). Utrecht University, The Netherlands.
- Delucchi, M.A., 2000. Environmental Externalities of Motor-Vehicle Use in the US. Journal of Transport Economics and Policy 34, 135–168.
- Douma, J.C., Weedon, J.T., 2019. Analysing continuous proportions in ecology and evolution: A practical introduction to beta and Dirichlet regression. Methods in Ecology and Evolution 10, 1412–1430. https://doi.org/10.1111/2041-210X.13234
- Elder, S.J., Roberts, S.B., 2007. The Effects of Exercise on Food Intake and Body Fatness: a Summary of Published Studies. Nutrition Reviews 65, 1–19. https://doi.org/10.1111/j.1753-4887.2007.tb00263.x
- Environment and Climate Change Canada, 2023. Social Cost of Greenhouse Gas Estimates Interim Updated Guidance for the Government of Canada. Government of Canada, Ottawa, Ontario, Canada.
- Fishman, E., Cherry, C., 2016. E-bikes in the mainstream: Reviewing a decade of research. Transport Reviews 36, 72–91. https://doi.org/10.1080/01441647.2015.1069907
- Fitch, D.T., Gao, Z., Noble, L., Mac, T., Mineta Transportation Institute, San Jose State University. College of Business, 2022. Examining the Effects of a Bike and E-bike Lending Program on Commuting Behavior (No. 22–07). https://doi.org/10.31979/mti.2022.2051



- Frank, L.D., Bigazzi, A., Hong, A., Minaker, L., Fisher, P., Raine, K.D., 2022. Built environment influences on healthy eating and active living: The NEWPATH study. Obesity 30, 424–434. https://doi.org/10.1002/oby.23352
- Fyhri, A., Fearnley, N., 2015. Effects of e-bikes on bicycle use and mode share. Transportation Research Part D: Transport and Environment 36, 45–52. https://doi.org/10.1016/j.trd.2015.02.005
- Geller, R., 2006. Four Types of Cyclist. Portland Bureau of Transportation.
- GeoBC, 2024. Gridded CDED format DEM (25 m course resolution). https://www2.gov.bc.ca/gov/content/data/geographic-data-services/topographic-data/elevation#getDEM
- Gillingham, K., Stock, J.H., 2018. The Cost of Reducing Greenhouse Gas Emissions. Journal of Economic Perspectives 32, 53–72. https://doi.org/10.1257/jep.32.4.53
- Goins, K.V., Salcedo, A., Mook, G., Lemon, S., 2025. Potential for Increasing Physical Activity through an e-Bike Pilot Program to Reduce Greenhouse Gas Emissions. Journal of Healthy Eating and Active Living 5, 64–75. https://doi.org/10.51250/jheal.v5i1.95
- Gojanovic, B., Welker, J., Iglesias, K., Daucourt, C., Gremion, G., 2011. Electric Bicycles as a New Active Transportation Modality to Promote Health. Medicine & Science in Sports & exercise: Official Journal of the American College of Sports Medicine 43, 2204–2210.
- Gössling, S., Kees, J., Litman, T., 2022. The lifetime cost of driving a car. Ecological Economics 194, 107335. https://doi.org/10.1016/j.ecolecon.2021.107335
- Government of Canada, S.C., 2022. Population counts, population centre size groups and rural areas [WWW Document]. URL https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=9810000801 (accessed 7.30.25).
- Government of Canada, S.C., 2016. Low income cut-offs (LICOs) before and after tax by community size and family size, in current dollars [WWW Document]. URL https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1110024101 (accessed 7.29.25).
- Government of Canada, S.C., 2013. Economic Regions SGC 2006 59 British Columbia [WWW Document]. URL https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=131938&CVD=1388 62&CPV=59&CST=01012006&CLV=1&MLV=4 (accessed 7.15.25).
- Government of Canada, S.C., 2011. Urban and rural areas "Urban" versus "rural" variant 8.1 Urban [WWW Document]. URL https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=113331&CVD=113332&CPV=8.1&CST=01010001&CLV=1&MLV=2&adm=0&dis=0 (accessed 7.25.25).
- Grabow, M., Hahn, M., Whited, M., 2010. Valuing Bicycling's Economic and Health Impacts in Wisconsin.
- Greene, W.H., 2008. Econometric Analysis. Pearson/Prentice Hall.
- Groenwold, R.H.H., White, I.R., Donders, A.R.T., Carpenter, J.R., Altman, D.G., Moons, K.G.M., 2012. Missing covariate data in clinical research: when and when not to use the missing-indicator method for analysis. CMAJ 184, 1265–1269. https://doi.org/10.1503/cmaj.110977



- Harris, C.R., Millman, K.J., van der Walt, S.J., Gommers, R., Virtanen, P., Cournapeau, D., Wieser, E., Taylor, J., Berg, S., Smith, N.J., Kern, R., Picus, M., Hoyer, S., van Kerkwijk, M.H., Brett, M., Haldane, A., del Río, J.F., Wiebe, M., Peterson, P., Gérard-Marchant, P., Sheppard, K., Reddy, T., Weckesser, W., Abbasi, H., Gohlke, C., Oliphant, T.E., 2020. Array programming with NumPy. Nature 585, 357–362. https://doi.org/10.1038/s41586-020-2649-2
- Hassanpour, A., Bigazzi, A., 2024. Four-Year Trends of Personal Mobility Devices in Metropolitan Vancouver: The Evolution of Mode Shares, Speeds, and Comfort in Off-Street Paths. https://doi.org/10.2139/ssrn.5056565
- Hiselius, L.W., 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
- Huang, B. (Amelia), Wüst, H., de Haas, M., 2024. Assessing the E-bike trends and impact on sustainable mobility: A national-level study in the Netherlands. Journal of Cycling and Micromobility Research 2, 100027. https://doi.org/10.1016/j.jcmr.2024.100027
- Hunter, J.D., 2007. Matplotlib: A 2D Graphics Environment. Computing in Science & Engineering 9, 90–95. https://doi.org/10.1109/MCSE.2007.55
- Hyams, K., Fawcett, T., 2013. The ethics of carbon offsetting. WIREs Climate Change 4, 91–98. https://doi.org/10.1002/wcc.207
- Johnson, N., Fitch-Polse, D.T., Handy, S.L., 2023. Impacts of e-bike ownership on travel behavior: Evidence from three northern California rebate programs. Transport Policy 140, 163–174. https://doi.org/10.1016/j.tranpol.2023.06.014
- Jones, L.R., Bennett, C., MacArthur, J.H., Cherry, C.R., 2024. Consumer Purchase Response to E-bike Incentives: Results from Nationwide Stated Preference Study. Transportation Research Part D: Transport and Environment Forthcoming.
- Jones, M.P., 1996. Indicator and Stratification Methods for Missing Explanatory Variables in Multiple Linear Regression. Journal of the American Statistical Association 91, 222–230. https://doi.org/10.1080/01621459.1996.10476680
- Jones, T., Harms, L., Heinen, E., 2016. Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility. Journal of Transport Geography 53, 41–49. https://doi.org/10.1016/j.jtrangeo.2016.04.006
- Jordahl, K., Van den Bossche, J., Fleischmann, M., Wasserman, J., McBride, J., Gerard, J., Leblanc, F., 2020. geopandas/geopandas: v0.8.1 (Version v0.8.1). Zenodo.
- Kalibrate, 2025. Petroleum price data.
- Kok, R., Annema, J.A., van Wee, B., 2011. Cost-effectiveness of greenhouse gas mitigation in transport: A review of methodological approaches and their impact. Energy Policy, Clean Cooking Fuels and Technologies in Developing Economies 39, 7776–7793. https://doi.org/10.1016/j.enpol.2011.09.023
- Litman, T., 2022. Transportation Cost Estimates. A summary of the costs to users and communities of various travel modes.
- Lumley, T., 2019. survey: analysis of complex survey samples.



- MacArthur, J., Harpool, M., Scheppke, D., Cherry, C., 2018a. A North American Survey of Electric Bicycle Owners (No. NITC-RR-1041). National Institute for Transportation and Communities, Portland, Oregon.
- MacArthur, J., Harpool, M., Scheppke, D., Cherry, C., 2018b. A North American Survey of Electric Bicycle Owners. TREC Final Reports. https://doi.org/10.15760/trec.197
- MacArthur, J., Kobel, N., Dill, J., Mumuni, Z., 2017. Evaluation of an Electric Bike Pilot Project at Three Employment Campuses in Portland, Oregon.
- Mageau-Béland, J., Morency, C., 2021. Assessing Physical Activity Achievement by using Transit. Transportation Research Record 2675, 506–514. https://doi.org/10.1177/0361198121999057
- Maier, M., 2014. DirichletReg: Dirichlet Regression for Compositional Data in R. DirichletReg: Dirichlet Regression for Compositional Data in R, Research Report Series / Department of Statistics and Mathematics. https://doi.org/10.57938/ad3142d3-2fcd-4c37-aec6-8e0bd7d077e1
- Marincek, D., Rérat, P., 2021. From conventional to electrically-assisted cycling. A biographical approach to the adoption of the e-bike. International Journal of Sustainable Transportation 15, 768–777. https://doi.org/10.1080/15568318.2020.1799119
- Mason, J., Fulton, L., McDonald, Z., 2015. A Global High Shift Cycling Scenario: The Potential for Dramatically Increasing Bicycle and E-bike Use in Cities Around the World, with Estimated Energy, CO2, and Cost Impacts. Institute for Transportation & Development Policy, Davis, California.
- McQueen, M., MacArthur, J., Cherry, C., 2020. The E-Bike Potential: Estimating regional e-bike impacts on greenhouse gas emissions. Transportation Research Part D: Transport and Environment 87, 102482. https://doi.org/10.1016/j.trd.2020.102482
- McQueen, M., MacArthur, J., Cherry, C., 2019. How e-bike incentive programs are used to expand the market (White Paper). Transportation Research and Education Center, Portland, Oregon.
- Meister, A., Felder, M., Schmid, B., Axhausen, K.W., 2023. Route choice modeling for cyclists on urban networks. Transportation Research Part A: Policy and Practice 173, 103723. https://doi.org/10.1016/j.tra.2023.103723
- Mildestvedt, T., Hovland, O., Berntsen, S., Bere, E., Fegran, L., 2020. Getting Physically Active by E-Bike: An Active Commuting Intervention Study. Physical Activity and Health 4, 120–129. https://doi.org/10.5334/paah.63
- Ministry of Environment and Climate Change Strategy, 2024. British Columbia's Carbon Tax. Province of British Columbia, Victoria, Canada.
- Mueller, N., Rojas-Rueda, D., Cole-Hunter, T., de Nazelle, A., Dons, E., Gerike, R., Götschi, T., Int Panis, L., Kahlmeier, S., Nieuwenhuijsen, M., 2015. Health impact assessment of active transportation: A systematic review. Preventive Medicine 76, 103–114. https://doi.org/10.1016/j.ypmed.2015.04.010
- Nosratzadeh, H., Bhowmick, D., Carmona, A.B.R., Pearson, L., Thompson, J., Thai, T., Beck, B., 2025a. Implementing without evaluating: The missing link in understanding the effectiveness of financial incentive programs for e-bikes. Cities 156, 105528. https://doi.org/10.1016/j.cities.2024.105528



