DEVELOPMENT OF AN ELECTRIC BICYCLE INCENTIVE PROGRAM FOR VICTORIA

research on active transportation
react

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The views and opinions expressed in this report are those of the authors and do not represent the official policy or position of the City of Victoria. Any errors are the responsibility of the authors.

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Source: City of Victoria

Part I:

Objectives and Context

Project Overview

The City of Victoria has made a commitment to promote active modes of transportation to enhance connectivity to services, reduce dependence on fossil fuels, and create safe networks of access through pedestrian and cycling-oriented policies and programs. This commitment has been solidified through the Official Community Plan, which sets out a goal of 60% of all trips by bike, walking or transit by 2041.

Electric-assist bicycles ("e-bikes") are a mode of transport that could potentially help the City of Victoria move towards its 2041 mode share goals. E-bikes offer a sustainable alternative mode of transport that is often utilized by a greater range of ages and abilities than conventional bicycles. Victoria seeks to understand 1) the role that electric bicycles could play in advancing transportation and sustainability goals, 2) the potential for economic benefits to the local economy and 3) what the municipality can do to reduce barriers and accelerate/expand e-bike adoption in the city.

Project Objectives

This project aims to design an e-bike incentive program (EBIP) that is suitable and feasible for the residents and businesses in the City of Victoria. The 6-month objectives are to develop and forecast the expected costs and impacts of a municipal-led e-bike incentive program, which can subsequently be implemented by the City of Victoria as a pilot program with an integrated monitoring component. This project aims to present options for an EBIP that align with the City's values and can help achieve the overarching goal of increasing trips made by active modes of transportation.

The following objectives for an e-bike incentive program were developed in discussions with the City of Victoria and were used to evaluate EBIP alternatives.

1. Increase active transportation use for a diverse range of travellers (residents, businesses, and organizations)
2. Reduce greenhouse gas emissions from motor vehicle use by residents, visitors, and businesses/organizations
3. Address cost barriers associated with e-bikes and support e-bike options for travellers of all income levels
4. Enhance e-bike options for a variety of trip types: utilitarian, recreational, tourism, and business
5. Support safety, comfort, and security for e-bike and other road users
6. Stimulate local economic activity by supporting local e-bike businesses and proposing e-bikes as a cost-efficient travel option for businesses and organizations
7. Ensure accountability, efficiency, scalability, and sustainability of the EBIP

8. Increase general understanding and awareness of the rules and regulations of operating e-bikes in Victoria
9. Enhance personal and community resiliency by providing a diversity of sustainable mobility options
10. Explore opportunities and potential to create partnerships with interested organizations

Project Context

Guiding Frameworks

The vision, goals, objectives, and targets related to e-bikes that have been established by the City of Victoria were examined by reviewing the existing Official Community Plan and other related plans that the City is involved with.

City Context

Official Community Plan (OCP)

Firstly, the OCP highlights current policy challenges, one of which is the need to increase trips made by active modes of transport and public transit. An increase in these sustainable modes of transport will help reduce greenhouse gas emissions that is expected from the increase in the number of regional commuters. Therefore, this highlights the opportunity for e-bikes to be incorporated as a viable active mode of transport that connects to major commercial hubs and transit networks for residents, commuters, and visitors.

The OCP lists three main goals related to transportation and mobility:

- 7 (A) Transportation options reduce fossil fuel dependence, help conserve energy and produce low greenhouse gas emissions and other air contaminants
- 7 (B) Victorians move freely and efficiently via a safe, integrated and convenient network of public transit, bike routes, and a supportive, inviting pedestrian realm in preference to driving alone
- 7 (C) Services, amenities, buildings, facilities, and public space are accessible (City of Victoria, 2012)

With the anticipated increase in the elderly population combined with the growth in employment, the plan continues to list the transportation and mobility priorities, with pedestrians being a top priority, followed by cyclists, and transit users to enhance connectivity between the main hubs and employment/industrial districts. This is supported by their quantified target of having a “minimum of 60% of all trips by Victoria residents to take place by walking, cycling and public transit by 2041” (City of Victoria, 2012). Therefore, the City has indicated their strong commitment to and preference for increasing active modes of transport through their three main goals and priorities, both of which can benefit from the incorporation of e-bikes.

Climate Leadership Plan

As encompassed in the OCP, sustainability remains to be a core value of the City which is further emphasized in the Climate Leadership Strategy which targets a 100% renewable City by 2050 (City of Victoria n.d.). The Strategy provides a framework on how to reduce greenhouse gas emissions from the transportation and housing sectors, and mitigate climate change impacts on the community and the natural and built environment. The 2018 Climate Leadership Plan describes a number of actions to reach an 80% reduction in greenhouse gas emissions (from 2007 levels) by 2050, by addressing buildings and lighting, energy generation, greenspace, solid waste, transportation, water and wastewater. Under Low Carbon Mobility, a proposed action for initiation by 2020 is to "introduce an electric bicycle incentive program in partnership with CRD and the Province."

<u>Regional Context</u>

Regional Growth Strategy for the Capital Regional District

The Regional Growth Strategy created for and by the Capital Regional District is a plan that lists goals, policies, and actions for the overarching aim to improve the quality of life in the region and improve the well-being of the community and the environment. The stated goal relevant to this project is to increase transportation choice, with a focus on enhancing transportation modes that are sustainable and affordable. The enlisted action to meet this goal is for the region to prepare a Regional Transportation Strategy that seeks to encourage the shift from automobiles to active modes of transportation and public transit. This plan specifies quantifiable targets related to increasing the share of walking, cycling, and public transit trips:

1. By 2026, achieve a minimum PM peak period region–wide transit mode share of 10% of trips;
2. By 2026, achieve a minimum PM peak period mode share by non–auto modes of 40% for trips to, from and within the Metropolitan Core;
3. By 2026, achieve a minimum region–wide transit mode share of 15% for journey–to–work trips;
4. By 2026, achieve a minimum cycling mode–share of 10% within the Victoria Census Metropolitan Area for journey–to–work trips, and 15% for journey–to–work trips for residents of the combined areas of Victoria, Oak Bay, Esquimalt and urban Saanich. (Capital Regional District, 2003)

Regional Transportation Plan

The Regional Transportation Plan created in 2014 by the IBI Group is intended to shift the distribution of transportation modes to reduce single occupancy vehicle travel for both residents and visitors, while promoting sustainable modes of transport. Thus, the plan aims for a coordinated effort of the member municipalities to create a "regional multi-modal transportation system that meets future growth demands and is focused on sustainability" (IBI Group, 2014).

The relevant outcome statement is for cycling to be an "appealing, safe, [convenient] and viable travel option for residents and visitors" (IBI Group, 2014). The supporting actions for this statement are:

1. Implement Pedestrian and Cycling Master Plan, Pedestrian and Cycling Master Plan-Salt Spring Edition and Southern Gulf Island-Cycling and Pedestrian Draft Trail Plan and recommended cycling facilities and amenities
2. Enhance existing regional trails and continue to fund the expansion of new trails, in line with the Pedestrian and Cycling Master Plan design guidelines, with a focus on connectivity.
3. Expand and harmonize the regional cycling data collection program
4. Identify and market cycle tourism in the region

The outcome statement and subsequent action includes the tourism sector as another aspect to incorporate sustainable modes of transport. Moreover, as identified by the list above, the actions reference the Regional Pedestrian & Cycling Masterplan which is another regional plan that is focused solely on promoting active transportation.

Regional Pedestrian & Cycling Masterplan

The Capital Regional District Pedestrian and Cycling Masterplan includes a target within their overall vision to increase the cycling mode share to 25% in urban/high-density areas and to 15% region-wide by 2038 (Alta Planning + Design, 2011). Additionally, the vision aims for a sustainable community where walking and cycling are the prominent modes in the region's transportation network that are utilized across all ages and abilities. The plan follows three prominent goals which are:

1. More walking and cycling
2. Safer walking and cycling
3. More places to walk or cycle

Each goal is supported by three to four performance measures that will help monitor the progress to meet these goals. Meanwhile, the objectives and initiatives range in category from improving bike riding facilities, implementing educational programs on active transportation, enforcing regulations and practices to enhancing safety and security, to creating evaluation frameworks for each of the mentioned objectives.

In summary, based on the existing city and region-wide plans, there is a general trend to focus transportation-related efforts to increase walking and cycling trips while reducing reliance on automobile trips, particularly SOV trips. This is related to the identified vision that formalizes the dedication to reduce greenhouse gas emissions and promote sustainability. Secondly, another common theme across these plans is the focus on increasing active transportation trips by both residents and visitors. This is especially relevant for a city like Victoria, which remains a popular tourist destination year-round. Thirdly, the focus on active transportation is partnered with efforts to improve public transit use. In the context of e-bikes, this signifies a need to enhance connectivity of active transportation modes to major transit hubs to promote public transit use. Lastly, in relation to connections to the transit network, there is an emphasis on increasing commuter trips by active and public modes of transport in the established plans. Thus, an area for consideration for e-bike promotion is how e-bikes can be communicated as an attractive option for both recreational and commuter trips in the City of Victoria.

Background Information

Population

In 2016, the city of Victoria's population amounted to 85,792, a 7.2% increase since 2011 (Statistics Canada, 2017). In addition, the City anticipates approximately 10,000 new people by 2041 just in the urban core (City of Victoria, 2012). As stated in the city's OCP, this consistent increase in population signifies a need to enhance the city neighbourhoods' sustainability, resiliency, and livability to respond to this growth and subsequent impacts. Although the trend of aging population is prominent across Canada, this trend is also highly prevalent in Victoria where the average age of the population is 44.5 years, which is greater than the national average of 40.1 (Statistics Canada, 2016).

Table 1. Population age for the City of Victoria, British Columbia, and Canada (2016)

	City of Victoria	British Columbia	Canada
0 to 14 years	9.3%	14.9%	16.6%
15 to 64 years	69.7%	66.9%	66.5%
65 years and over	21.0%	18.3%	16.9%
85 years and over	3.9%	2.3%	2.2%
Average age	44.5	42.3	41.0

Source: Statistics Canada, 2016 Census of Population

Although data regarding the annual visitor/tourist population in Victoria are not readily available, the region is perceived as a top destination nationally. In 2016, "Greater Victoria's accommodation sector reported an average occupancy of 74.23 percent in 2016" (Douglas Magazine, 2017), a four percent increase from 2015. This has also led to an increase in both the average room rate and revenue per available room. In addition, Victoria International Airport reported the greatest ever record of people arriving in 2016 of 1,856,099 (Douglas Magazine, 2017). Quoting Bill Lewis, chairman of Tourism Victoria, Duffy (2017) attributes this to Canada turning 150 and being named the number one place to visit by prominent agencies such as Lonely Planet and the New York Times.

Transportation

In regards to transportation characteristics, "Victoria had the highest proportion of commuters using sustainable transportation in 2016" out of all mid-sized metropolitan areas, at 39% (Statistics Canada, 2017). The other mid-sized metropolitan areas include Halifax, London, Windsor, Regina, and Saskatoon. This has resulted in Victoria also having the highest proportion of active transportation users out of all metropolitan areas with 10.3% of individuals walking and 6.6% cycling as their primary mode of transport to work (Statistics Canada, 2017). The share of public transit users was less with 10.9%, resulting in the second highest proportion out of the mid-sized metropolitan areas.