- Nosratzadeh, H., Bhowmick, D., Carmona, A.B.R., Thompson, J., Thai, T., Pearson, L., Beck, B., 2025b. A scoping review of the design and characteristics of e-bike financial incentives. Transport Reviews.
- Nuzzo, R., 2014. Scientific method: Statistical errors. Nature 506, 150–152. https://doi.org/10.1038/506150a
- OpenStreetMap contributors, 2015. Planet dump.
- Park, K., Esfahani, H.N., Novack, V.L., Sheen, J., Hadayeghi, H., Song, Z., Christensen, K., 2023. Impacts of disability on daily travel behaviour: A systematic review. Transport Reviews 43, 178–203. https://doi.org/10.1080/01441647.2022.2060371
- Pierce, J.M.T., Nash, A.B., Clouter, C.A., 2013. The in-use annual energy and carbon saving by switching from a car to an electric bicycle in an urban UK general medical practice: the implication for NHS commuters. Environ Dev Sustain 15, 1645–1651. https://doi.org/10.1007/s10668-013-9454-0
- Plazier, P.A., Weitkamp, G., van den Berg, A.E., 2017. "Cycling was never so easy!" An analysis of e-bike commuters' motives, travel behaviour and experiences using GPS-tracking and interviews. Journal of Transport Geography 65, 25–34. https://doi.org/10.1016/j.jtrangeo.2017.09.017
- Polikakhina, P., Bigazzi, A., Hassanpour, A., 2025. Who Are the Marginal Purchasers? Examining Induced Adoption from Income-Conditioned E-Bike Rebates in British Columbia, Canada. Presented at the 104th Annual Meeting of the Transportation Research Board, Washington, D.C.
- Probst, B., Toetzke, M., Kontoleon, A., Diaz Anadon, L., Hoffmann, V.H., 2023. Systematic review of the actual emissions reductions of carbon offset projects across all major sectors (Working Paper). ETH Zurich. https://doi.org/10.3929/ethz-b-000620307
- R Core Team, 2025a. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing.
- R Core Team, 2025b. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.
- Ranganathan, P., Hunsberger, S., 2024. Handling missing data in research. Perspect Clin Res 15, 99–101. https://doi.org/10.4103/picr.picr\_38\_24
- Rojas-Rueda, D., de Nazelle, A., Teixidó, O., Nieuwenhuijsen, MJ., 2013. Health impact assessment of increasing public transport and cycling use in Barcelona: A morbidity and burden of disease approach. Preventive Medicine. https://doi.org/10.1016/j.ypmed.2013.07.021
- Saanich Sustainability Division, 2024. Saanich Community E-Bike Incentive Pilot Program. Final Report.
- Statistics Canada, 2023. Spatial Access Measure.
- Statistics Canada, 2022a. 2021 Census Profile. Ottawa, Ontario, Canada.
- Statistics Canada, 2022b. The Canadian Bikeway Comfort and Safety metrics (Can-BICS):

  National measures of the bicycling environment for use in research and policy.

  https://www.doi.org/10.25318/82-003-x202201000001-eng



- Sun, Q., Feng, T., Kemperman, A., Spahn, A., 2020. Modal shift implications of e-bike use in the Netherlands: Moving towards sustainability? Transportation Research Part D: Transport and Environment 78, 102202. https://doi.org/10.1016/j.trd.2019.102202
- Sundfør, H.B., Fyhri, A., 2022. The effects of a subvention scheme for e-bikes on mode share and active mobility. Journal of Transport & Health 26, 101403. https://doi.org/10.1016/j.jth.2022.101403
- Sundfør, H.B., Fyhri, A., 2017. A push for public health: the effect of e-bikes on physical activity levels. BMC Public Health 17. https://doi.org/10.1186/s12889-017-4817-3
- The pandas development team, 2022. pandas-dev/pandas: Pandas. https://doi.org/10.5281/zenodo.7093122
- Tian, X., Waygood, E.O.D., An, C., Chen, Z., Peng, H., 2023. Achieving urban net-zero targets through regionalized electric bus penetration and energy transition. Transportation Research Part D: Transport and Environment 120, 103797. https://doi.org/10.1016/j.trd.2023.103797
- Ton, D., Duives, D., 2021. Understanding long-term changes in commuter mode use of a pilot featuring free e-bike trials. Transport Policy 105, 134–144. https://doi.org/10.1016/j.tranpol.2021.03.010
- Wang, T., Hamann, A., Spittlehouse, D., Carroll, C., 2016. Locally Downscaled and Spatially Customizable Climate Data for Historical and Future Periods for North America. PLoS ONE 11, e0156720. https://doi.org/10.1371/journal.pone.0156720
- Wasserstein, R.L., Lazar, N.A., 2016. The ASA's statement on p-values: context, process, and purpose. The American Statistician 00–00. https://doi.org/10.1080/00031305.2016.1154108
- Wild, K., Woodward, A., Shaw, C., 2021. Gender and the E-bike: Exploring the Role of Electric Bikes in Increasing Women's Access to Cycling and Physical Activity. Active Travel Studies. https://doi.org/10.16997/ats.991
- Williams, T., Sones, M., Poirier Stephens, Z., Fischer, J., Barr, V., Winters, M., 2023. Practices and Inspiration for Sustainable Transportation Equity. Case studies from Canadian cities. Interventions, Equity, Research, and Action in Cities Team.
- Wolf, A., Seebauer, S., 2014. Technology adoption of electric bicycles: A survey among early adopters. Transportation Research Part A: Policy and Practice 69, 196–211. https://doi.org/10.1016/j.tra.2014.08.007



# **Appendix**



# Appendix A. Recruitment Text

The following text was included on the rebate application form to facilitate study recruitment. "A UBC (University of British Columbia) team led by Dr. Alex Bigazzi is conducting research on ebike purchase rebates. UBC would like to send you information about the study by email. This will not obligate you to participate in the study, and no other information about you will be shared with the research team. Participation in the study will not affect whether you receive a purchase incentive through this program. Do you agree to share your email address with UBC? [I agree; I do not agree]"

Appendix B. Survey Instrument

Appendix B.1. Wave 1 Questionnaire

Section 1: Consent form

## **Effects of Bicycle Purchases on Travel Behaviour over Time**

## **Research Team & Study Purpose**

Thank you for considering participation in this study. The study is being conducted by Dr. Alex Bigazzi and the Research on Active Transportation (REACT) Lab at the University of British Columbia (UBC), in collaboration with researchers at Simon Fraser University and University of Toronto. We are investigating the effects of bicycle purchases on travel behaviour over time. We seek study participants from the province of British Columbia who are considering purchasing or have recently purchased or acquired an electric bicycle and are at least 19 years of age. The study findings will help to inform programs and policies that facilitate bicycle adoption and promote sustainable transportation.

## **Survey Details**

To measure long-term effects, we are using a three-part study design. In Part 1 (this survey), you will be asked to provide information about your travel habits, your household, any recent bicycle purchase you have made, and your most recent 2 trips made using that bicycle. Then, at the end of the survey, you will be asked if you agree to be contacted in 3 months to participate in Part 2 of this study, which is a follow-up survey about changes to your travel habits and bicycle ownership. Part 3 of the study will be a similar follow-up survey after 12 months.

Each of the three surveys should take around 10 minutes to complete. Participation is voluntary, and you can withdraw at any time. You may complete this survey and decline to be contacted or participate in Part 2 or Part 3. Study data will be encrypted and your responses will remain confidential. No personally identifying information will be included when the study findings are presented or published.



#### Draw for Ten \$25 Gift Cards

You may enter a draw for one of ten \$25 gift cards and/or request to have the final study results sent to you by entering your email address below. Your email address will not be shared or used for any other purpose. Everyone who takes the survey and enters their email address will be considered in the prize draw (even those who withdraw or do not answer every question). Your chance of receiving a gift card is approximately 1 in 500; all gift cards will be distributed in British Columbia.

#### **Contact Information**

If you have any questions about this study, or if you have accessibility needs to take the survey, including in another language, please email react.lab@ubc.ca. If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at 604-822-8598 or email RSIL@ors.ubc.ca or call toll free at 1-877-822-8598 (ethics ID: H21-02361).

Click on "I agree" below to indicate your consent to participate in this survey and proceed.

- I agree
- I disagree

[Skip to end of survey if selected "I disagree"]

Do you want to enter the draw for a gift card and/or hear about the results of the study? Check all that apply.

- I want to enter the draw for a gift card
- I want to hear about the results of this study
- I do not want to enter the draw for a gift card or hear about the results

[Display this question if did not select "I do not want to enter the draw for a gift card or hear about the results"]

Please enter your email address. Your email will not be used for any other purposes. [open text box]

Section 2: Bicycle purchase

Which option best describes you?

- I recently purchased an electric bike
- I am considering purchasing an electric bike
- I am not considering purchasing an electric bike



## [Display this question if answered "I am not considering purchasing an electric bike"]

We are investigating the effects of electric bike purchases on travel behaviour over time. This survey is for those who recently purchased or are considering purchasing an electric bike. As per your selection, you are not considering purchasing an electric bike, so you will be taken to the end of the survey. In case you mistakenly chose "I am not considering purchasing an electric bike", please change your selection and proceed.

For the questions below, please tell us about your most recent electric bicycle (e-bike) purchase. Include purchases of used bikes, and any bikes that were purchased for you.

On what date was your e-bike purchase made? [open text box]

What are the make and model of your e-bike? [open text box]

If your e-bike has an odometer, please enter the current approximate number of kilometres on your e-bike's odometer.

- My e-bike does not have an odometer
- The number of kilometres on my e-bike's odometer is: [open text box]

What percentage of your e-bike's use do you expect will be by you (versus others in your household)? [slide from 0 to 100%]

Section 3: First purchase, rebate, e-bike use, and recent trips

What were the main considerations in purchasing an e-bike? Please select and rank up to 3, with most important first, by dragging and dropping your selections into the box. Top 3 considerations:

- Purchase cost
- Appearance/style
- Weight
- Maintenance needs
- Charging needs
- Riding comfort
- Physical effort to ride
- Fun to ride

- Frequency of use
- Riding speed
- Riding distance
- Substitute other modes of travel
- Carry children
- Carry cargo
- Other [open text box]

Please indicate the amount of rebates you received (or expect to receive) from Province of British Columbia in dollars.

- I did/will not receive any rebates
- \$350

- \$1,000
- \$1,400

If you received any other rebate or financial incentive not listed above, please describe them below. Please list source(s) and enter the amount in dollars. [open text box]



What is the final approximate amount you paid (after any rebates described above)? Do not include accessories such as a helmet, lock, or lights. [open text box]

## [Display this question if did not select "I did/will not receive any rebates"]

If the rebate described on the previous page had not been available for this purchase, what is the likelihood each of the following would have happened? Please click anywhere inside the bars to move the sliders. Numbers should add up to 100%. [sliders from 0 to 100]

- The same purchase would have been made
- A different e-bike would have been purchased
- A conventional bike would have been purchased
- No bike purchase would have been made

In the past month, what have been your main considerations in deciding whether to use your e-bike versus another mode of travel for a trip? Please select and rank up to 3, with most important first. Top 3 considerations:

- Travel distance
- Travel time
- Weather
- Riding facilities
- Cargo I need to carry
- Accompanying travellers

- Physical exertion/exercise
- Bike parking
- Battery charging
- Environmental impacts
- Fun/enjoyment
- Other [open text box]

Have you used your e-bike at least 2 times in the past month?

• Yes • No

## [Skip to end of section if selected "No"]

We will next ask about the most recent 2 round/return trips you made with your e-bike. A round/return trip is leaving from home and returning home again, with any number of stops along the way. Please provide your best estimate for all questions.

What date was your most recent trip made? [open text box]

What was the main purpose of this trip?

- Travel to work or school (commuting)
- Work-related travel (other than commuting)
- Personal shopping or errands (store, bank, health appointments, etc.)
- Social, recreational, or dining (visiting friends/family, religious activity, etc.)
- Exercise/leisure trip with no main destination
- Escort/chauffeur someone on their trip (to school, work, etc.)



• Other (please specify) [open text box]

About how many kilometres did you travel over the entire round trip? [slider from 0 to 40]

Had you not made this purchase, what is the likelihood you would have used each of the following for this trip? Please click anywhere inside the bars to move the sliders. Numbers should add up to 100%. [slider from 0 to 100%]

- Walking, running, or mobility device
- Conventional bike
- E-bike
- Car, truck, or motorcycle (private, shared, or taxi)
- Public transit (bus, ferry, etc.)
- Other [open text box]
- I would not have made the trip

Would the length or your trip have been different if it had been made using the most likely travel mode indicated above?

- Yes
- No
- Not applicable (I most likely would not have made my trip)

[Display this question if selected "Yes"]

How do you expect your total trip distance would have changed?

-75%

+25%

-50%

• +50%

• -25%

+75%

What date was your second-to-last trip made? [open text box]

What was the main purpose of this trip?

- Travel to work or school (commuting)
- Work-related travel (other than commuting)
- Personal shopping or errands (store, bank, health appointments, etc.)
- Social, recreational, or dining (visiting friends/family, religious activity, etc.)
- Exercise/leisure trip with no main destination
- Escort/chauffeur someone on their trip (to school, work, etc.)
- Other (please specify) [open text box]

About how many kilometres did you travel over the entire round trip? [slider from 0 to 40]



Had you not made this purchase, what is the likelihood you would have used each of the following for this trip? Please click anywhere inside the bars to move the sliders. Numbers should add up to 100%. [slider from 0 to 100%]

- Walking, running, or mobility device
- Conventional bike
- E-bike
- Car, truck, or motorcycle (private, shared, or taxi)
- Public transit (bus, ferry, etc.)
- Other
- I would not have made the trip

Would the length or your trip have been different if it had been made using the most likely travel mode indicated above?

- Yes
- No
- Not applicable (I most likely would not have made my trip)

[Display this question if selected "Yes"]

How do you expect your total trip distance would have changed?

- -75%
- -50%
- -25%

- +25%
- +50%
- +75%

## Section 4: Travel matrix

[For participants who reported not purchasing an e-bike, "In the month before you made this purchase" was replaced with "In the past month"]

In the month before you made this purchase, on average how many days per week did you use each of the following modes of travel (for any purpose, including exercise or recreation)? [from 0 to 7]

- Walking, running, or mobility device
- Conventional bike
- E-bike
- Car, truck, or motorcycle (private, shared, or taxi)
- Public transit (bus, ferry, etc.)
- Other



In the month before you made this purchase, on average how many kilometers per day did you travel with each of the following modes of travel, on days that you used them (for any purpose, including exercise or recreation)? [sliders from 0 to 50]

- Walking, running, or mobility device
- Conventional bike
- E-bike
- Car, truck, or motorcycle (private, shared, or taxi)
- Public transit (bus, ferry, etc.)
- Other

How comfortable would you feel cycling on your own in each of the following situations? [Very uncomfortable, somewhat uncomfortable, somewhat comfortable, very comfortable]

- On local neighbourhood streets with little traffic and low speeds
- On major streets that have bike lanes separated from traffic with a physical barrier
- On major streets that have a painted bike lane with no physical barrier

Section 5: Commute, household and personal information, and closing

This last set of questions about you and your household will help us understand the context for e-bike adoption.

If you commute to work or school, what are the first 3 digits of the postal code (or other location identifier) for the place to which you most often commute?

- I do not commute to work/school
- I commute to work (please enter the first 3 digits of the postal code below) [open text box]

## [Display this question if selected "I commute to work"]

In the past month, what modes of travel did you use to get to work or school? Please rank from most to least often used by dragging and dropping your selections into the box. Modes used:

- Walking, running, or mobility device
- Conventional bike
- E-bike
- Car, truck, or motorcycle (private, shared, or taxi)
- Public transit (bus, ferry, etc.)
- Other [open text box]

What are the first 3 digits of your home postal code? (or other home location identifier, if you prefer, such as neighbourhood) [open text box]



How many adults, including yourself, are living in your household? A household is defined as a group of people who share a kitchen, and excludes visitors.

• 1

• 2

• 3

• 4

• 5

• 6+

How many children are living in your household?

• 0

• 1

• 2

• 3

• 4

• 5

6+

What is your household dwelling type?

- Single-detached house
- Semi-detached house (duplex, row house, townhouse)
- Apartment or condominium
- Other (please specify): [open text box]

How many of each of the following working/functional vehicles are currently available to the members of your household, including yourself? Please include personal and business vehicles. [from 0 to 4+]

- Registered and insured motor vehicles (cars, trucks, motorcycles, etc.)
- Conventional bikes
- E-bikes

[Display this question if had at least 1 conventional or electric bike]

At home, where do you normally park your bike(s)? Check all that apply.

- On the street
- In a shared/common space (bike room, courtyard)
- In a private outdoor space (balcony, patio, yard)
- Inside my unit/house
- Other (please specify): [open text box]

Do you have a driver's license?

Yes

No

What is your age in years?

• 16 - 19

20 - 29



- 30 39
- 40 49
- 50 59
- 60 69

What is your current gender identity? Check all that apply.

- Man
- Woman
- Not listed [open text box]
- Non-binary
  - Prefer not to answer

Prefer not to answer

Which of the following census categories best describes you? Check all that apply.

- Métis, First Nations, or Indigenous
- White
- Asian
- Black

Latin American

70 - 79

>79

- Arab
- Prefer not to answer
- Other [open text box]

Do you have any difficulty walking, using stairs, or doing other physical activities?

- No
- Sometimes

- Often
- Always

What is the highest level of education you have completed?

- Some high school or less
- Completed high school/equivalency
- College/university certificate or diploma
- Bachelor's degree
- Graduate degree (master's or doctorate)
- Prefer not to answer

What is your gross (pre-tax) annual household income? (in CAD)

- Less than \$25,000
- \$25,000 \$50,000
- \$50,000 \$75,000
- \$75,000 \$100,000

- \$100,000 \$150,000
- More than \$150,000
- Prefer not to answer

Thank you for participating. The survey is now complete. Do you have any comments or clarifications about the information you provided in this survey? [open text box]

This survey was Part 1 of a 3-part study designed to investigate the effects of e-bike purchases on travel behaviour over time. The next two parts are follow-up surveys that will ask about changes from the responses you have given here after 3 and 12 months. Your continued participation in the next two parts of the study will be essential to the value of your responses. If



you select "I agree" below, an invitation email for the next survey will be sent to you in 3 months, with up to 2 reminders. You will not be obligated to complete the survey, and can withdraw at any time. Your email address will not be used for any other purpose. Do we have your permission to contact you for the follow-up survey in 3 months?

- I agree to be contacted
- No I do not wish to be contacted about the next part of the survey

[Display this question if selected "I agree to be contacted"]

Please enter your email address. Your email will not be used for any other purposes. [open text box]

## Appendix B.2. Wave 2 Questionnaire

Section 1: Consent form

## Effects of Bicycle Purchases on Travel Behaviour over Time - Part 2

### **Research Team & Study Purpose**

Thank you for considering continued participation in this study, which will be essential to the value of your past responses. The study is being conducted by Dr. Alex Bigazzi and the Research on Active Transportation (REACT) Lab at the University of British Columbia (UBC), in collaboration with researchers at Simon Fraser University and University of Toronto. We are investigating the effects of bicycle purchases on travel behaviour over time. The study findings will help to inform programs and policies that facilitate bicycle adoption and promote sustainable transportation.

### **Survey Details**

This is Part 2 of a 3-part study. You have been invited because you completed Part 1 and agreed to be contacted to participate in Part 2. If you did not complete Part 1, or have any questions or concerns about your invitation to participate in Part 2, please contact <a href="mailto:react.lab@ubc.ca">react.lab@ubc.ca</a>.

This survey should take around 10 minutes to complete. You will be asked to provide updated information about your travel habits, and bicycle ownership. At the end of the survey, you will be asked if you agree to be contacted in 9 months to participate in Part 3 of this study, which is a similar follow-up survey. Participation is voluntary, and you can withdraw at any time. You may complete this survey and decline to be contacted or participate in Part 3. Your responses will remain confidential, and any identifying information will be removed before the results are presented.

## **Draw for Ten \$40 Gift Cards**



You may enter a draw for one of ten \$40 gift cards and/or request to have the final study results sent to you by entering your email address below. Your email address will not be shared or used for any other purpose. Everyone who takes the survey and enters their email address will be considered in the prize draw (even those who withdraw or do not answer every question). Your chance of receiving a gift card is approximately 1 in 500; all gift cards will be distributed in British Columbia.

#### **Contact Information**

If you have any questions about this study or if you have accessibility needs to take the survey, including in another language, please email react.lab@ubc.ca. If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at 604-822-8598 or email RSIL@ors.ubc.ca or call toll free at 1-877-822-8598 (ethics ID: H21-02361).

Click on "I agree" below to indicate your consent to participate in this survey and proceed.

I agree

• I disagree

[Skip to end of survey if selected "I disagree"]

Do you want to enter the draw for a gift card and/or hear about the results of the study? Check all that apply.

- I want to enter the draw for a gift card
- I want to hear about the results of this study
- I do not want to enter the draw for a gift card or hear about the results

Section 2: Still own e-bike?

[Display this question if participant reported purchasing an e-bike in Wave 1 questionnaire]

Do you still own the e-bike you previously told us about in the Part 1 survey? Make and model of your e-bike from part 1 survey: [model specified by participants in Wave 1 questionnaire]

- Yes, I still own that e-bike
- No, I do not (if possible, please elaborate why not?) [open text box]

[Display this question if participant reported not purchasing an e-bike in Wave 1 questionnaire or selected "No, I do not" in previous question]

Which option best describes you regarding the e-bike you told us about in Part 1?

- I replaced that e-bike with another e-bike
- I did not replace that e-bike



[Display this question if selected "I replaced that e-bike with another e-bike"]

Which option best describes you?