In terms of infrastructure improvements, the City has made considerable effort to bring cycling infrastructure to the forefront of new developments. This is exemplified by the City's Bicycle Master Plan which is currently undergoing an update. In addition, there is an extensive plan to expand the active transportation network within the city through three phases from 2017 until 2022. This network is intended to achieve the identified goal of the City to increase walking, cycling, and public transit trips. The final planned result by the year 2022 includes 24km of infrastructure intended for all ages and abilities that connects neighbourhoods to the downtown core and surrounding municipalities (City of Victoria, n.d.). The first phase consists of establishing a grid of protected bike lanes within the downtown core that currently faces a high demand for safe cycling facilities (City of Victoria, n.d.). This grid consists of five main corridors, which will amount to 5.4 km of protected bike lanes when completed (City of Victoria, n.d.).

Current E-bike Market

E-bike Regulations & Policies

In regards to e-bike regulations, the Capital Regional District (CRD) has jurisdiction over regional trails and has permitted the use of e-bikes on all regional trails. In addition, e-bikes are allowed on designated cycling trails in some regional parks. For use on other riding facilities, the CRD makes reference to e-bike regulations stated by ICBC. As specific e-bike regulations for the City are not set, e-bike regulations most likely follow these ICBC guidelines in which e-bikes (also referred to as motor-assisted cycles) must adhere to the same regulations as motor vehicles. An important factor to consider is that e-bikes are only permitted for individuals aged 16 years and above. Therefore, to align with the aim to make active transportation accessible for all ages and abilities, e-bike programs will have to be designed to attract the eligible age groups.

In the City's OCP, there is a reference to promoting e-bikes under the Transportation and Mobility Section. More specifically, e-bikes are mentioned under the goal to "support the reduction of transportation-generated greenhouse gas emissions" (City of Victoria, 2012). Thus, a supporting action is to provide charging stations for electric vehicles, which include electric cars, scooters, and bicycles, in new multi-unit residents, commercial, office and mixed-use developments (City of Victoria, 2011). The City's support for e-bikes are also highlighted in the provision of e-bike recharging stations in four of the City-owned parkades. In addition, the City's Bicycle Parking Strategy also recommends "that electric outlets be provided for 50% of long-term bicycle parking spaces" (City of Victoria, 2011) as currently done in the City of Vancouver. The Strategy also recommends implementing solar panels for recharging purposes as a design guideline for bicycle lockers. Given these policies, the City has enhanced the capacity to adopt e-bikes through the provision of accommodating infrastructure, primarily in the form of appropriate e-bike parking units.

E-bike Market

Although there is limited data on the current e-bike market in Victoria, the amount of current retail shops of e-bikes can be used as a proxy to understand the availability of e-bikes. Conducting a scan of e-bike and bicycle stores in British Columbia found that Vancouver currently has the highest amount both specialized e-bike stores and bicycle shops that include e-bikes in their collection, which was followed by the city of Victoria. More specifically, the city of Vancouver had ten bike stores that included the sale of e-bikes and four specialized e-bike retailers. While in Victoria, there were seven bicycle retail stores that sold e-bikes, and three stores that specialized in the retail of e-bikes. Therefore, Victoria's e-bike market—in terms of the availability of e-bike retail—is likely sufficient to support the growing interest and adoption of e-bikes in the city. However, e-bike manufacturers within BC were mostly concentrated in the Metro Vancouver region.

E-bike Programs

The research on e-bike retail stores sheds some light on the programs currently implemented to promote e-bike use by e-bike retailers. Ride the Glide, a Victoria-based e-bike retail store, offers a *Bike to Work Promo* which allows individuals to rent an e-bike for a week, and if an e-bike purchase is then made, half of the rental cost is applied to the e-bike purchase.

The BC SCRAP-IT program is an early retirement vehicle program implemented by the province of BC in which incentives are provided to replace polluting vehicles with sustainable transportation modes (BC SCRAP-IT Program Society, n.d.). Although this program is not centered around e-bikes as the main incentive is a discount for the purchase of a new electric vehicle, one available option is a discount for a new e-bike purchase. The specific incentive is a discount of $850 which is comprised of a $100 discount at the point of sale of the vehicle and an additional $750 at the point of e-bike purchase (BC SCRAP-IT Program Society, n.d.). However, this program applies only to purchases made in participating e-bike retailers which there are currently eight in Victoria.

Bike Share Program

For general bicycling programs, a relevant initiative recently implemented in Victoria is bike-share. U-bicycle introduced 150 rental bikes in Victoria in September 2017, using a "dockless" system which allows rentals to begin and end anywhere within a designated service area or "home zone" using a smartphone application (CBC News, 2017). Rentals cost $1 per 30 minutes of use. Bike-share programs in general are known to increase bicycle usage and decrease auto trips (Fishman, 2016), and this system will likely help Victoria move toward sustainable mobility goals.

Bike-share systems have expanded rapidly throughout the world, and are more recently moving toward electric bicycles. DropBike, for example, is launching dock-less electric bike-share systems in several British Columbia cities in 2018 and 2019. Lime Bikes has increasingly shifted their dock-less bike-share fleets in various North American cities away from conventional and toward electric bicycles. Evidence is still limited because these systems are new, but in addition to direct usage effects, electric bike-share systems could have the added benefit of expanding awareness of and comfort with e-bikes.

Project Process and Report Outline

The rest of this report follows the steps involved in executing the research:

- Part II provides an overview of existing e-bike incentive programs from cities around the world,
- Part III outlines a range of options for a municipal-led e-bike incentive program that could be implemented in Victoria,
- Part IV develops more details on two potential financial incentive programs: a new rebate program and an enhancement of the existing BC SCRAP-IT program,
- Part V presents an e-bike demand modeling method and results for evaluating the rebate and SCRAP-IT programs described in Part IV, and
- Part VI presents the recommended rebate-based e-bike incentive program for Victoria, along with an estimation of broader impacts and suggestions for further study and analysis.


Source: City of Victoria

Part II:

Existing E-Bike Incentive Programs

Summary of Program Types & Case Studies

E-BIKE PROGRAM TYPES

PURCHASE REBATES

E-Bike Rebate Program, Los Angeles (United States)

E-Bike Fleet Program, Texas (United States)

Grants for Electric Cargo Bikes, Oslo (Norway)

RENTAL/LENDING

Summit Bike Share in Park City, Utah (United States)

City Bike, Stockholm (Sweden)

JUMP Bikes, San Francisco (United States)

Lloyd Employee E-Fleet Program in Lloyd District, Portland (United States)

Journey Matters Bike Scheme, Rotherham (England)

Momentum Mag's E-Bike Lending Library, Vancouver (Canada)

Electric Bike Pilot Project, Montreal (Canada)

INFRASTRUCTURE

Solar Charging Station in Oakland, California (United States)

Quikbyke in Omaha, Nebraska (United States)

EDUCATION & TRAINING

E-Bike Riding Guidance by the Association of Bikeability Schemes, (England)

E-Bike Rebate Program, Los Angeles (United States)

OVERVIEW

An example of an e-bike incentive program that incorporated a training component was the E-bike Rebate Program administered by Bike San Gabriel Valley (BikeSGV) and the City of El Monte. BikeSGV is a cycling coalition that advocates for better active transportation and public transit trips in San Gabriel Valley. Thus, they aim to promote cycling through building partnerships between the city and the community, creating educational opportunities for interested cyclists, and supporting policies that increase bicycle, pedestrian, and transit friendly communities. Although the specific intent of this program was not disclosed, the program worked to incentivize residents living near the I-10 freeway in California to purchase e-bikes by entering them for a chance to win a $700 rebate after purchasing an e-bike. Thus, eligible applicants were limited to residents living within three miles of the I-10 freeway. In addition, to ensure safety of these e-bike riders and the surrounding road users, applicants were required to participate in a three-hour cycling class held by BikeSGV in order to be eligible for the rebate.

E-Bike Fleet Program, Texas (United States)

OVERVIEW

In an effort to encourage e-bike fleets for organizations and delivery operations, the City of Austin launched an E-Bike Fleet Rebate program in 2016. The program was initiated by Austin Energy and the City of Austin with the aim to electrify transportation options downtown (Austin Energy 2016). Thus, this program provides rebates that increase with the sale price of the e-bike. As a fleet program, applicants must purchase five to 25 e-bikes to qualify for this rebate (Austin Energy 2016). Thus, these fleets are deemed suitable to promote e-bike use for companies that wish to provide their employees a sustainable mode of transport for lunch breaks and off-campus meetings (Austin Energy 2016). Although advertised as an e-bike fleet program, e-scooters also qualify for rebates.

CHARGING STATIONS

The first e-bike fleet purchased through this rebate program was by BikeTexas, a non-profit organization that educates and advocates for better cycling safety and access. With the expected increase in e-bike usage, the City of Austin and Austin Energy has installed public charging stations that are powered by renewable energy throughout the city. More recently, Austin Energy has built a Solar Kiosk—designed by Sol Design Lab—which utilizes solar energy to charge e-bikes whilst providing shaded seating and emergency power during black outs (Sol Design Lab 2017). A similar solar e-bike charging system has been built in Portland, Oregon (Maus 2010).

Key points

- Where: City of El Monte, Los Angeles
- Program: Applicants living near I-10 freeway have a chance to win a $700 e-bike rebate after participating in BikeSGV's cycling class
- Financing: BikeSGV and the City received funds from the toll revenue collected from the I-10 freeway
- Result: There is potential for program expansion as the pilot ended with a wait list of interested and potential e-bike riders

Key points

- Where: Austin, Texas (Population: 947,890)
- Program: Rebates are offered for purchases of five to 25 e-bikes to incentivize fleet purchases for companies and organizations. To promote e-bike use, the City has also made efforts to increase charging infrastructure.
- Fee: Retail price of e-bikes after rebate (between $100-400)
- Result: First e-bike fleet purchased by BikeTexas, a cycling coalition in Texas

Grants for Electric Cargo Bikes, Oslo (Norway)

Electric cargo bike used by German postal service (Carl Paulaner Gefeweizen, n.d.)

OVERVIEW

In Oslo, the government is providing up to $1,200 for the purchases of electric cargo bikes. The program is designed so the City provides 25% of the electric cargo bike purchase cost to successful applicants, which is capped at $1,200. This initiative is partly in response to the poor air quality in Oslo that lead to the City implementing a temporary driving ban on diesel-fuelled vehicles (Weller 2017). This program also supports the nation's agenda to shift residents from using automobiles to sustainable and cleaner modes of transport. Thus, the program is part of the $1 billion scheme that Norway has dedicated for new bike infrastructure and a total of 5 million kroner ($600,000) has been dedicated specifically to this project (Weller 2017). Therefore, considering the high average cost of e-bikes, this program will provide approximately 500 to 1,000 electric cargo bikes (Weller 2017).

RECEPTION

Although this program is deemed as an appropriate solution for the hilly terrain in Oslo, the program has received criticism regarding the fair allocation of grants. As a program designed without a selection method of grant recipients from the applicant pool, there is concern that it will be utilized mainly by Oslo's wealthier residents. This is largely due to the perception that lower income residents will be unlikely to take advantage of the grant, given the high initial purchase cost of electric cargo bikes (MacCarthy 2017). However, it should be noted that the City has implemented this program based on the previous success of a similar bike incentive program which offered up to $600 for the purchase of conventional bicycles (MacCarthy 2017). As a result of these efforts to increase active transportation and e-bike use, national e-bikes sales are said to have increased from 20,000 units in 2015 to over 40,000 units in 2017 (Vakmedianet 2017).