- I recently purchased an e-bike
- I am considering purchasing an e-bike
- I am not considering purchasing an e-bike

[The following questions are similar to section 2 in Wave 1 questionnaire with questions regarding newly purchased e-bikes]

For the questions below, please tell us about your most recent electric bicycle (e-bike) purchase. Include purchases of used bikes, and any bikes that were purchased for you.

For the questions below, please tell us about your most recent electric bicycle (e-bike) purchase. Include purchases of used bikes, and any bikes that were purchased for you.

On what date was your e-bike purchase made? [open text box]

What are the make and model of your e-bike? [open text box]

What percentage of your e-bike's use do you expect will be by you (versus others in your household)? [slide from 0 to 100%]

Section 3: First purchase, and rebate

[This section is similar to section 3 in Wave 1 questionnaire with questions regarding newly purchased e-bikes and was shown to participants if they reported purchasing an e-bike in this wave]

What were the main considerations in purchasing an e-bike? Please select and rank up to 3, with most important first, by dragging and dropping your selections into the box. Top 3 considerations:

- Purchase cost
- Appearance/style
- Weight
- Maintenance needs
- Charging needs
- Riding comfort
- Physical effort to ride
- Fun to ride

- Frequency of use
- Riding speed
- Riding distance
- Substitute other modes of travel
- Carry children
- Carry cargo
- Other [open text box]

Please indicate the amount of rebates you received (or expect to receive) from Province of British Columbia in dollars.

- I did/will not receive any rebates
- \$350



• \$1,000 • \$1,400

If you received any other rebate or financial incentive not listed above, please describe them below. Please list source(s) and enter the amount in dollars. [open text box]

What is the final approximate amount you paid (after any rebates described above)? Do not include accessories such as a helmet, lock, or lights. [open text box]

[Display this question if did not select "I did/will not receive any rebates"]

If the rebate described on the previous page had not been available for this purchase, what is the likelihood each of the following would have happened? Please click anywhere inside the bars to move the sliders. Numbers should add up to 100%. [sliders from 0 to 100]

- The same purchase would have been made
- A different e-bike would have been purchased
- A conventional bike would have been purchased
- No bike purchase would have been made

In the past month, what have been your main considerations in deciding whether to use your e-bike versus another mode of travel for a trip? Please select and rank up to 3, with most important first. Top 3 considerations:

- Travel distance
- Travel time
- Weather
- Riding facilities
- Cargo I need to carry
- Accompanying travellers

- Physical exertion/exercise
- Bike parking
- Battery charging
- Environmental impacts
- Fun/enjoyment
- Other [open text box]

Section 4: E-bike use and recent trips

If your e-bike has an odometer, please enter the current approximate number of kilometres on your e-bike's odometer.

- My e-bike does not an odometer
- The number of kilometres on my e-bike's odometer is: [open text box]

In the past month, what have been your main considerations in deciding whether to use your e-bike versus another mode of travel for a trip? Please select and rank up to 3, with most important first. Top 3 considerations:

- Travel distance
- Travel time
- Weather

- Riding facilities
- Cargo I need to carry
- Accompanying travellers



- Physical exertion/exercise
- Bike parking
- Battery charging

- Environmental impacts
- Fun/enjoyment
- Other [open text box]

How has your experience been with the following aspects of your e-bike, compared to your expectations? [sliders from -10 to 10]

- Overall experience
- How often you use it
- Enjoyment/fun
- Riding comfort

- Safety
- Parking
- Charging
- Other [open text box]

Have you used your e-bike at least 2 times in the past month?

Yes

No

### [Skip to end of section if selected "no"]

We will next ask about the most recent 2 round/return trips you made with your e-bike. A round/return trip is leaving from home and returning home again, with any number of stops along the way. Please provide your best estimate for all questions.

What date was your most recent trips made? [open text box]

What was the main purpose of this trip?

- Travel to work or school (commuting)
- Work-related travel (other than commuting)
- Personal shopping or errands (store, bank, health appointments, etc.)
- Social, recreational, or dining (visiting friends/family, religious activity, etc.)
- Exercise/leisure trip with no main destination
- Escort/chauffeur someone on their trip (to school, work, etc.)
- Other (please specify) [open text box]

About how many kilometres did you travel over the entire round trip? [sliders from 0 to 40]

Had you not made this purchase, what is the likelihood you would have used each of the following for this trip? Please click anywhere inside the bars to move the sliders. Numbers should add up to 100%. [sliders from 0 to 100%]

- Walking, running, or mobility device
- Conventional bike
- E-bike
- Car, truck, or motorcycle (private, shared, or taxi)
- Public transit (bus, ferry, etc.)



- Other [open text box]
- I would not have made the trip

Would the length or your trip have been different if it had been made using the most likely travel mode indicated above?

- Yes
- No
- Not applicable (I most likely would not have made my trip)

[Display this question if selected "Yes"]

How do you expect your total trip distance would have changed?

-75%

+25%

• -50%

• +50%

-25%

• +75%

What date was your second-to-last trip made? [open text box]

What was the main purpose of this trip?

- Travel to work or school (commuting)
- Work-related travel (other than commuting)
- Personal shopping or errands (store, bank, health appointments, etc.)
- Social, recreational, or dining (visiting friends/family, religious activity, etc.)
- Exercise/leisure trip with no main destination
- Escort/chauffeur someone on their trip (to school, work, etc.)
- Other (please specify) [open text box]

About how many kilometres did you travel over the entire round trip? [sliders from 0 to 40]

Had you not made this purchase, what is the likelihood you would have used each of the following for this trip? Please click anywhere inside the bars to move the sliders. Numbers should add up to 100%. [sliders from 0 to 100%]

- Walking, running, or mobility device
- Conventional bike
- E-bike
- Car, truck, or motorcycle (private, shared, or taxi)
- Public transit (bus, ferry, etc.)
- Other [open text box]
- I would not have made the trip



Would the length or your trip have been different if it had been made using the most likely travel mode indicated above?

- Yes
- No
- Not applicable (I most likely would not have made my trip)

## [Display this question if selected "Yes"]

How do you expect your total trip distance would have changed?

- -75%
- -50%
- -25%

- +25%
- +50%
- +75%

## Section 5: Experienced incidents

While riding your e-bike, have you had an incident where you fell to avoid contact, caused someone to fall, or made contact with another person or vehicle?

YesNo

## [Display this question if selected "Yes"]

With which of the following other road users have you had an incident? Check all that apply.

- Pedestrian
- Cyclist or someone on a scooter, skates, or other wheeled device
- Car, truck, van, motorcycle or other registered motor vehicle
- Fixed object or other fall with no one else involved

## [Display this question if selected "Yes"]

How serious was the most severe incident for you?

- Very serious (overnight hospital stay)
- Serious (hospital visit, not overnight stay)
- Minor (scrapes and bruises)
- No injury (property damage only)
- No injury, no property damage

Section 6: Travel matrix, commute, household and personal information, and closing

In the past month, on average how many days per week did you use each of the following modes of travel (for any purpose, including exercise or recreation)? [from 0 to 7]



- Walking, running, or mobility device
- Conventional bike
- E-bike
- Car, truck, or motorcycle (private, shared, or taxi)
- Public transit (bus, ferry, etc.)
- Other

In the past month, on average how many kilometers per day, on days used, did you travel with each of the following modes of travel, on days that you used them (for any purpose, including exercise or recreation)? [sliders from 0 to 50]

- Walking, running, or mobility device
- Conventional bike
- E-bike
- Car, truck, or motorcycle (private, shared, or taxi)
- Public transit (bus, ferry, etc.)
- Other

How comfortable would you feel cycling on your own in each of the following situations? [Very uncomfortable, somewhat uncomfortable, somewhat comfortable, very comfortable]

- On local neighbourhood streets with little traffic and low speeds
- On major streets that have bike lanes separated from traffic with a physical barrier
- On major streets that have a painted bike lane with no physical barrier

Did you take a course on cycling skills or safety in the past 12 months?

- Yes
- No



If you commute to work or school, what are the first 3 digits of the postal code (or other location identifier) for the place to which you most often commute?

- I do not commute to work/school
- I commute to work (please enter the first 3 digits of the postal code below) [open text box]

## [Display this question if selected "I commute to work"]

In the past month, what modes of travel did you use to get to work or school? Please rank from most to least often used by dragging and dropping your selections into the box. Modes used:

- Walking, running, or mobility device
- Conventional bike
- E-bike
- Car, truck, or motorcycle (private, shared, or taxi)
- Public transit (bus, ferry, etc.)
- Other

This last page of questions about you and your household shows the responses you provided in the Part 1 survey. Please review the answers you provided in the Part 1 survey.

[The responses to demographics questions provided in Wave 1 questionnaire presented to participants here]

Is this information still correct?

- Yes
- No I need to update some answers

## [Display this question if selected "No - I need to update some answers"]

- Please select the questions you would like to update. Check all that apply.
- What are the first 3 digits of your home postal code?
- How many adults, including yourself, are living in your household?
- How many children are living in your household?
- How many registered and insured motor vehicles does your household have?
- How many conventional bikes?
- How many e-bikes?
- What is your household dwelling type?
- Where do you normally park your bikes(s)?
- Do you have any difficulty walking, using stairs, or doing other physical activities?
- Do you have a driver's license?



## [Questions selected above were presented again for participants to update their answers]

Have there been any other changes in your life situation that have significantly affected your travel habits? If so, please describe. [open text box]

Thank you for participating. The survey is now complete. Do you have any comments or clarifications about the information you provided in this survey? [open text box]

This survey was Part 2 of a 3-part study designed to investigate the effects of e-bike purchases on travel behaviour over time. Part 3 is another follow-up survey that will ask about changes from the responses you have given here in 9 more months. Your continued participation in the last part of the study will be essential to the value of your responses. If you select "I agree" below, an invitation email for the next survey will be sent to you in 9 months, with up to 2 reminders. You will not be obligated to complete the survey, and can withdraw at any time. Your email address will not be shared or used for any other purpose.

Do we have your permission to contact you for the follow-up survey in 9 months?

- I agree to be contacted
- I disagree I do not wish to be contacted about the next part of the survey

Please enter your email address. Your email will not be used for any other purposes. [open text box]



## Appendix B.3. Wave 3 Questionnaire

[The Wave 3 questionnaire was materially the same as the Wave 2 questionnaire. In addition, the following four questions were added to section 6]

Which of the following best describes your attitude towards cycling?

- No way, no how
- Interested but concerned
- Enthused and confident
- Strong and fearless
- I don't know/Prefer not to answer

To what extent does your annual household income satisfy your household's needs?

- Very well
- Well
- Not so well
- Not at all
- I don't know/Prefer not to answer

Do you consent to be contacted in 1 to 5 years for a possible future follow-up study on longer-term cycling impacts?