Key points

- Where: Oslo, Norway (Population: 618,000)
- Program: Residents in Oslo can apply for grants that cover up to 35% of new electric cargo bike purchases, regardless of income level
- Fee/Cost: Retail price after ~$1,200 subsidy
- Financing: Part of Norway's $1 billion investment catered for bicycling infrastructure. A total of $600,000 is dedicated to this program specifically

Summit Bike Share in Park City, Utah (United States)

CONTEXT

In 2017, Summit County in Park City, Utah, launched a bike share program that specializes only in renting pedal-assist e-bikes. Similar to Victoria, Park City is a municipality that has made a commitment to promote sustainability through their goal to be a net-zero carbon city that runs on 100% renewable electricity for city operations by 2022 (Park City n.d.). This goal is extended until 2032 for the community. Thus, the mountainous terrain in Summit County, combined with their goal to increase sustainable modes of transportation make an e-bike share system feasible in the area.

FUNDING

The program was created through a partnership with Bewegen Technologies, a Canadian company who found that in a bike share program that offered both conventional bicycles and e-bikes, pedal assist e-bikes were checked out three times more often than conventional bikes (Smith 2017). The main source of funding was provided by the Utah Transit Authority who awarded $500,000 for this program (McNaughton 2017). Being the first complete e-bike share program implemented in the United States that utilizes a mobile app, this program allows extensive data collection regarding e-bike usage. The publicly available data indicates the most popular return and check-out stations, total distances traveled, and the total number of trips and active members.

PAYMENT SYSTEM

Despite using e-bikes instead of conventional bicycles, the e-bike share operates similarly to standard bike share systems with docking stations. However, these docking stations are equipped with charging technology as the battery typically lasts three to four hours (Smith 2017). Users can use an app or a pass that can be purchased at the kiosk located next to the docking stations. The current stations are located near major transit stations and city centers to encourage use by both Summit County residents and visitors. Thus, the fee system also offers a variety of passes to accommodate short-term visitors and long-term users.

NUMBER OF E-BIKES

With a relatively small estimated population of 40,307 in 2016, the scale of the program is relatively small with a total of nine stations and 88 e-bikes (U.S. Census Bureau n.d.; Smith 2017). However, there is already a plan for expansion by Summit County and Park City to add eight more stations given the positive response and feedback regarding the program (Smith 2017). These additions will also be funded by an additional grant provided by the Utah Transit Authority (McNaughton 2017). Alfred Knotts, Park City Transportation Planning Manager, has revealed the goal is to eventually expand the program to 250 e-bikes (Smith 2017).

Key points

- Where: Summit County, Utah (Population: 40,307)
- Program: E-bike share program in the U.S. implemented in 2017 with a starting set-up of 9 docking stations and 88 e-bikes
- Cost: Pass based (single trip, weekly, monthly) and membership based (annual, resident, employee) pricing system
- Finance: Funded through grants provided by the Utah Transit Authority

Summit Bike Share docking station (Angelique McNaughton, n.d.)

City Bike, Stockholm (Sweden)


Stockholm Vice Mayor of Traffic on one of the new hybrid e-bike (City of Stockholm, n.d.)

CONTEXT

A prominent example of a successful bike share system that has transformed into an e-bike share is the City Bike program implemented in Stockholm, Sweden. The bike share program initially consisted of 1,200 bicycles and was used more than 500,000 times in 2016 (Roden 2017). Given the positive performance of the system and to present bike sharing as a viable option for commuters, 5000 new e-bikes replaced the existing bike share fleet. The new system utilizes a dock-less system and is available from 300 locations (Markham 2017). Also, due to the demand for longer borrowing periods, the program extended their hours from 6am to 10pm to 24 hours year-round (Markham 2017).

'HYBRID' E-BIKES

A unique approach of this bike share system is that users are provided with the e-bike battery after they sign up for the program. Therefore, the newly added e-bikes are referred to as 'hybrid e-bikes' as users can ride them as a conventional bicycle or as an e-bike, depending on whether they choose to add their battery for additional power. This minimizes the need for charging stations as users can charge the battery at home or at the workplace prior to renting the hybrid e-bike.

FEE SYSTEM

The program fee costs 270 kroner (approximately $33) for an annual pass (Love 2017). Therefore, it is a relatively affordable system compared to similar membership-based bike share programs in North America. This is partially due to the newly formed partnership between the City of Stockholm and JCDecaux SA, a worldwide outdoor advertising company. Their 10-year contract allows JCDecaux to provide funding by advertising street furniture. As a result, JCDecaux "will operate 280 double-sided back-lite 2m2 advertising units and 70 digital 86" units which will display animated advertising content" (JCDecaux n.d.)

Key points

- Where: Stockholm, Sweden (Population: 950,000)
- Program: Existing dock-less bike share system in Stockholm that was replaced by 5000 'hybrid e-bikes' which can be utilized as both a conventional bicycle and an e-bike
- Cost: Relatively low membership fee of $33/year
- Financing: Financed by JCDecaux Sweden, an outdoor advertising company, through advertising street furniture

JUMP Bikes, San Francisco (United States)

CONTEXT

JUMP Bikes is planned to implement a dock-less bike-sharing system that provides pedal-assist e-bikes in San Francisco. As a dock-less system, the u-locks are equipped on the e-bike to be used for parking on proper public bike racks (Baldassari 2018). JUMP Bikes utilizes geofencing technology, so although bikes can be locked onto any bike parking facility, they have to be returned within a certain area.

FEE SYSTEM

In regards to user fees, JUMP Bikes charge $2 for the first 30 minutes, with an additional 7 cents per minute after the initial 30 minutes (Pender 2018). However, as these e-bikes will require charging, e-bikes will be picked up and charged at a warehouse by JUMP initially. However, the company hopes to install designated charging stations in the long-term.

EXCLUSIVE PERMIT

Although there were several other bike and e-bike sharing systems interested in operating in San Francisco, JUMP Bikes was issued the sole permit from the San Francisco Municipal Transportation Agency to run the program as a pilot with 250 starting e-bikes. If the city approves, this 18-month permit will allow an additional 250 e-bikes after the first nine months (Pender 2018). The exclusive permit system was chosen by the Agency as the performance of this pilot program are deemed to provide recommendations for the current dock-less bike share permit application process in addition to general policy recommendations (Jose 2018). However, in response, this exclusive permit system has sparked controversy surrounding the permit process from other competing dock-less bike sharing companies that also submitted applications.

FINANCING

In terms of financing, the program has raised $10 million in a Series A round led by Menlo Ventures (Dickey 2018). Other participating companies include Sinewave Ventures, and Esther Dyson (Dickey 2018). More recently, JUMP has partnered with Uber so Uber customers can locate and reserve a JUMP bike through the Uber app.

Key points

- Where: San Francisco (Population: 864,816)
- Program: Pilot dock-less e-bike sharing system launched in January 2018
- Fees: $2 for the first 30 minutes, with an additional 7 cents per minute afterwards
- Financing: $10 million funding by Menlo Ventures, Sinewave Ventures, Esther Dyson, and others

A JUMP Bike (JUMP Bike, n.d.)

Lloyd Employee E-Fleet Program in Lloyd District, Portland (United States)

THE LLOYD ECODISTRICT (LED)

Lloyd EcoDistrict is a business association located in Portland, Oregon that encourages, educates, and supports residents and businesses in the Lloyd neighbourhood to achieve prosperity, better environmental quality and social welfare (Lloyd District n.d.). Their programs aim to improve energy efficiency in ways that also produce economic benefits for the community. Thus, their programs primarily address transportation, water, energy, waste and education for neighbourhood residents, businesses, and public agencies (Lloyd District n.d.).

E-BIKE CHALLENGE

The E-Bike Challenge is a program that was implemented in 2015 by LED and GenZe, an e-bike manufacturer, in Lloyd District. This district-wide program incentivized e-bike use through a challenge to test e-bikes by signing up for a local trip which entered participants into the pool to win a GenZe e-bike. With the support of 12 area businesses, the program aimed to engage both local residents and employees to test e-bikes as a viable mode of transport (Lloyd EcoDistrict, n.d.). This initial program helped create partnerships with the local businesses which helped the formation of the Employee E-Fleet Program.

EMPLOYEE E-FLEET PROGRAM

The Employee E-Fleet Program operated by LED is a pilot program that was launched from April 25th to June 5th, 2016 (Lloyd EcoDistrict 2016). This program was formed and operated through a partnership between the Lloyd EcoDistrict, GenZe, and Go Lloyd, a non-profit organization that addresses local transportation issues through public/private partnerships (Lloyd EcoDistrict n.d.). As a program that aimed to incorporate e-bike use by businesses, the pilot consisted of four participating businesses that operate in the Lloyd District. The program loaned e-bikes for a three-week period to these businesses, with each entity having three or four e-bikes. However, to ensure participants could utilize these e-bike to its full potential, GenZe allowed test rides and hosted information sessions for the participating employees (Lloyd EcoDistrict 2016, 4). Participants also completed exit surveys and interviews to allow LED evaluate the performance of the program in terms of operation efficiency, employee satisfaction, and benefits to the community. As a result, 57% of participants used the e-bikes for their lunch breaks, while 27% used them for running personal or business errands (Lloyd EcoDistrict 2016, ii).

FUTURE PLANS

According to LED, this pilot program is anticipated to expand to include 25 businesses after the first phase of implementation (Lloyd EcoDistrict 2016). The ultimate goal of this program is to reach out to the residents of Lloyd District. In addition, this program led to the creation of a collective buy-in program that allows businesses to purchase an e-fleet at discounted rates (Lloyd EcoDistrict n.d.). Moreover, to accommodate the potential growth in e-bike use, LED also plans to partner with the City to increase e-bike charging infrastructure in the district (Lloyd EcoDistrict 2016).

Key points

- Where: Lloyd District, Portland, Oregon (Population: 15,887)
- Program: Three-week rental of e-bike fleets to interested local businesses
- Result: 57% of participants used e-bikes for lunch breaks and 27% used for them for running personal/ business errands. Led to the creation of their e-bike collective buy-in program

GenZe e-bike (Lloyd EcoDistrict, 2016)

Journey Matters Bike Scheme, Rotherham (England)

CONTEXT

The Journey Matters bike scheme is an e-bike rental program funded by Carplus-Bikeplus and the Department for Transport that provides local employees and residents free e-bikes for up to three months (Rotherham Metropolitan Borough Council 2015). Carplus-Bikeplus is a non-profit organization that focuses on shared mobility in England. In regards to implementation, the program is operated by Inmotion!, a partnership organization between councils in South Yorkshire that aim to implement the Department for Transport's Sustainable Travel programs, and Journey Matters, an organization that promotes bicycling use and education (Inmotion! n.d.). This program was originally one of the 11 projects under the Shared Electric Bike Program implemented by Carplus-Bikeplus across England to understand how these programs performed in their respective study areas.

TRAINING

Currently, 65 e-bikes are available for free rental through the Journey Matters Bike Scheme. However, as a long-term rental program, the program also provides bike lights, a bike lock and helmet to make renting an easy and attractive option for interested participants (Inmotion! n.d.). Moreover, to familiarize inexperienced cyclists and encourage e-bike use for all skill levels, the program also provides bike maintenance and free cycle training throughout the rental period. Lastly, with the intention to increase bicycling in general, the rental program also provides a range of bikes from pedal to folding bikes.

RESULTS

As a result of this program which is also perceived as a "try-before-you-buy" scheme, 29% of participants intended to purchase an e-bike after their rental trial (Carplus n.d.). Carplus also reports that 35% of participants purchased an e-bike as a result of participating in the program (Carplus 2016). However, the report also notes that some participants could not afford to purchase the e-bikes after the rental period due to high retail prices. Overall, the program (which include standard bike rentals) is perceived to be successful as it was utilized by several businesses in Rotherham including, South Yorkshire Police, Rotherham Borough Council, Royal Mail, NHS, and Webhelp UK (Carplus n.d.). Moreover, their success is largely attributed to their branding of a mobile cycle hub, which works as an e-bike hire service with other complementary services such as cycle training, e-bike check-ups and repair (Carplus n.d., 54). Additionally, this mobile hub increases accessibility as it often visits major town centers in Rotherham.

Mobile HUB used for the Journey Matters program (Carplus, n.d.)

Key points

- Where: Rotherham, England (Population: 947,890)
- Program: Free e-bike rental for up to three months which includes bike lights, bike lock and helmet rental
- Fee: Free
- Financing: Reliant on grant funding from the Department for Transport

Momentum Mag's E-Bike Lending Library, Vancouver (Canada)

Momentum Magazine and ABUS locks have partnered with local e-bike manufacturers in Vancouver to implement a E-bike Lending Library which offers e-bike rentals for up to two weeks. The library offers a range of e-bike types to allow new e-bike riders to explore different e-bikes and find which best suits their lifestyle (Momentum Mag n.d.). Interested e-bike riders simply create an account on Momentum Mag's website and can check out available e-bikes for 3 to 14 days. According to the user agreement, users are charged $100 for each e-bike that is rented out, although it was available for free between May 18th and June 31st. These bikes must be picked up and returned to the bike store located in East Vancouver. Moreover, there is limited availability as this location is open only on Mondays and Thursdays.

E-B ike Lending Library Project (Momentum Mag, 2017)

Key points

- Where: Vancouver, British Columbia (Population: 947,890)
- Program: E-bike rental program that allows riders to borrow an e-bike for up to two weeks
- Fee: $100 per e-bike
- Results: Follow-up and results of performance currently not available

Electric Bike Pilot Project, Montreal (Canada)

In Montreal, the City and Velo-Transit, an e-bike manufacturer, teamed up to implement an e-bike pilot project aimed at local businesses and their employees. This pilot consisted of 50 e-bikes that were rented out to employees of partner companies in the Montreal metropolitan area (E-bike Generation 2017). As a result, the project had 500 participating employees sharing 50 bikes for two weeks at a time (Carpenter 2017). The aim was to encourage commuters who may be hesitant to cycle to work due to long distances, to start using e-bikes as an alternative option to the car. To make e-bike use easier, the project also built charging facilities at the workplace and charged a fee of $25 to cover insurance (Carpenter 2017). However, after the pilot period, participants have to purchase their own e-bikes to cover the cost of the e-bike, secure parking, a charging station, and road-side assistance (Carpenter 2017). As a result, continuing users will incur an estimated cost between approximately $3,000 and $4,000.

A Velo-Transit Bike (Velo-Transit, n.d.)

Key points

- Where: Montreal, Canada
- Program: Pilot program that rented out e-bikes to employees of local companies
- Fee: $25 per use during the pilot phase
- Results: Uptake and results of pilot program currently unavailable

Solar Charging Station in Oakland, California (United States)

Solar powered charging station in Oakland, California (DC Solar)

In Oakland, a pilot program was implemented to provide solar powered electric bikes and scooters. This pilot includes a mobile solar charging station provided by Bike Solar Oakland, a community partnership that aims to promote sustainable urban transportation. This station also includes eight solar powered e-bikes provided by Mahindra Genze, an e-bike and e-scooter company. This community partnership also consists of DC Solar, which built the solar powered charging station and California Clean Energy Fund, which is a solar service company, and Jack London Improvement District, where the pilot was implemented. This temporary station provides e-bikes that can be rented out for short trips. Although the exact system used for renting and returning these e-bikes is not disclosed, these e-bikes are most likely returned to the station for solar charging.

Key points

- Where: Oakland, California (Population: 420,005)
- Program: Pilot bike share system that provides eight solar powered e-bikes in a mobile charging station
- Financing: Partnership between Jack London Improvement District, Mahindra Genze, DC Solar, California Clean Energy Fund, Sungevity, and IRFTS Shadow Solar

Quikbyke in Omaha, Nebraska (United States)


Self-contained solar powered shipping container (Treehugger/Quikbyke)

Quikbyke is a type of e-bike share system that is offered from a solar-powered shipping container. This small-scale e-bike share system provides six e-bikes for rent and was trialed in Nebraska, Omaha. This program was implemented by EV world, which is an internet-based web publication that advocates for electric vehicle technology. A self-container was used to allow the system to be carried by ship or truck to various locations. As external energy inputs are not required due to its solar-powered component, the container does not require any power hook-ups or additional infrastructure.

Key points

- Where: Omaha, Nebraska (Population: 446,970)
- Program: Trial program that provides six solar powered e-bikes for rent from a solar powered shipping container
- Financing: Created and implemented by EV World

E-Bike Riding Guidance by the Association of Bikeability Schemes, England

OVERVIEW

The Association of Bikeability Schemes (TABS) is a trade association that aims to deliver cycle training to enhance road safety. They have recognized the growing use of e-bikes in England, which has led to the creation of publicly available documents regarding e-bike training. Similar to the Journey Matters Scheme, this initiative was funded by BikePlus as part of their Shared Electric Bike Program.

NATIONAL STANDARD

Firstly, an E-Bikebility National Standard was created which outlines the criteria trainers should refer to when assessing the skill level of e-bike riders. The National Standard follows similar principles for when training motorists and car drivers (Department of Transport 2012). Thus, this criterion contains requirements such as demonstrating the understanding of e-bike parts and their functions as well as the laws regarding e-bike use. Other requirements that aim to ensure safety include demonstrating a solid understanding of safety equipment and e-bike security, and being able to share riding facilities with pedestrians and other cyclists.

GUIDANCE FOR E-BIKE RIDERS

TABS also produced a document that outlines detailed guidance for e-bike riders. This includes summarizing the legalities of riding an e-bike in England, what parts to check before riding an e-bike to ensure safety (e.g. brakes, wheels, helmets), and how to ride e-bikes on and off roads. This document is intended to help riders meet the requirements outlined in the E-Bikeability National Standard.

E-BIKE RIDING TIPS

Lastly, there is a document catered for e-bike users that outlines TABS' top ten tips for riding e-bikes. This summarizes the main points mentioned in the detailed guidance document for e-bike riders in an infographic format. Increasing the availability of such guidelines are intended to reduce the uncertainty surrounding e-bike regulations and help potential riders of all abilities gain confidence in riding an e-bike.

Bikeability branding logo (British Cycling, n.d.)

Key points

- Where: England
- Program: Creation of an E-bikeability National Standard and e-bike riding tips by The Association of Bikeability Schemes (TABS)
- Fee: Documents available for free

Summary of Existing E-Bike Incentive Programs

The case studies examined above have multiple dimensions of program types; the table below summarizes the dimensions covered by each case study. This is important to consider when evaluating these case studies since some programs have multiple dimensions which can have a greater impact in promoting e-bikes.

EBIP Programs	**Program Types**			
	Purchase Rebates	Rental/Lending Programs	Infrastructure	Educational & Training Programs
E-Bike Rebate Program, Los Angeles	X			
E-Bike Fleet Program, Texas	X			
Grants for Electric Cargo Bikes, Oslo	X			
Summit Bike Share, Austin		X		
City Bike, Stockholm		X		
JUMP Bikes, San Francisco		X		X
E-Bike Challenge, Portland		X	X	
Lloyd Employee E-Fleet Program, Portland		X	X	X
Journey Matters Bike Scheme, Rotherham			X	X
E-Bike Lending Library, Vancouver			X	
Electric Bike Pilot Project, Montreal			X	
Solar Charging Station in Oakland, California		X	X	
Quikbyke in Omaha, Nebraska		X	X	
E-Bike Riding Guidance, England				X

Source: City of Victoria

Part III:

Overview of E-Bike Incentive Program Options for Victoria

Purchase Rebates

General

Purchase rebates for e-bikes are common incentive programs that are often led by the public sector. Rebate programs provide a refund that covers a certain amount of an e-bike purchase. These programs require an application system, where eligible participants apply to the operating organization to receive a rebate. Although incentive programs based on rebates are widely adopted, the requirements to receive a rebate can vary depending on the aim of the program. For example, in British Columbia, the BC SCRAP-IT program provide e-bike rebates in exchange for applicants giving away their high emissions automobile since the overarching aim is to reduce greenhouse gas emissions through cleaner transportation modes. In other cases, e-bike rebates can be limited to certain e-bike types to promote certain e-bike uses and typologies. Many of these programs require partnerships with local e-bike retailers or manufacturers to enlist as eligible retailers where the rebates can be used.

Cargo only

To promote electric cargo bikes ('e-cargo bikes'), purchase rebates can be limited to purchases of e-cargo bikes. An example of this is the grant program for electric cargo bikes implement in Oslo, Norway, where the government refunded 25% of the e-cargo bike purchase cost to applicants. The application was open to any resident of Oslo, regardless of income level.

Fleet only

Similar to rebate programs that are limited to e-cargo bikes, another option is to implement rebate programs that are limited to e-bike fleet purchases. This would likely be catered to organizations and corporations that are looking to purchase a fleet for their employees or members. An example of a fleet rebate program is the E-Bike Fleet Rebate program implemented in Austin, Texas by Austin Energy and the City of Austin. The program incentivized e-bike fleet purchases by providing rebates for purchases between five and 25 e-bikes.

Lottery-type or "earned" through one of the other programs

E-bike rebates can also be organized through a lottery-based system. This entails applicants being entered to win an e-bike rebate in exchange for participating in another e-bike related program. One example of this is the E-Bike Challenge implemented by Lloyd EcoDistrict, where individuals who participated in e-bike test rides for their local trips were entered to win a free e-bike. Although this program did not offer rebates, applicants were incentivized to test e-bikes as part of their daily travel. Another example is the E-bike Rebate Program in the City of El Monte, where to be eligible, participants were required to participate in a cycle training class at BikeSGV. Although, this type of program limits the number of rebates that can be offered to residents, it promotes e-bikes through other program channel

Similar rebate programs implemented in Victoria:

Rainwater Rewards Program

- Program implemented since May 2015
- Homes with a 1 - 4 units can apply for a rebate to help with installation costs

FortisBC Energy Efficiency Programs

- Offers rebates and incentives on efficient natural gas equipment
- Ranges from boilers, water heaters, and cooking equipment

Rental/Lending Programs

Public e-bike share (docked or dockless)

E-bike share is a growing incentive program that is often implemented on the municipal scale. E-bike shares offer rental e-bikes for short-term trips that residents and visitors can pick-up and drop-off either at specific docking stations or any other designated bike parking locations. Docking stations for e-bike shares are often equipped with charging technology as done by Summit Bike Share in Utah. In contrast, dockless e-bike share systems may require program operators to pick up and charge the e-bikes occasionally, or require users to return their e-bike to a designated charging station for credit as planned by JUMP Bikes. The payment system may differ across programs, as Summit Bike Share requires riders to purchase a membership pass that ranges from a weekly pass to an year-long pass. However, they also offer a fee for single trips presumably to promote e-bike use by occasional riders or visitors. In comparison, JUMP Bikes users do not require memberships, however are charged by the length of time of their bike ride. Most bike share systems set up a fee for 30 minute rides, and riders accrue additional charges for trips exceeding 30 minutes. E-bike share systems offer different operating and financing schemes as they can be implemented by public agencies, as done in Summit County, a private agency such as JUMP Bikes, or through a private-public partnership like City Bike in Stockholm.

Lending library to individuals (free or fee)

Lending libraries are similar to e-bike shares, however, offer e-bike rentals for short-term periods (i.e. days or weeks). Therefore, e-bikes rented from lending libraries often require e-bikes to be picked up and dropped off at a designated store after the rental period. The Momentum Mag's E-Bike Lending Library is an example where e-bikes are available for rental between three to 14 days. This particular program charges users a $100 fee per e-bike. There is a similar variation in Brattleboro, Vermont, where interested riders can take an e-bike home for up to three days. However, unlike Momentum Mag's Lending Library, renters are required to participate in a free bike consultation to explore a suitable e-bike type and a training session to learn about e-b ike safety and operation prior to rental. Both programs are run by cycling organizations that aim to promote a cycling culture in their respective cities.