- Yes, I consent to be contacted
- No, I do not wish to be contacted

[OPTIONAL] Reflecting on your past year of e-bike ownership, is there anything else you would like to share about the benefits of owning an e-bike or the obstacles you encountered using it? [open text box]



# Appendix C. Part 1 Additional Results

Table 45. Moderators of the intervention (after e-bike purchase) effect on automobile and e-bike PKT

	Automob	oile PKT (propo	ortional	E-bike PKT (proportional change			
	chang	ge post-purcha	ase)	р			
	Reference	Moderated	P-	Reference	Moderated	P-	
	effect	effect	value <sup>1</sup>	effect	effect	value <sup>1</sup>	
Days since purchase	-0.19	-0.19	0.58	16.35	16.27	0.29	
Rebate value (\$100)	-0.20	-0.21	0.38	15.71	15.71	>0.99	
Purchase marginality	-0.20	-0.20	0.82	15.77	15.97	0.37	
Age (10 y)	-0.20	-0.20	0.69	15.75	15.84	0.85	
Physical disability	-0.20	-0.20	0.52	15.32	15.32	0.23	
Non-white	-0.18	-0.18	0.17	16.91	16.91	0.21	
Natural log of income (In(\$10,000))	-0.20	-0.28	0.05	15.62	13.16	0.17	
Children in household	-0.19	-0.23	0.60	17.10	12.99	0.17	
Bike parking inside	-0.21	-0.20	0.95	12.25	19.11	0.02	
Commuter	-0.14	-0.28	0.03	12.73	19.38	0.02	
Cycling pre-purchase	-0.21	-0.20	0.91	10.23	28.44	< 0.01	
Experienced injury crash with new e-bike	-0.20	-0.29	0.40	15.71	17.18	0.57	
Population density (100 people/km²)	-0.20	-0.21	0.58	15.74	15.73	0.92	
Season: fall or spring <sup>2</sup>	-0.16	-0.32	0.36	19.02	16.37	0.92	
Season: winter <sup>2</sup>	-0.16	-0.22	0.39	19.02	13.24	0.07	
Average winter temperature (°C)	-0.20	-0.20	0.88	15.77	15.75	0.83	
Non-auto access score	-0.21	-0.21	0.15	16.01	15.89	0.33	
Biking infrastructure density (km/km²)	-0.21	-0.21	0.15	15.84	15.77	0.58	

<sup>&</sup>lt;sup>1</sup>On moderated effect (vs. reference effect)

<sup>&</sup>lt;sup>2</sup> Reference level - summer



# Appendix D. Part 2 External Data References

## Appendix D.1. Low Income Cut-Offs

Table 46 presents the Federal pre-tax Low Income Cut-Offs (LICO) (Government of Canada, 2016) used for each of three geographies: Vancouver, Kelowna & Victoria, and Elsewhere, along with the 1.6x LICO threshold used to compute the "Low Income" household variable. The last column identifies the relevant income brackets from the survey data, rounded to the nearest \$25,000.

Table 46. Low income cut-offs (LICO)

		2022 federal cut-off	160% of federal cut-off	Corresponding income bracket cut-off
	1 person	\$25,146	\$40,200	< \$50,000
Elsewhere -	2 persons	\$31,304	\$50,100	< \$50,000
Based on	3 persons	\$38,484	\$61,600	< \$50,000
population	4 persons	\$46,726	\$74,800	< \$75,000
30,000 to	5 persons	\$52,996	\$84,800	< \$75,000
99,999	6 persons	\$59,771	\$95,600	< \$100,000
	7 persons or more	\$66,546	\$106,500	< \$100,000
	1 person	\$25,303	\$40,500	< \$50,000
Kelowna &	2 persons	\$31,498	\$50,400	< \$50,000
Victoria -	3 persons	\$38,723	\$62,000	< \$50,000
Based on	4 persons	\$47,016	\$75,200	< \$75,000
population 100,000 to	5 persons	\$53,323	\$85,300	< \$75,000
499,999	6 persons	\$60,142	\$96,200	< \$100,000
455,555	7 persons or more	\$66,958	\$107,100	< \$100,000
	1 person	\$29,380	\$47,000	< \$50,000
Vancouver -	2 persons	\$36,576	\$58,500	< \$50,000
Based on	3 persons	\$44,966	\$71,900	< \$75,000
population	4 persons	\$54,594	\$87,400	< \$75,000
500,000 and	5 persons	\$61,920	\$99,100	< \$100,000
over	6 persons	\$69,835	\$111,700	< \$100,000
	7 persons or more	\$77,751	\$124,400	< \$150,000



LICO multiplier values for each income bracket from the survey are presented in Table 47, calculated as a ratio of the mid point of the income bracket to the corresponding 2022 Federal LICO.

Table 47. LICO multipliers by federal cut-offs and income brackets

Elsewhere - Based on population 30,000 to 99,999

		Income bracket							
		Less than \$25k	\$25k-50k	\$50k-\$75k	\$75k-\$100k	\$100k-\$150k	More than \$150k		
				Correspon	ding mid-point				
Household size	2022 federal cut-off	\$12,500	\$37,500	\$62,500	\$87,500	\$125,000	\$175,000		
1 person	\$25,146	0.50	1.49	2.49	3.48	4.97	6.96		
2 persons	\$31,304	0.40	1.20	2.00	2.80	3.99	5.59		
3 persons	\$38,484	0.32	0.97	1.62	2.27	3.25	4.55		
4 persons	\$46,726	0.27	0.80	1.34	1.87	2.68	3.75		
5 persons	\$52,996	0.24	0.71	1.18	1.65	2.36	3.30		
6 persons	\$59,771	0.21	0.63	1.05	1.46	2.09	2.93		
7 persons or more	\$66,546	0.19	0.56	0.94	1.31	1.88	2.63		

Kelowna & Victoria - Based on Population 100,000 to 499,999

	·			Incom	ne bracket		
		Less than \$25k	\$25k-50k	\$50k-\$75k	\$75k-\$100k	\$100k-\$150k	More than \$150k
				Correspon	ding mid-point		
Household size	2022 federal cut-off	\$12,500	\$37,500	\$62,500	\$87,500	\$125,000	\$175,000
1 person	\$25,303	0.49	1.48	2.47	3.46	4.94	6.92
2 persons	\$31,498	0.40	1.19	1.98	2.78	3.97	5.56
3 persons	\$38,723	0.32	0.97	1.61	2.26	3.23	4.52
4 persons	\$47,016	0.27	0.80	1.33	1.86	2.66	3.72
5 persons	\$53,323	0.23	0.70	1.17	1.64	2.34	3.28
6 persons	\$60,142	0.21	0.62	1.04	1.45	2.08	2.91
7 persons or more	\$66,958	0.19	0.56	0.93	1.31	1.87	2.61



Vancouver - Based on Population 500,000 and over

	,			Incon	ne bracket		
		Less than \$25k	\$25k-50k	\$50k-\$75k	\$75k-\$100k	\$100k-\$150k	More than \$150k
				Correspon	ding mid-point		
Household size	2022 federal cut-off	\$12,500	\$37,500	\$62,500	\$87,500	\$125,000	\$175,000
1 person	\$29,380	0.43	1.28	2.13	2.98	4.25	5.96
2 persons	\$36,576	0.34	1.03	1.71	2.39	3.42	4.78
3 persons	\$44,966	0.28	0.83	1.39	1.95	2.78	3.89
4 persons	\$54,594	0.23	0.69	1.14	1.60	2.29	3.21
5 persons	\$61,920	0.20	0.61	1.01	1.41	2.02	2.83
6 persons	\$69,835	0.18	0.54	0.89	1.25	1.79	2.51
7 persons or more	\$77,751	0.16	0.48	0.80	1.13	1.61	2.25



## Appendix D.2. Internal Travel Costs Assumptions

Table 48. Internal travel cost assumptions

Mode	Assumption	Value (units)
Conventional bike	Lifetime distance travelled	15,000 (km)
	Annual distance travelled	2,500 (km)
	Purchase cost	1,500 (\$)
	Annual maintenance	150 (\$)
E-bike	Lifetime distance travelled	25,000 (km)
	Annual distance travelled	3,000 (km)
	Purchase Cost	1,900 (\$)
	Annual maintenance	200 (\$)
	Fuel cost (electric)	0.15 (\$/kW)
Auto	Lifetime distance travelled	250,000 (km)
	Annual distance travelled	12,000 (km)
	Principle cost	51,152 (\$)
	Interest	9,696(\$)
	Annual maintenance	1,000 (\$)
	Fuel cost (electric)	0.15 (\$/kW)
	Fuel efficiency (electric)	18 (kW/100km)
	Fuel cost (gas)	1.8 (\$/L)
	Fuel efficiency (gas)	8 (L/100km)
	Annual insurance	1,800 (\$)
	Annual license/fees	100 (\$)
	Annual parking	1,800 (\$)
	Percent of electric vehicles	5%
	Percent of motor vehicles bought on loan	50%
Transit	Average trip distance	12.9 (km)
	Average trip fare	3 (\$)

#### References Bicycle/E-Bike

- 1. https://www.forbes.com/sites/moneybuilder/2011/06/15/the-costs-and-savings-of-bicycle-commuting/
- 2. https://www.sheltron.net/2010/03/bicycle-running-costs-how-much-does-your-bike-cost-to-run-per-kilometre/
- 3. <a href="https://www.o2o.be/en/blog/my-lease-bike-on-bike-maintenance-how-much-does-it-cost">https://www.o2o.be/en/blog/my-lease-bike-on-bike-maintenance-how-much-does-it-cost</a>
- 4. https://www.bicycling.com/rides/a20024531/how-much-do-you-spend-on-cycling-gear-every-year/
- $\label{eq:continuous} \textbf{5.} \quad \frac{\text{https://scooteretti.com/blogs/news/e-bikes-vs-traditional-bicycles-true-cost-maintenance-comparison-in-2025?srsltid=AfmBOopRlc2nWSWmjSUGUqBQbqBWn692YkJoWRwZblDetXTyQE1chjf1}$

### Auto

- 1. <a href="https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=tran&juris=bct&rn=21&year=2021&page=0">https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=tran&juris=bct&rn=21&year=2021&page=0</a>
- 2. <a href="https://www.canadadrives.ca/blog/news/car-insurance-across-canada-whats-the-difference">https://www.canadadrives.ca/blog/news/car-insurance-across-canada-whats-the-difference</a>
- 3. https://carcosts.caa.ca/
- 4. <a href="https://www.ratehub.ca/blog/what-is-the-total-cost-of-owning-a-car/">https://www.ratehub.ca/blog/what-is-the-total-cost-of-owning-a-car/</a>
- 5. <a href="https://www.bctransit.com/media/affordability/">https://www.bctransit.com/media/affordability/</a>
- 6. <a href="https://www.bankrate.com/loans/auto-loans/average-car-maintenance-costs/">https://www.bankrate.com/loans/auto-loans/average-car-maintenance-costs/</a>

#### Transit

1. <a href="https://public.tableau.com/app/profile/translink/viz/Trip\_Diary\_2023/TripDiary">https://public.tableau.com/app/profile/translink/viz/Trip\_Diary\_2023/TripDiary</a>