Summary of E-bike Share Types

	Summit Bike Share	**City Bike**	**JUMP Bikes**
Docking/dockless	Docking stations	Dockless system	Dockless system
Payment system	Membership-based	Membership-based	Time-based
Number of e-bikes	87	5,000	250
Partnership and operating system	Publicly owned and operated	Publicly owned and privately operated	Privately owned and privately operated

U-Bicycle in Victoria (U-bicycle/CBC News)

Jurisdictaional Precendents

Public Bike Share in Vancouver

City staff requested the following bylaws to be amended to accommodate for their public bike share system:

- Sign bylaw
- Zoning and Development bylaw
- Various Comprehensiive Development (CD) District bylaws
- City Land Use bylaw
- Street Vending bylaw
- Vehicle for Hire bylaw
- License bylaw
- Building bylaw

Infrastructure

Public charging stations

For any incentive program that intends to increase e-bike use within an area, an important consideration is the need for accommodating public charging infrastructure. Public charging stations for e-bikes require standard level 1 charging outlets unlike electric automobiles. An example of a program that also increased publicly available charging stations is the E-Fleet Rebate Program in Austin, Texas. As a program implemented by Austin Energy and the City of Austin, over 100 public charging stations using renewable energy are currently made available by Austin Energy. Their efforts to electrify transportation options and promote e-bike use are also highlight by their recent collaboration with Sol Design Lab to implement a solar kiosk that operates as a e-bike charging facility and a rest stop.

Incentives for employer charging stations

For some e-bike share systems, docking stations can be designated to interested organizations and companies. For example, Ford GoBike—a bike share system that plans to include pedal-assist e-bikes into their fleet in 2018—has proposed a system that allows organizations and companies to purchase a docking station. This particular e-bike share system in San Francisco plans to allow organizations such as schools or local companies that wish to promote e-bike use for their employees, to purchase a docking station for $4,000 with maintenance fees. However, to ensure these locations are viable, the operator will provide discounts which will increase proportionately to the bike usage rates.

Mobi Bikes in Stanley Park (Mobi/Vancouver Bike Share Inc.)

Jurisdictaional Precendents

City of Victoria's Bicycle Parking Strategy

- Recommended that electric outlets be provided for 50% of long-term bicycle parking spaces
- Recommended zoning amendement to require the provision of one electrical outlet for every two long-term bicycle parking space

City of Vancouver Off-Street Bicycle Space Regulation

- Section 6.3.21 on electrical outlets states each two Class A bicycle spaces must have an electrical outlet

City of Vancouver's Rezoning and Development Application Requirements for Public Bike Share (PBS)

- PBS stations will be located on both public right-of-way and on statutory rights-of-way secured on private zoned lands
- Arrangements shall be made, to the satisfaction of the General Manager of Engineering Services and Director of Legal Services, for a Right of Way for the provision of space to accommodate a Public Bike Share (PBS) Station

Education & Training

Free classes

One method to incentivize e-bike use is through education and training sessions regarding e-bike riding. This method is particularly useful to offer inexperienced riders who may be hesitant to use e-bikes due to their unfamiliarity with road rules or e-bike technology. An example of a bicycling training program is the E-Bike Riding Guidance by the Association of Bikeability Schemes, which provides a national standard of e-bike riding skills that a rider must demonstrate. This organization also provides cycling sessions to teach interested riders on how to ride a bicycle safely. Although these sessions are available to anyone, it seems that the program is designed mainly for schools that wish to provide cycle training for their students. Moreover, there is a high degree of accessibility as training sessions can be taught by any registered Bikeability provider working in the area. Another example is the cycling class taught by BikeSGV in El Monte. Similar to the Bikeability Scheme, this program offers free cycling classes to help interested riders gain more confidence in riding bikes on the road.

Mobile van with training and test-bikes

An alternative method of implementing cycle training is through accessible, pop-up style outlets as done by the mobile HUB in the Journey Matters scheme. This mobile HUB circulates major areas in the city of Rotherham to advertise their free rentals of e-bikes. In addition to their bike loans, the HUB provides several other bike-related services such as providing advice regarding bike maintenance, planning out cycle routes, and scheduling free cycle trainings. The cycle training provided by Journey Matters is highly accessible as they are offered for free on any given day of the week. This program also offers a Bike Buddy system where riders can sign up to have a buddy to join the ride and offer advice on bike maintenance. This program is intended for cyclists across all skill levels to gain confidence and skills in cycling to help tackle new and alternatives routes.

Relevant Resources for Education and Training Programs

Creating Cycling Programs: The Toolkit

- Offers guidance on funding, structure, partnerships of bicycling programs in Canada for public, private, and non-profit agencies

BikeSense Manual

- Cycling safety manual for British Columbia
- Created by cycling instructors, cycling coalitions, police officers, and provicial authorities associated with traffic laws
- Currently maintained and updated by the BC Cycling Coalition

The Greater Victoria Bike to Work Society

- Non-profit society governed by a volunter board of directors
- Offers cycling courses for kids, youth, adults, and older adults
- Organizes Bike to Work Week annually

Cyclists in Greater Victoria (Bike to work BC Society)

Evaluation Table & Initial Assessment

The EBIP objectives were used as evaluation criteria in an initial qualitative assessment of the identified program types. Initial assessment results are shown in the table below, with values of 'low', 'medium', and 'high' indicating the broad potential of each program type to meet the objective, based on information available from the case studies.

EBIP Objectives	Program Types				
	Purchase Rebates	Rental/Lending Programs		Infrastructure	Educational & Training Programs
		Trip-based	Long-term		
1. Increases active transportation	**Low-medium** Purchase rebates often have a limit of available rebates, making the impact on active transportation relatively small	**Medium** Trip based systems directly provide e-biking options to more people	**Medium** These programs increase the accessibility of e-bikes at different locations, however are often limited in the number of e-bikes available	**Low-medium** The reviewed programs only include small-scale infrastructure initiatives, making the impact on active transportation relatively small	**Unknown** The immediate effects and impacts of educational and training programs of e-bikes on active transportation are unknown
2. Reduces GHG	**Low-medium** Although e-bike purchases are made easier, the impact on car substitution is limited given the limited availability of rebates	**Medium** Trip-based systems can increase short distance cycling trips that meet the standard time limit of bike share trips, however, are less likely to substitute longer car trips	**Medium** Rental e-bikes can help substitute automobile leisure trips, however, the impact on mode shift is limited due to the small number of e-bikes available	**Low-medium** These programs can incentivize longer e-bike trips from its charging technology and available e-bike rentals, however the impact on car substitution is limited given the small scale of the projects	**Unknown** The immediate effects and impacts of educational and training programs of e-bikes on the mode shift from cars are unknown
3. Addresses cost barriers	**High** These programs directly aim to reduce the purchase cost of e-bikes	**Medium** Rental programs reduce the need for owning an e-bike, making it more accessible in terms of cost		**Low-medium** Infrastructural improvements do not address the cost barriers of e-bikes directly, although increases accessibility	**Low** The reviewed programs do not address cost barriers
4. Enhances e-bike options	**Medium** Rebates can be catered to specific and different types of e-bikes	**Low** The reviewed trip-based programs are catered to standard e-bikes	**Medium** Some rental programs can offer different e-bike types to cater to different needs	**Low-medium** The reviewed programs only explore standard e-bikes	**Low-medium** The programs often provide education and training for standard e-bikes, which can be applied to other e-bikes types to a certain extent
5. Supports safety, comfort, and security	**Low-medium** E-bike owners need to enrol in cycling training themselves to feel safe and secure, unless the rebate program requires prior training	**Medium-high** Trip-based programs do not require security measures due to its docking stations and locking technology	**Medium** Some longer term rentals offer training programs to educate inexperienced cyclists	**Medium-high** The reviewed programs do not require security measures as the built infrastructure serves as a docking station	**High** Educational/training programs help riders improve their skills in increasing security (e.g. locking bikes) and safety (e.g. riding on traffic lanes) when riding e-bikes
6. Stimulates local economic activity	**High** Rebates can incentivize purchases from local e-bike manufacturers and retailers	**Medium-high** Increasing non-motorized access can help foster greater economic activity from both residents and visitors	**High** The reviewed programs are often catered to businesses to use instead of car fleets and can incentivize e-bike purchases after the rental period	**Low-medium** Due to the partnership with e-bike manufacturers, these programs can benefit the e-bike industry	**Low-medium** The availability of e-bike training programs may increase e-bikes ownership, stimulating the e-bike market
7. Ensures accountability, efficiency, scalability, and sustainability	**Low** Rebate programs are often limited in terms of availability and sustainability due to the high financial cost	**Medium** Sustainability, accountability, and scalability can be ensured depending on the uptake of the rental program and its financial model		**Low-medium** These programs are sustainable due to its energy efficiency and compact nature, however is best suited for small-scale programs	**High** Training and educational programs can be implemented at a lower cost in comparison to other program types and can be expanded across different municipalities, offering sustainability and scalability
8. Increases understanding and awareness of e-bike rules/regulations	**Low-medium** These programs often do not include any educational/training components, unless the rebate program requires prior training	**Medium** These programs can include educational/training components	**Medium** Rental programs can include an educational/training component	**Low** These programs often do not include any educational/training components	**High** These programs help riders learn and abide by the existing e-bike rules and regulations
9. Explores potential to create partnerships with other industry stakeholders and government agencies	**Medium** Rebates often require partnership with local e-bike retailers and manufacturers	**High** Offers a potential to partner with different advertising or bike share companies and can be implemented across different municipalities	**Medium** Longer-term bike rentals can be made possible through partnerships with local retailers and manufacturers	**High** These charging stations create the potential to partner with local e-bike manufacturers and energy suppliers	**Medium-high** Some e-bike training and educational classes can be incentivized as part of another rebate program in partnership with an e-bike manufacturer. These programs can be implemented on a regional level as well.

Based on this high-level evaluation, the most effective program types in regards to the nine objectives center around trip-based and long-term rental e-bike programs. A consideration is to design an incentive program that contains several dimensions to incorporate less effective program types (i.e. purchase rebates, infrastructure, and educational/training programs) as supplementary components.


Source: City of Victoria

Part IV:

Developing a Rebate-Based E-Bike Incentive Program

Introduction

After consultation with City of Victoria staff regarding findings from Parts I through III above, the decision was made to proceed with development of two potential financial incentive program types: a new rebate program, initially led by a municipal program in Victoria with potential to scale to the region, and an enhancement of the existing BC SCRAP-IT program with additional incentives for Victoria residents. The objective of this part of the report is to explore these two options in more detail. Options for program eligibility requirements, application processes, and rebate amounts are described and discussed. The next part of the report (Part V) estimates the potential impacts of the programs on e-bike sales in Victoria.

New Rebate Program

Program Overview

<u>What is a rebate program?</u>

Purchase rebates for e-bikes are common incentive programs that are often led by the public sector. In the context of e-bike incentives, rebate programs provide a refund that covers a certain amount of an e-bike purchase. These programs require an application system, where eligible participants apply to the operating organization to receive a rebate. Although incentive programs based on rebates are widely adopted, the requirements to receive a rebate can vary depending on the aim of the program. The BC SCRAP-IT program provides e-bike rebates in exchange for applicants scrapping their high emissions automobile as their overarching aim is to reduce greenhouse gas emissions through cleaner transportation modes. In other cases, e-bike rebates can be limited to certain e-bike types to promote different e-bike uses and typologies. Many of these programs require partnerships with local e-bike retailers or manufacturers to enlist as eligible retailers where the rebates can be used. The new rebate program described here would not entail specific requirements like scrapping a vehicle. Rebate program models both at the municipal and regional scales are discussed.