Appendix E. Part 2 Additional Results

Appendix E.1. Mobility Impacts

Appendix E.1.1. E-bike Trip Purpose and Mode Substitution

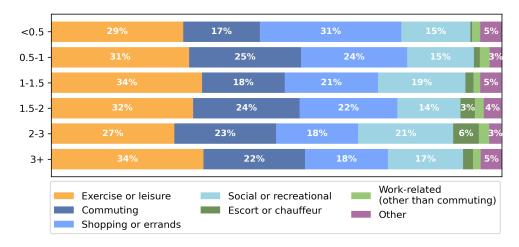


Figure 61. Average e-bike trip purpose by LICO multiplier

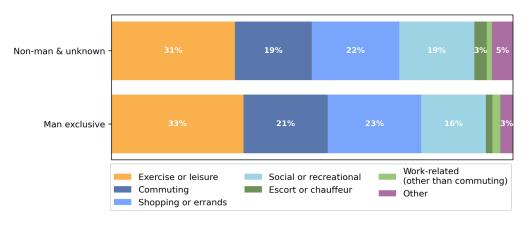


Figure 62. Average e-bike trip purpose by gender



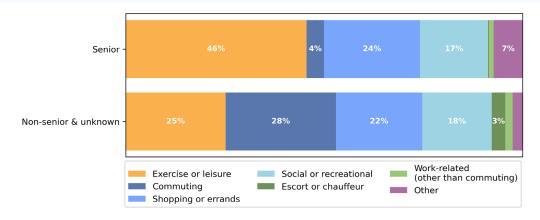


Figure 63. Average e-bike trip purpose by senior status

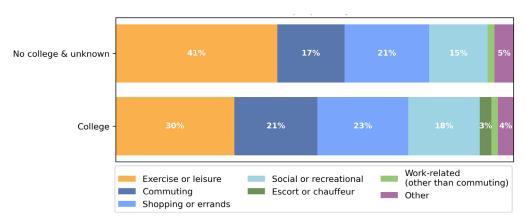


Figure 64. Average e-bike trip purpose by educational attainment

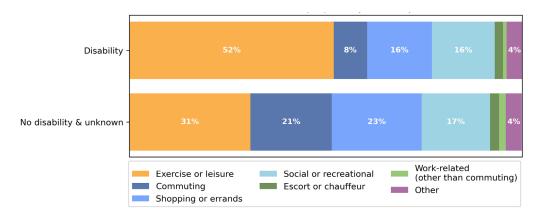


Figure 65. Average e-bike trip purpose by disability status



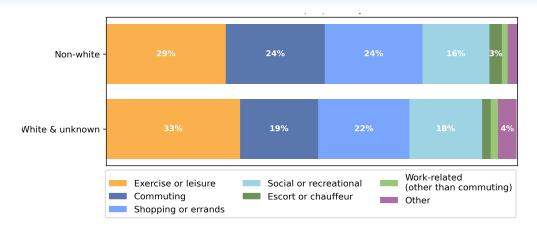


Figure 66. Average e-bike trip by race

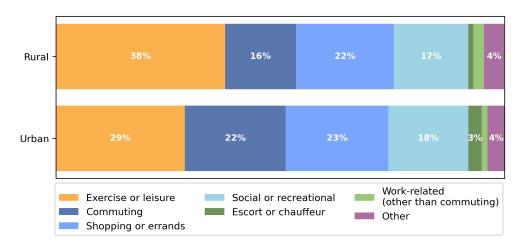


Figure 67. Average e-bike trip purpose for rural versus urban residents

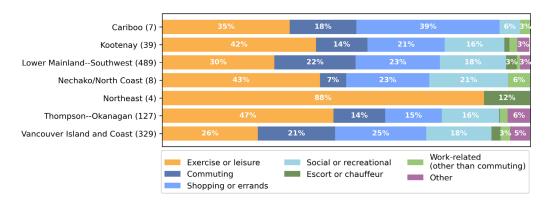


Figure 68. Average e-bike trip purpose by economic region



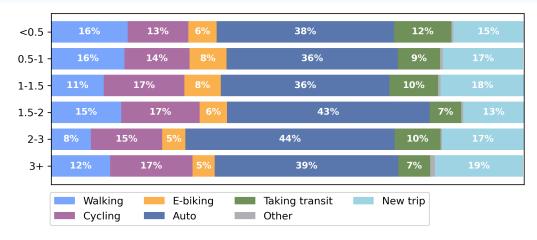


Figure 69. Average e-bike mode substitution by LICO multiplier

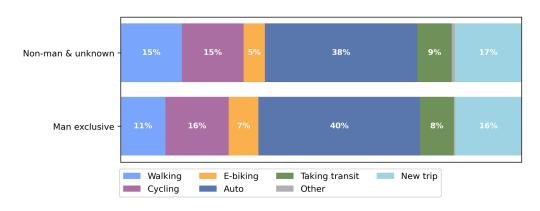


Figure 70. Average e-bike mode substitution by gender

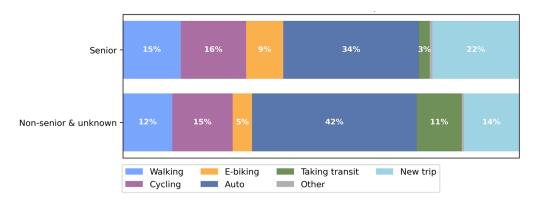


Figure 71. Average e-bike mode substitution by senior status



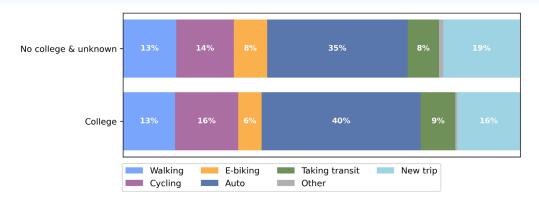


Figure 72. Average e-bike mode substitution by educational attainment

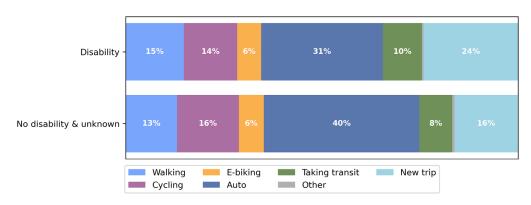


Figure 73. Average e-bike mode substitution by disability status

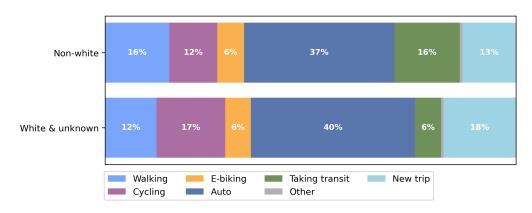


Figure 74. Average e-bike mode substitution by race



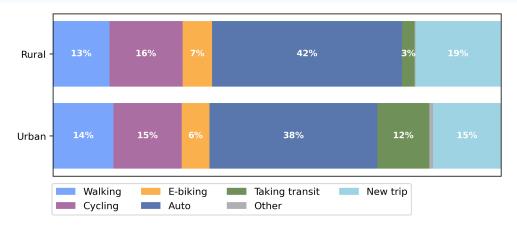


Figure 75. Average e-bike mode substitution by rural area

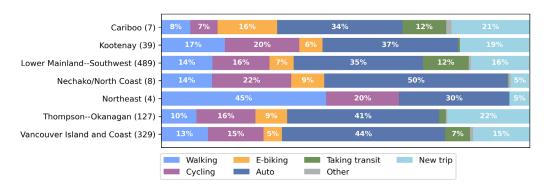
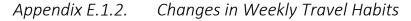


Figure 76. Average e-bike mode substitution by economic region



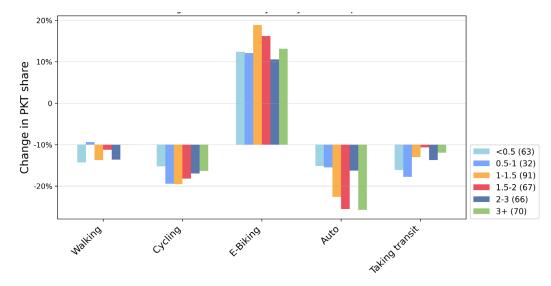


Figure 77. Average change in share of weekly PKT by mode, segmented by household LICO multiplier<sup>70</sup>