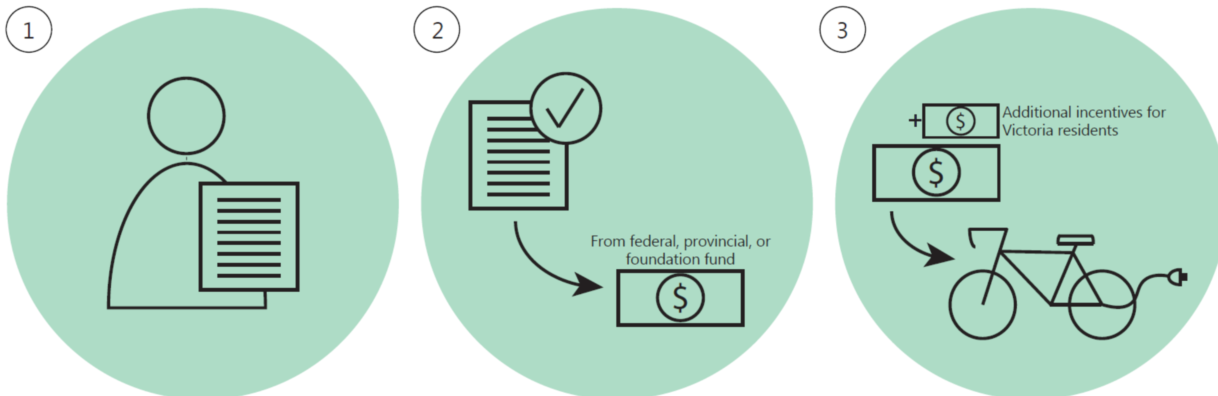
<u>Program options</u>

The following list outlines the different options considered under three key considerations for the program. This includes eligibility requirements, application and implementation procedures, and rebate amounts and structures of the program.

- Eligibility requirements for the program
  - E-bike typologies
  - Minimum e-bike price
  - Number of e-bikes
  - Additional incentives
- Application and implementation
  - Distribution of rebates
  - Third party organization

- Rebate amounts and number
    - Flat rebate
    - Tiered rebate

Model of a region-wide rebate program



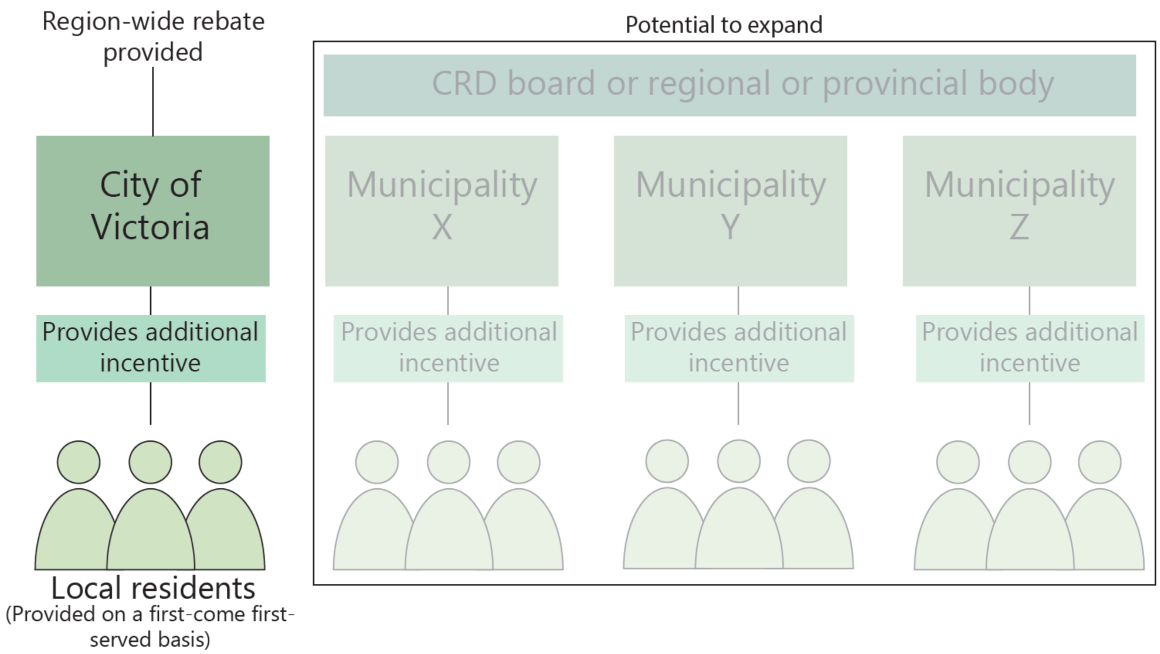
Rebate application sent to program administrator (i.e. third party group) by program participants in the Capital Regional District after the purchase of an e-bike.

Applications approved on a first-come first-served basis by the municipality. Rebates are provided from a federal, provincial, or foundation fund.

Municipal governments can supplement additional e-bike purchase incentives for residents in their municipality to enhance local e-bike adoption.

Program design considerations

Although this program can ultimately be administered as a region-wide program, the program's rebate amounts and impacts are estimated on the local scale as phase 1 of this program is expected to be implemented in Victoria as shown below. However, other program design components such as the eligibility requirements are applicable to the whole region. Therefore, the organizational structure consists of the City of Victoria piloting the program with the potential to extend the program to other member municipalities with the support from either the CRD board or a regional or provincial body as shown below. The method of distributing these rebates from either the CRD board, regional, or provincial body to member municipalities are discussed further in this report. These member municipalities can then contribute top-up or additional incentives to help promote local e-bike uptake. Therefore, local residents will apply for the rebates within their municipality and these rebates will be issued on a first-come first-served basis. The program itself will be administered by a third party organization which is explored later in this report.

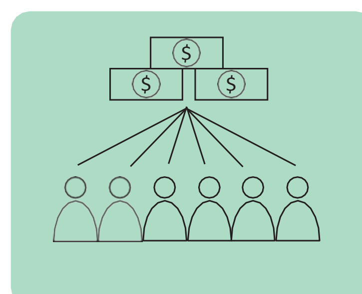


Rebate Distribution within a Region

If implemented as a region-wide program, an important component to consider is whether the rebates will be limited in supply. If the number of rebates available is limited, the distribution of rebates across the participating municipalities is essential to incorporate into the program design. Therefore, this section considers the method of distributing rebates from the region to member municipalities.

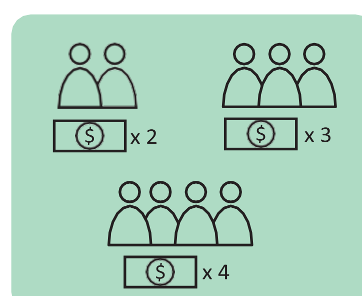
No distribution

An option to consider prior to exploring distribution methods is administering the program in a first-come, first-served fashion. This would entail designing a program that does not assign a specific number of rebates to each municipality. Instead, rebates will be issued from the CRD to applicants on a first-come, first-served basis regardless of their residing municipality.



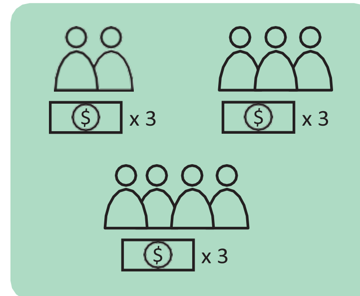
Distribution by population size

One option for rebate distribution is through population size. This would consist of allocating the number of rebates allowed by the program's fund, proportionately to each municipality's population size. However, a caveat of this structure is that it does not reflect the bicycling activity in each municipality, as some municipalities may have a higher cycling population that may be more interested in e-bike adoption.



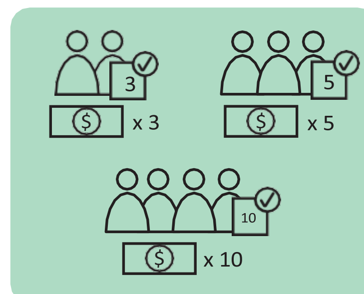
Equal distribution

Another method of distribution is to provide the same amount of rebates to each municipality. An example of a region-wide rebate program that utilizes equal distribution is the Rainwater Harvesting Rebate Program administered by the Regional District of Nanaimo (RDN). In this program, all residents have equal access to the rebate funds. However, once a municipality reaches 10% of the total program budget, approvals of additional applications are suspended to ensure these rebates are evenly distributed (RDN, n.d.). If there are still available funds after review, program funds may be re-allocated to municipalities that have already reached their 10% quota (RDN, n.d.). Therefore, this distribution type requires the program fund to be reviewed periodically to reallocate funds and ensure equal distribution, while responding to different program uptakes across municipalities.



Distribution by matching

Another option is for the regional rebate distribution to match the municipality's contribution for their local rebate. Therefore this requires municipalities to determine their funding allocated for the additional rebate, which is intended to promote local uptake of the program. The rebate from the regional fund will then be allocated to the municipality in a way that matches their municipal fund. This option ensures that the regional fund is distributed in a way that supports the municipality's initiative to implement the e-bike incentive program.

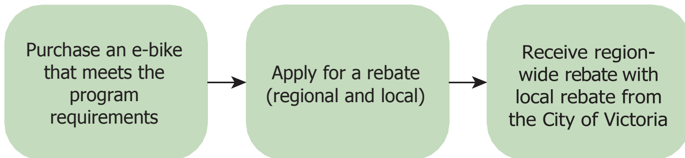


Rebate Application Process

The application process for residents can vary depending on the requirements for the additional rebate. Therefore, this section describes several possible application processes that applicants residing in Victoria can follow to receive a rebate. The local rebate refers to the top-up/additional incentive provided by the City of Victoria. The processes are presented in a way that does not require coordination between retailers and program administrators. Similar processes could be defined which provide the rebates at the point of sale, continent upon availability.

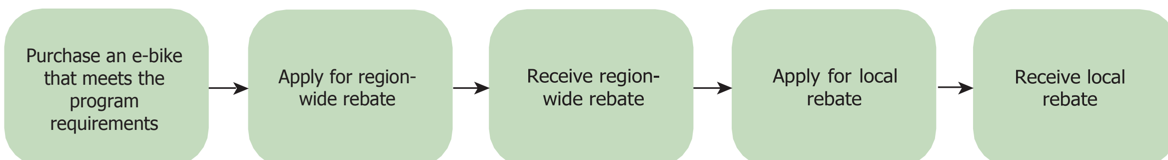
No additional requirement for a local rebate

Option 1a: One application with no additional requirements for local rebate



This option simplifies the application process for both the administering organization and the program participants as both rebates can be provided through the same application. Moreover, it may appeal to residents that there are no additional requirements to earn the local rebate.

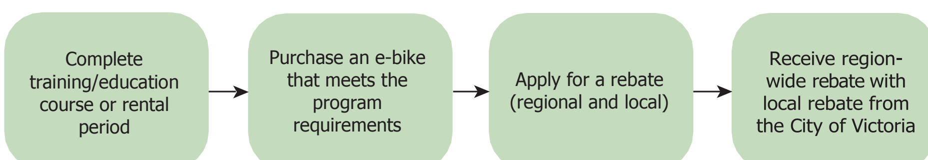
Option 1b: Two applications with no additional requirements for local rebate



Applicants may find this process inconvenient as it requires two application steps to receive the maximum rebate.

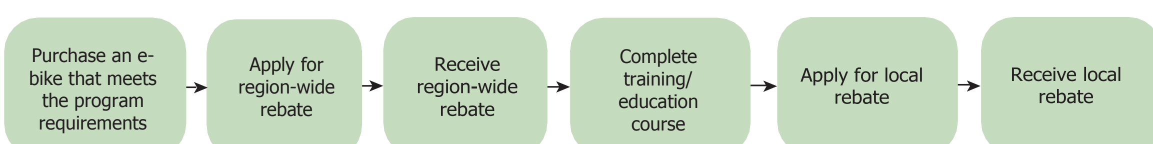
Education/training or rental requirement for a local rebate

Option 2a: One application with education/training or rental requirement for local rebate



This allows applicants to gain some experience in e-bike riding prior to purchase, either through a training/education program or during an initial rental period. This may be more appealing to interested but inexperienced potential cyclists/applicants. Similar to Option 1a, both the applicants and the administering organization benefit from a simplified application process.

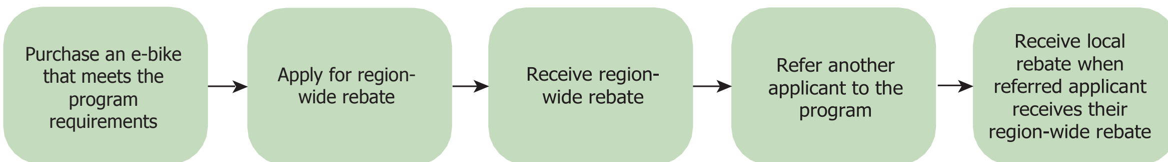
Option 2b: Two applications with education/training requirement for local rebate



Similar to Option 1b, applicants require two steps to receive the total rebate. However, as program participants will have purchased an e-bike, participants can use their own e-bikes to participate in the training/education course.

<u>Referral requirement for a local rebate</u>

Option 3: One application with referral requirement for local rebate



This option may require a significant amount of time until the applicant receives the additional (local) rebate as it is contingent on another applicant purchasing an e-bike and applying for the rebate. This also requires the administering organization to create a system that helps identify past program participants. Moreover, given the time between the initial application and receiving an additional rebate through a referral, this requirement and application process may be suitable for a longer-term program.

Program Administration

Important considerations in program administration include costs, coordination with retailers and funding agencies, mechanisms for verification of residency, privacy and data access, and responsibilities for program marketing and communications. The e-bike incentive program could be administered by the sponsoring municipal and/or regional government(s), or administered by a third-party organization on behalf of the governments. This choice presents several differences in costs, complexity, risk, and information availability. Governments have access to information which could be used in program administration, such as residency verification and low-income status. On the other hand, a third-party administrator would provide a privacy buffer for citizens concerned about public data recording and access. Third-party organizations could have more experience and flexibility to initiate the pilot program, but could also demand higher administrative costs.

The following section lists potential organizations that could implement this program and undertake its related responsibilities.

<u>CITY GREEN</u>

Background

City Green defines its organization as a “non-profit with a mission to excite, inspire and lead British Columbians in finding innovative home and building energy efficiency solutions” (City Green Solutions, n.d.). Therefore, this organization specializes in programs that promote and install energy efficient technology in homes and buildings. Their services range from providing access to programs and resources related to energy efficient home upgrades, to assessing and evaluating the energy efficiency of homes.

Relevant programs

- Oil to Heat Pump Incentive Program is a province-wide rebate program where incentives in the form of rebates (up to $1700) are awarded to applicants who upgrade from an oil heating to an air source heat pump. To be eligible for the rebate, applicants are required to receive an EnerGuide evaluation pre- and post-retrofit. As a province-wide program, individual top-up incentives are provided by some municipalities.
- Home Renovation Rebate Program provides rebates to certain upgrades to increase a home's energy efficiency. Similar to the Oil to Heat Pump Incentive Program, City Green helps conduct the EnerGuide evaluation pre- and post-retrofit

Advantages

- Specializes in programs that promote energy efficiency, including rebate programs
- Experience in managing the branding, outreach, promotion, and tracking of programs (see Solar Colwood program)
- May have suitable measures to conduct evaluation on energy efficiency resulting from e-bike adoption
- Office located in Victoria

Disadvantages

- Current and past programs generally involve home upgrades through sustainable and efficient technology
- Lack of transportation-related precedents

<u>BC SUSTAINABLE ENERGY ASSOCIATION</u>

Background

The BC Sustainable Energy Association (BCSEA) is a non-profit organization that promotes sustainable energy production, distribution, and consumption in BC (BCSEA, n.d.). Their services include developing educational programs, conducting public outreach, and undertaking energy planning.

Advantages

- There is a BC Sustainable Energy Association Victoria Chapter

Disadvantages

- Programs are in the form of educational workshops and conferences
- A limited number of programs in their portfolio

BC HEALTHY COMMUNITIES

Background

BC Healthy Communities is a "province-wide not-for-profit organization that facilitates the ongoing development of healthy, thriving and resilient communities" (BC Healthy Communities, n.d.). They have a wide range of services related to community engagement, facilitation and consultation, workshops and events, curriculum development, leadership training, community planning processes, and research and evaluation. Their focus primarily surrounds community health which also encompasses social, environmental, economic, cultural, physical and political health (BC Healthy Communities, n.d.).

Relevant programs

- PlanH is a program that focuses on local government engagement and partnerships to achieve healthy communities, which encompasses people, societies, and the environment. In this program, BC Healthy Communities helps provide local governments with learning opportunities, partnerships, and plans that help build healthier communities.

Advantages

- Can provide evaluation in the form of community feedback from engagement/facilitation
- May have helpful health indicators to measure the EBIP's impact on health
- Can help access grant opportunities through the PlanH Healthy Communities Fund
- Office located in Victoria

Disadvantages

- Lack of past and current programs that utilize a rebate structure or focuses on promoting active transportation
- Many programs are informative and policy/strategy oriented
- Program involvement is usually in the form of community engagement

BETTER ENVIRONMENTALLY SOUND TRANSPORTATION

Background

Better Environmentally Sound Transportation (BEST) is a non-profit organization that focuses on promoting sustainable transportation. Their services include facilitation, program design, and implementation.

Advantages

- Experience with sustainable transportation programs
- Current work focuses on increasing transportation options for seniors

Disadvantages

- Programs are generally in the Lower Mainland
- No existing case studies of rebate programs
- The depth of their post-implementation evaluation is unclear

<u>FRASER BASIN COUNCIL</u>

Background

The Fraser Basin Council (FBC) is a not-for-profit organization that specializes in building communities and partnerships across different sectors for sustainability initiatives. Their services include facilitation, education, conflict resolution, applied research and analysis, and program coordination.

Relevant programs

- In the FBC'S Strategic Plan (2016-2021) which sets out the initiative direction and organizational framework of FBC, there is an objective listed under their strategic priority of 'taking action on climate change and air quality to reduce greenhouse gas emissions and improve energy efficiency in BC's transportation sector' (FBC, n.d.). FBC lists facilitating "a 100% increase in the market share of zero-emission vehicles through the provision of financial incentives, outreach and training as well as the expansion of fueling infrastructure" (FBC, n.d.) as an action to meet their strategic priority.
- E3 Fleet is a program that reviews and rates a public or private sector organization's transportation fleet. This program is deemed suitable for any organization looking to improve its fleet's fuel efficiency and reduce emissions through new and innovative technologies. This program also offers appropriate tools and resources to help organizations meet their respective sustainability goals.
- Plug in BC is a province-wide program that "help lay the groundwork for plug-in electric vehicles and related electric charging infrastructure" (FBC, n.d.). Plug in BC offers access to information and initiatives related to electric vehicles (EV) promotion. FBC had a particular role of connecting auto manufacturers with BC fleets that were interested in incorporating EVs. Additionally, they administered two incentive programs to build charging stations on the provincial level. These incentive programs provided funding for purchasing/installing electric charging stations and for hosting community planning processes related to EV charging infrastructure (FBC, n.d.).

Advantages

- A diverse portfolio of sustainability programs
- Offers a wide range of services that can be applied to the EBIP (e.g. administrative, monitoring, institutional coordination, project coordination, and research)
- Relevant experience in promoting electric/emissions-free vehicles

Disadvantages

- Lack of active transportation-related programs
- Work primarily focuses on sustainability initiatives in the Fraser Valley region, Thompson region, Cariboo-Chilcotin region and the Upper Fraser region

Rebate Amounts

Next, the different possibilities of rebate amount and structure are explored. This entails the low, middle, and high amount of rebates that could be implemented given the program budget of $50,000. Rebate amounts under a budget of $75,000 and $100,000 were also considered to illustrate the different possibilities of rebate amounts under different program budgets. In terms of rebate structure, a flat rebate structure and a tiered rebate structure are considered in this section.

<u>Flat rebate structure</u>

By rebate size

Prior to assigning rebate amounts, existing e-bike rebates, grants, or discount programs were reviewed to determine the low, medium, and high scales for rebates. If available, the amount of funding for the program was also obtained. The programs were limited to rebate programs that targeted residents of a specific area instead of company or business-oriented programs. Once the rebate amounts from different programs were collected and converted into CAD, the average, median, and ranges of e-bike rebates were calculated. As a result, average rebate prices for e-bikes in general, as well as for specific e-bike types were calculated (outlined below). The suggested e-bike amounts were then created based on these existing precedents and their rebate structures.

Table 2. Rebate amounts from case studies (in CAD)

	Minimum	Mean	Median	Maximum
All e-bike types	$260	$680	$610	$1,593
Pedal-assist e-bikes	$260	$290	$300	$302
Electric cargo bikes	$612	$1,030	$920	$1,557
Converted e-bikes	$260	$390	$300	$612

For e-bikes in general, the lowest rebate amount was $260 CAD and the highest was $1,593 CAD. Unfortunately, the programs did not provide sufficient data to estimate the impact of rebate size on adoption. The size of the rebate is expected to impact adoption in a predictable way, equivalent to a commensurate decrease in price for the consumer. There is a risk that a rebate that is too small will not provide a sufficient signal to motivate adoption, but that risk is low when the rebate is on the scale of hundreds of dollars and more than 5-10% of the total price.

Another risk is that rebates could lead retailers to increase prices in compensation. The market price effect of the rebates is expected to depend on the relative sensitivity of consumers and producers to price signals. As long as the rebate purchases comprise a relatively small share of the total e-bike market for manufacturers, price effect is likely low, but this effects merits consideration.

The suggested range for rebate amounts based on existing programs is as follows:

Table 3. Suggested ranges for rebate amounts

Low	Medium	High
$200 to $400	$400 to $1,000	$1,000 to $1,600

One alternative is to set one rebate that is applicable across all e-bikes, regardless of their sales price. Example calculations of the different possibilities of e-bike rebate amounts and the resulting number of rebates available based on different budgets are summarized in Table 4.

Table 4. Example number of rebates available, by rebate amount and program budget

Rebate amount (CAD)		Number of rebates available, based on program budgets		
		$50,000	$75,000	$100,000
Low	$300	166	250	333
Medium	$700	71	107	142
High	$1300	38	57	76

<u>Tiered rebate structure</u>

By e-bike price

A tiered rebate structure refers to rebates that differ based on the different level of a variety of factors (e.g. sales prices, number of sales, sales growth), which is determined by the program organizer. This structure is used by the E-Ride Rebate program implemented by Austin Energy, where the rebate amount increases with the purchase price of the e-bike. From their program, they reported a total of 577 rebates being issued since 2012 and an average rebate amount of $175. However, given the high cost of e-bikes, they report issuing the $300 incentive—which is provided for purchases of over $2000—most frequently. Following this structure, the following tables represent three possible scenarios (low, medium, and high) of a tiered e-bike rebate program based on e-bike price. The price ranges are based on the e-bike price investigation described in Appendix B. This rebate structure raises the possibility of price adjustments by retailers at the margins of the price tiers, in addition to the potential price increases with a broad-scale rebate incentive.