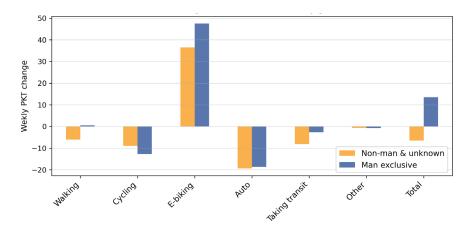


Figure 78. Average PKT change between Waves 1 & 3 by gender

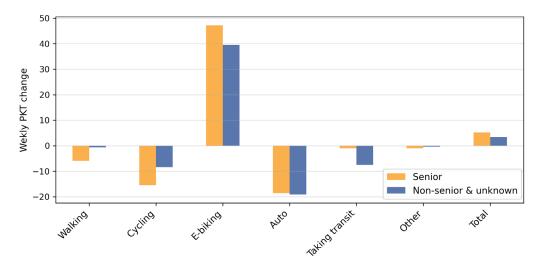


Figure 79. Average PKT change between Waves 1 & 3 by senior status



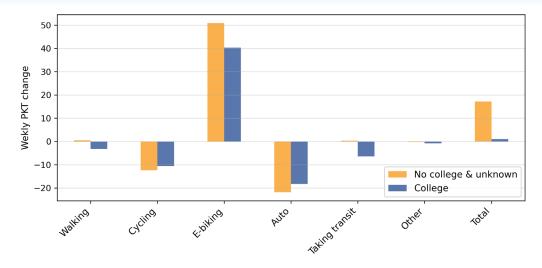


Figure 80. Average PKT change between Waves 1 & 3 by educational attainment

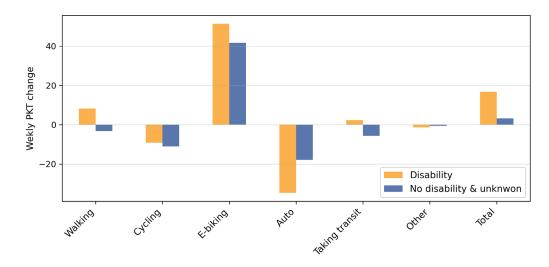


Figure 81. Average PKT change between Waves 1 & 3 by disability status



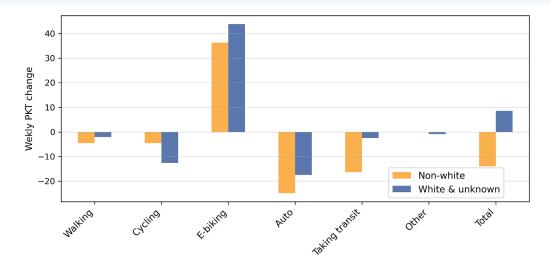


Figure 82. Average PKT change between Waves 1 & 3 by race

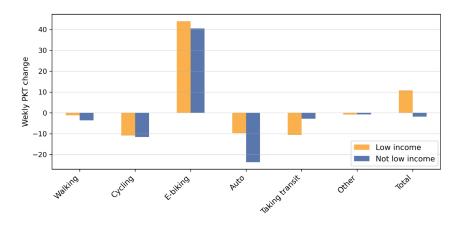


Figure 83. Average PKT change between Waves 1 & 3 by LICO multiplier



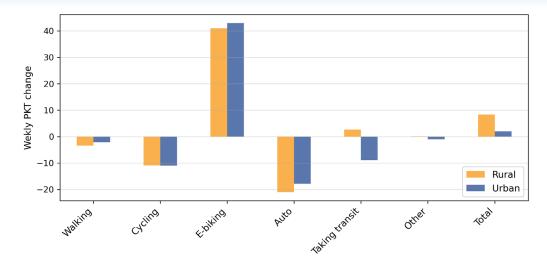


Figure 84. Average PKT change between Waves 1 & 3 by rural area

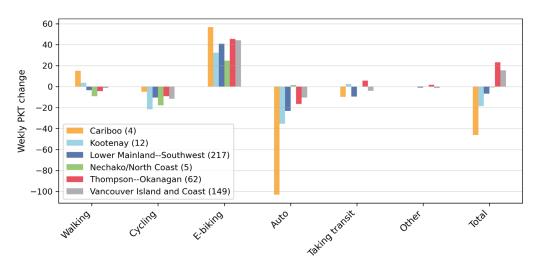


Figure 85. Average PKT change between Waves 1 & 3 by economic region



# Appendix E.1.3. New Mobility and Access

Table 49. New mobility and access estimates in weekly PKT

Category	Variable	New e-biking	New e-biking for exercise	New e-biking for access	
All recipients	None	5.7	3.5	2.1	
1160	Low income	7.2	4.4	2.8	
LICO	Not low income	4.4	2.8	1.6	
Income	Not well	5.9	3.2	2.7	
satisfaction	Well	5.5	3.5	2.0	
level	Very well	5.9	3.7	2.2	
Gender	Non-man & unknown	4.7	2.8	1.8	
	Man exclusive	6.8	4.4	2.4	
Race	Non-white	3.6	2.0	1.6	
Race	White & unknown	6.3	4.0	2.3	
	Disability	13.0	10.0	3.0	
Disability	No disability & unknown	5.3	3.2	2.1	
Education	No college & unknown	7.3	4.1	3.2	
	College	5.3	3.4	1.9	
	Senior	8.9	6.0	2.9	
Senior status	Non-senior & unknown	4.3	2.5	1.8	
lti	Rural	8.0	5.7	2.3	
Location	Urban	4.7	2.7	2.0	
	Kootenay	7.1	4.4	2.7	
Farancia	Lower Mainland Southwest	5.3	3.1	2.2	
Economic regions <sup>1</sup>	Thompson Okanagan	9.2	6.4	2.8	
	Vancouver Island and Coast	4.9	3.3	1.7	

<sup>&</sup>lt;sup>1</sup> For regions with at least 10 participants



# Appendix E.2. Affordability

Table 50. Total weekly costs - only those who took Wave 3

	Internal1	Internal2	Internal3	External1	External2	External3	Total1	Total2	Total3
Walking	0.00	0.00	0.00	0.28	0.22	0.24	0.28	0.22	0.24
Cycling	2.66	0.98	1.22	1.71	0.63	0.78	4.37	1.61	2.00
E-biking	1.18	6.93	7.54	0.89	5.19	5.66	2.07	12.12	13.20
Auto	73.34	54.50	59.94	48.23	35.83	39.42	121.57	90.33	99.36
Transit	5.56	4.32	3.90	2.17	1.69	1.53	7.73	6.01	5.42
Other	0.34	0.14	0.11	0.17	0.07	0.06	0.51	0.21	0.17
Total	83.08	66.87	72.71	53.45	43.63	47.69	136.53	110.50	120.39

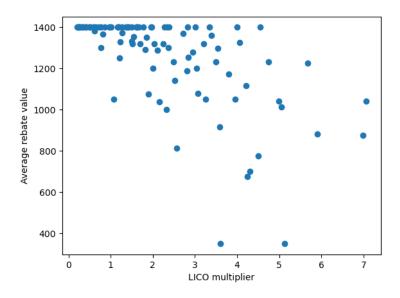


Figure 86. Average rebate value by LICO multiplier



Table 51. Affordability Summary

			Bike cost		1 travel ost <sup>1</sup>		3 travel ost	Change Wave 1 to Wave 3		Savings
Category	Category Variable		paid by participant	Total cost	Cost per 100km	Total travel cost	Cost per 100km	Total savings	Savings per 100km	per e- bike trip
All recipients	None	\$1,320	\$1,771	\$82.7	\$45.0	\$73.6	\$39.1	-\$9.1	-\$5.8	-\$2.5
LICO	Low income  Not low income	\$1,381 \$1,259	\$1,607 \$1,962	\$77.8 \$83.0	\$43.8 \$44.5	\$71.2 \$72.0	\$38.8 \$38.4	-\$6.7 -\$11.0	-\$5.0 -\$6.0	-\$2.3 -\$2.7
Income	Not well	\$1,360	\$1,502	\$75.5	\$45.4	\$64.7	\$37.8	-\$10.8	-\$7.7	-\$2.7
satisfaction level	Well Very well	\$1,310 \$1,277	\$1,907 \$2,259	\$84.1 \$87.7	\$43.9 \$45.3	\$82.5 \$76.7	\$43.5 \$38.8	-\$1.6 -\$11.0	-\$0.3 -\$6.5	-\$2.4 -\$2.5
Gender	Non-man & unknown	\$1,316	\$1,782	\$82.6	\$43.8	\$69.8	\$39.1	-\$12.8	-\$4.7	-\$2.2
Gender	Man exclusive Non-white	\$1,323 \$1,356	\$1,770 \$1,405	\$82.5 \$89.3	\$45.8 \$43.0	\$78.3 \$80.7	\$39.0 \$38.6	-\$4.2 -\$8.6	-\$6.8 -\$4.4	-\$2.9 -\$2.6
Race	White & unknown	\$1,306	\$1,912	\$80.4	\$45.3	\$71.6	\$39.2	-\$8.8	-\$6.1	-\$2.5
Disability	Disability No disability & unknown	\$1,317 \$1,319	\$2,117 \$1,759	\$99.2 \$81.6	\$54.2 \$44.2	\$74.9 \$73.7	\$41.2 \$38.9	-\$24.3 -\$7.9	-\$13.0 -\$5.3	-\$2.2 -\$2.6
Education	No college & unknown College	\$1,343 \$1,314	\$1,503 \$1,836	\$83.3 \$82.4	\$45.5 \$44.6	\$78.6 \$72.9	\$37.1 \$39.4	-\$4.8 -\$9.6	-\$8.4 -\$5.2	-\$2.4 -\$2.6
Senior status	Senior Non-senior & unknown	\$1,288 \$1,331	\$2,042 \$1,679	\$80.5 \$87.7	\$43.7 \$47.3	\$73.2 \$75.4	\$38.2 \$41.1	-\$7.4 -\$12.3	-\$5.5 -\$6.2	-\$2.1 -\$2.7
Location	Rural Urban	\$1,304 \$1,325	\$1,971 \$1,702	\$96.8 \$77.7	\$52.9 \$41.9	\$90.1 \$68.2	\$45.2 \$36.9	-\$6.7 -\$9.5	-\$7.7 -\$5.0	-\$2.8 -\$2.4
	Kootenay	\$1,276	\$1,991	\$91.3	\$50.5	\$77.5	\$41.1	-\$13.8	-\$9.4	-\$1.3
Economic regions <sup>2</sup>	Lower MainlandSouthwest ThompsonOkanagan	\$1,332 \$1,284	\$1,613 \$2,060	\$80.5 \$96.9	\$41.2 \$56.4	\$67.1 \$96.1	\$36.0 \$45.0	-\$13.5 -\$0.8	-\$5.2 -\$11.4	-\$2.4 -\$2.6
	Vancouver Island and Coast	\$1,311	\$2,014	\$80.2	\$47.0	\$78.9	\$43.0	-\$1.3	-\$4.0	-\$3.1

<sup>&</sup>lt;sup>1</sup> For those who took Wave 3 survey

<sup>&</sup>lt;sup>2</sup> For regions with at least 10 participants



# Appendix E.3. Physical Activity

Table 52. Physical Activity – Marginal MET Minutes (MMM)

Catagoria	Variable	Wave 1 <sup>1</sup>		Wave 3		V Wav	MMM per e-	
Category	Variable	Total MMM	MMM per 100km	Total MMM	MMM per 100km	Net MMM	MMM per 100km	bike trip
All recipients	None	1,077	670	1230	752	153	82	84
LICO	Low income	916	671	1152	761	236	90	77
LICO	Not low income	1,234	693	1297	759	63	66	89
Income	Not well	976	631	1061	760	84	129	84
satisfaction	Well	1,233	730	1192	683	-40	-46	76
level	Very well	1,089	672	1301	757	212	85	78
	Non-man & unknown	1,134	695	1177	764	42	68	80
Gender	Man exclusive	1,026	650	1299	741	273	90	89
_	Non-white	1,095	617	1235	715	139	97	77
Race	White & unknown	1,079	692	1235	765	156	72	87
D: 1:111	Disability	686	507	1276	728	589	220	75
Disability	No disability & unknown	1106	684	1233	754	126	70	85
- L	No college & unknown	1022	650	1342	763	319	112	89
Education	College	1095	679	1214	751	119	72	84
Senior	Senior	1051	667	1238	760	187	93	84
status	Non-senior & unknown	1164	692	1227	736	63	43	87
	Rural	999	565	1164	651	165	85	89
Location	Urban	1112	711	1259	788	147	76	83
	Kootenay	1117	658	1063	785	-54	126	44
Economic regions <sup>2</sup>	Lower MainlandSouthwest	1164	713	1276	803	111	90	83
regions	ThompsonOkanagan	1049	500	1303	662	254	161	105
	Vancouver Island and Coast	913	665	1128	679	214	14	83

<sup>&</sup>lt;sup>1</sup> For those who took Wave 3 survey

<sup>&</sup>lt;sup>2</sup> For regions with at least 10 participants



## Appendix E.4. Reflections on E-bike Adoption

#### Table 53. Additional transformative impact comments

The e-bike is our second vehicle. My husband takes our vehicle to work, leaving me with no vehicle.

I plan on using it for days when my disabilities flare (to get to work when I can't conventional bike), and to help me access more affordable grocery stores (like superstore/costco) that I would otherwise need a car for. I do not like using the bus in my city, it is unreliable and often unavailable .... So I often am forced to bike at the detriment to my health, or do not show up for work on days I cannot bike. This compromises me in a way I think the ebike will fully fix.

I am legally blind. Bus a lot. I can safely ride my e-bike slowly on quiet roads

Recent rehab for pulmonary fibrosis made bike essential to maintain any function, so the ebike I bought has a rack which does hold my oxygen tank. Only drawback is with such a valuable bike, I can't safely park it to shop. So, the bus is part of the way I go.

I want to emphasize and re-emphasize how getting an e-bike has been a life changing purchase. Sadly, purchasing an e-bike really was only within reach after saving up for a year, selling my conventional bike, and then qualifying for the \$1400 rebate. ... My e-bike has opened up so many doors for me when it comes to transportation in Vancouver, everyone deserves to feel this mobile.

I have a child on the ASD spectrum. He is considered non-verbal and is home schooled. We have to drive around to go to his therapy sessions. We are hoping to use the ebike cargo bike we recently purchased for this purpose. He doesn't sit on chairs, or on his bum in general. However, he does sit in the car seat and will sit on his bike seat. At the moment he has not sat on the back of the e-bike yet and he is resisting. We have it in our living room so he can access it on his own terms and hopefully sit on it...

I am a very fit senior who lives with severe ankylosing spondylitis. On bad days I walk with a cane. I have relied on our car for in city trips because I do not trust the bus system and find it difficult when I have problems walking. Having an ebike allows me greater mobility without relying on my auto....

My ebike is a tricycle. I feel very safe on it. I have osteoarthritis and have had 2 knee replacements. My major use of the bike is to go to the swimming pool, the gym, visiting friends in the community and going to the grocery store for small shopping. I often have to use canes when walking. I am much more physically active when I can use my bike rather than my car. It is hard for me to get into and exit my car. I am also more socially active when I can visit friends rather than using the car or trying to walk. This bike has brought a lot of happiness ..... it is much for flexible than a mobility scooter. I get more places over rougher roads and trails. I get to go on lovely scenic rail trails and avoid busy highways and streets. It means I can stay in my out of town residence and not have to move to a more expensive residence in the city close to the things I need. I am also hoping it keeps me from having to go into a care facility...

Needing to move cargo make it more likely to use ebike vs conventional because I had no car for weeks at a time.

I believe getting my e-bike has been a life changer overall. And I want to deeply thank the people who have made this blessing possible in my life. I save money on gas and get to explore more places and climb up hills that I Never Did Before. Many Thanks!!!

I have permanent disabilities my ebike makes me mobile

The e-bike has given me the confidence to make longer and more difficult bike trips that I would not have attempted on a conventional bike. These longer trips have enriched my physical and mental well being and have allowed me to discover the beauty of both the urban and rural areas of British Columbia. I am so happy with the support provided by the province that allowed me to make my e-bike purchase.



Purchasing an ebike upgraded my life. After experiencing deep grief losing several family members and two best friends my health declined and income dropped from embarrassingly comfortable to well below the poverty line. I use my car for heavy errands and emergencies but only one or two times per month. No idea why I'm paying for insurance! The ebike gets me out daily to parts of town I wouldn't walk or drive to. It gives me longer range and better hill climbing capacity. I made a Facebook group and am arranging 'group E rides.' ... After riding in July and August 2023, I got out of my grief shell enough to volunteer for the last 52 Sundays at the local united church soup kitchen. I credit that in part to seeing a better world on two wheels. ... Overall, I'm really grateful for this lifesaving machine. It rekindled my love of being an avid cyclist (age 5 to 38), let me see nearby natural wonders and feel the wind without a windshield. I know so many people who could use the same life upgrade and am now looking into how I can use my teaching, entrepreneurial and grant writing skills to make that happen. Healed people heal people and communities, right? ...

This e bike purchase with the rebate was one of the best purchases I have ever made in my life. The value that I have gotten is 10/10

As expected, I find that my days of riding a conventional bike are decreasing mostly due to age as I will be 65 this year. A 50 km bike ride is much more difficult than it was when I was 30. Now I am able to go out for a ride from 10 to 60 km on an e-Bike that I probably wouldn't do on a conventional bike. I still feel like I'm getting a good cardio workout as I try to ride in Eco mode as much as possible and I'm still traveling 30-60 km, whereas if I were on a conventional bike, I would probably only be traveling 10-20 km.

... My husband has recently been diagnosed with Alzheimer's but thankfully can still operate the e-bike safely and enjoys riding it. I think it will provide him with some independence when his drivers licence is rescinded. We live in a large gated community and the major use is to go to recreation and social events in the community. Because mobility is getting harder all of those shortish trips would be by the car, or my husband would not attend.

It's been so great! So easy to get my toddler onto the ebike. Helps her regulate after a day at preschool.

Due to how my body has been negatively affected during recovery from long covid having the e-bike has allowed me to be more active and participate in family biking outings with little pain and little aftereffects

Purchasing my E-bike has been one of the best things I've done in my life. An E-bike can truly improve many aspects of our lives. In my opinion.

Yes! This bike has changed my life in SO many wonderful & unexpected ways! I have become significantly healthier - physically I'm stronger, more muscle, lost weight, improved balance, improved bloodwork. My mood & well being are significantly improved (and I suffer from major long term depression). It has done more for my mental health than all the medications I took for decades and stopped 7 years ago. I love going on long bike rides ... I love to pack a picnic and go exploring and on adventures. I feel like a kid again - it is so much fun. Being out in nature and experiencing so many moments of awe! I have used 1/2 tank of gas in the last 14 months and let my car insurance expire back in March so my car is off the road saving me the costs of gas & insurance.... I am so grateful for this because without it the bike would be less enjoyable. I am also forever grateful for the grant you provided which allowed me to purchase my bike - thank you for changing my life!

I am astonished by my results. I had thought that an e-bike would make me weaker and more reliant on the electronic assist. It has instead made me stronger and more capable on my conventional bike as well as throughout other aspects of my life. ... My life has transformed for the better in so many ways, both physically and mentally. I now only seem to use the e-bike if it's a relatively short errand with a radical change in elevation (I live in one of the highest points of the city). I now spend the majority of my traveling on the conventional bike, certainly not what I had anticipated. The e bike has provided a bridge of sorts, allowing me to recover and surpass where I was before, both physically and mentally. The fuss and bother of keeping two bikes in a studio apartment pale in comparison of the phenomenal gains I've made ... I still have memories of where, on my favoured routes, I'd have to dismount and walk uphill. Then came the e bike rebuilding my strength so that ow I seemingly glide up on my conventional bike, merely shifting to lower gears. If I continue to gain in strength and stamina as I have been doing, I may even sell the e bike in the upcoming year.

Absolutely the greatest invention ever. No matter what age you can get out there and ride. I love riding and more than likely with out ebike would not be riding conventional bike.



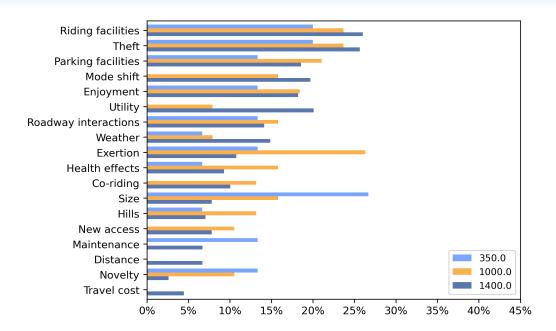


Figure 87. Topic mentions by rebate value

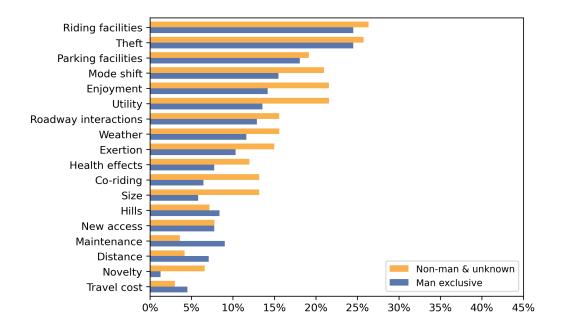


Figure 88. Topic mentions by gender



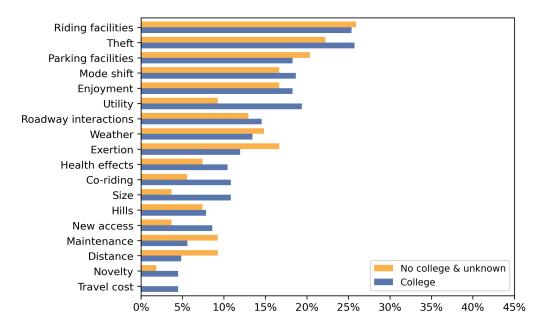


Figure 89. Topic mentions by education

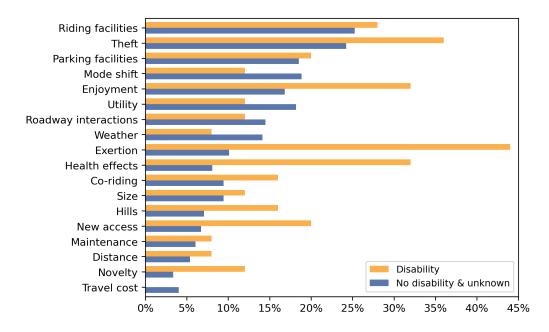


Figure 90. Topic mentions by disability



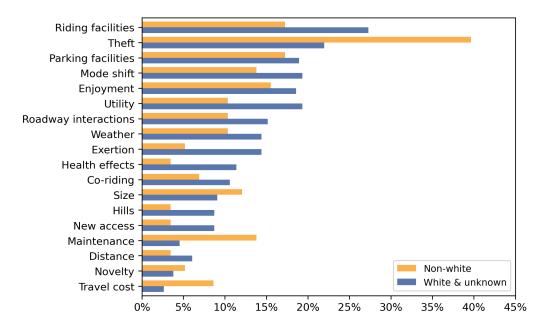


Figure 91. Topic mentions by race

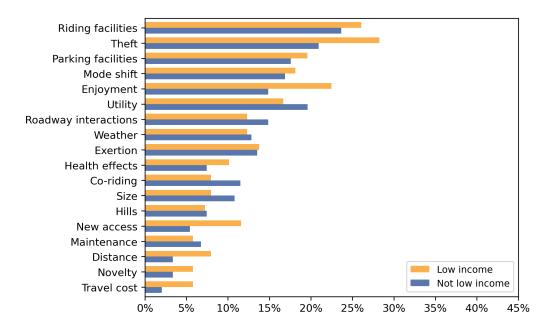


Figure 92. Topic mentions by income



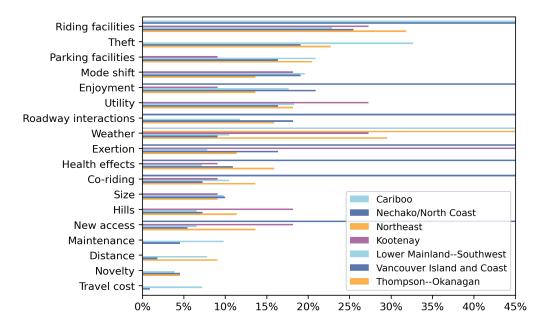


Figure 93. Topic mentions by economic region

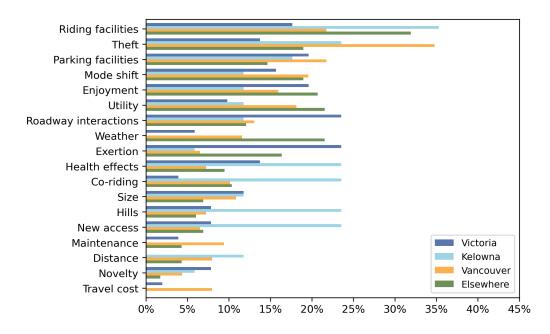


Figure 94. Topic mentions by metropolitan region