Table 5. Tiered rebate structure for low, medium and high rebate scenarios

E-Bike Price (CAD)	Rebate Amount (CAD)		
	Low	Medium	High
$1,000 to $1,999	$150	$200	$250
$2,000 to $2,999	$300	$400	$500
$3,000 to $3,999	$400	$600	$800
$4,000 to $4,999	$500	$800	$1,100
Over $5,000	$600	$1000	$1,400

By percentages

Another option is to implement a rebate in the form of a fixed percentage that is capped at a certain amount. Previous examples of these programs that implemented a similar rebate structure are summarized in the table below:

Table 6. Examples of percentage rebates

Location	Eligible E-bike Types	Rebate Percentage	Maximum Rebate (CAD)	Program Budget (CAD)
Oslo, Norway	Electric cargo bikes	25%	$1,557	$778,413
Sweden	Electric bikes	25%	$1,593	Not available
Arnhem-Nijmegen region, The Netherlands	Electric bikes	30%	$918	Not available
The State of Guernsey, UK	Electric bikes	25%	$653	$174,129
Nantes, France	Bikes and cargo bikes (electric and non-electric)	25%	$612	Not available
Region of Friuli Venezia Giulia, Italy	Pedal-assist e-bikes	30%	$302	Not available
Province of Walloon Brabant, Belgium	Electric bikes or conversion kits	20%	$302	Not available

As indicated by previous examples, the standard percentage for a rebate is most commonly designed to cover approximately 25% of the original e-bike price. However, the maximum rebate available ranges vastly between different programs. This may be attributed to the difference in the program's budget and the local e-bike market. Therefore, the maximum rebate amount is contingent on the funding allocated to the rebate program and the desired number of available rebates.

The table below summarizes different rebate scenarios based on rebate percentages of 10% to 30%, with maximum rebate amounts that roughly scale with the rebate percentages and program budgets of $50,000 to $100,000. Average rebate amounts are based on an average e-bike price of $4,500, based on the price analysis described in Appendix B.

Table 7. Example number of rebates available, by rebate amount and program budget

Rebate %	Average Rebate Amount[1] (CAD)	Maximum Rebate Amount (CAD)	Expected number of rebates available,[2] based on program budgets		
			$50,000	$75,000	$100,000
10%	$450	$650	111	167	222
15%	$675	$975	74	111	148
20%	$900	$1,300	56	83	111
25%	$1,125	$1,625	44	67	89
30%	$1,350	$1,950	37	56	74

[1] Based on an assumed average e-bike price of $4,500
[2] Using average rebate amounts

Enhanced BC SCRAP-IT Program

Program Overview

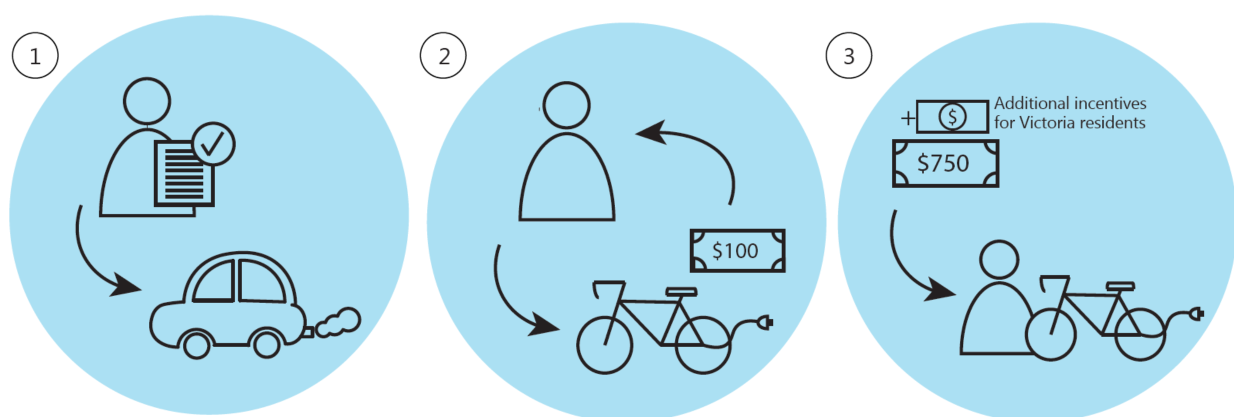
What is the BC SCRAP-IT program?

The BC SCRAP-IT program is an early retirement vehicle program implemented by the province of BC in which incentives are provided to replace polluting vehicles with sustainable transportation modes (BC SCRAP-IT Program Society, n.d.). The main incentive is a discount for the purchase of a new electric vehicle. Therefore, although this program is not centered around e-bikes, one available option is a discount for a new e-bike purchase. The specific incentive is a discount of $850 which is comprised of a $100 discount from the e-bike retailer at the point of e-bike purchase, and an additional $750 from BC SCRAP-IT after the purchase (BC SCRAP-IT Program Society, n.d.). However, this program applies only to purchases made at participating e-bike retailers which there are currently eight in Victoria.

Program design considerations

This program model is described as an enhanced BC SCRAP-IT program as the municipality will add an additional rebate to the existing e-bike rebate provided by the BC SCRAP-IT program.

The program model



Applicants send in their application and once they receive an approval letter, they scrap their vehicle at any SCRAP-IT authorized drop off locations

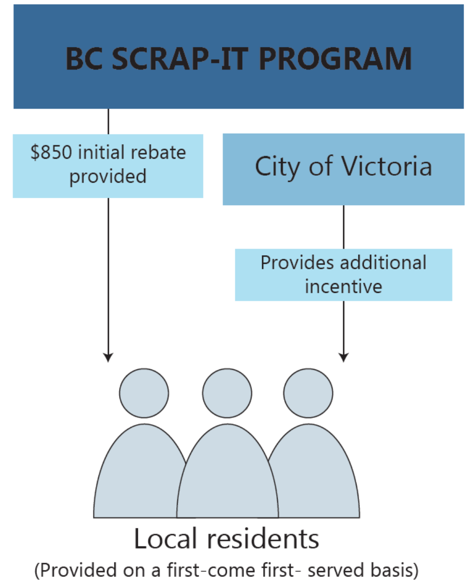
Applicants receive an initial $100 rebate at the point of e-bike purchase

Applicants receive the remaining $750 rebate from BC SCRAP-IT, and Victoria residents receive additional incentives from the local government

Program options

The following list outlines the different options considered under the eligibility requirements, application and implementation process, and rebate amounts/structures of the program:

- Eligibility requirements for the program
    - Existing program requirements
    - Eligible e-bike retailers
    - Eligibility to earn additional rebates
- Application and implementation
    - Administering organization
    - Program application
- Rebate amounts and number
    - Flat rebate
    - Tiered rebate



Existing SCRAP-IT Program Requirements

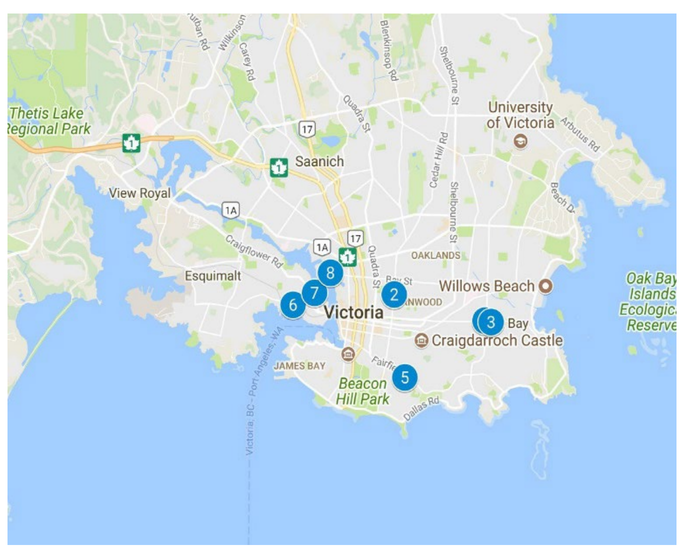
The current requirements for the purchased e-bike to be eligible for the rebate (as outlined by BC SCRAP-IT) are:

- Minimum e-bike retail price of $1,000
- Must be a new e-bike purchased from a participating retailer
- Bike must have the motor attached (no conversion kits)
- E-bikes must meet the requirements and definitions outlined Motor Assisted Cycle Regulation

Participating E-Bike Retailers

Currently, there are eight e-bike retailers in Victoria that are listed as participating retailers of the BC SCRAP-IT Program. These retailers are listed below:

1. Oak Bay Bicycle Shop
2. Canada Scooter Inc.
3. Pedego Victoria
4. Sooke Mountain Cycle LTD.
5. Fairfield Bicycle Shop Ltd
6. Trek Bike Store (Catherine St.)
7. Trek Bike Store (Harbour Rd)
8. Cit-E-Cycles



Given the large number of participating retailers relative to other BC municipalities, a consideration is to inquire the general uptake of the e-bike incentive from the BC SCRAP-IT Program from the existing retailers. Based on the responses obtained from existing retailers, it seems there has been limited uptake of the e-bike incentive from the program.

Therefore, other efforts to increase uptake such as advertising the e-bike incentive through the BC SCRAP-IT program or promoting the benefits of e-bike usage may be necessary. Moreover, since participating e-bike retailers are required to cover the initial $100 of the discount at the point of sale, another consideration may be to provide the initial $100 out of the total $850 e-bike rebate ($750 covered by BC SCRAP-IT program).

Eligibility to Earn Additional Incentives

As mentioned under the new rebate program, the additional incentive provided by the municipality can require additional requirements such as a training or referral component to help promote the local e-bike uptake. However, under this program model, given that the applicants have already scrapped their car in exchange for the e-bike, it may be feasible to provide the additional incentive without any further requirements. This would have implications to the program application processes which are explored in the following section.

Program Administration

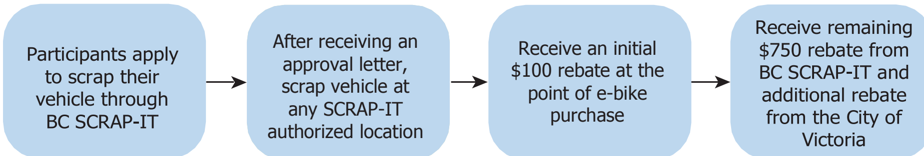
Given that this model builds upon the BC SCRAP-IT program, management of the enhanced BC SCRAP-IT program could be conducted by the BC SCRAP-IT Society. However, this is contingent upon their willingness and capacity to undertake an additional dimension to their e-bike incentive. Moreover, the monitoring components necessary for this program and the components already monitored by the BC SCRAP-IT Society will have to be reviewed in order to ensure the relevant program impacts are measured to help assess the success of the program.

Rebate Application Process

Contingent on the administering organization, there are two broad options for the enhanced BC SCRAP-IT program application process. First, the application for additional incentives can be attached to the existing application that participants must fill in to scrap their car and receive their desired incentive. However, given that these requirements are best suited for after an e-bike is purchased, this option is best suited for the program model that does not have requirements to earn the additional rebate. The second option is to create a second application process after the participants receive their initial $850 rebate from BC SCRAP-IT. This may entail having a separate administering organization to carry on the application process to ensure applicants have fulfilled the assigned requirement to receive an additional rebate.

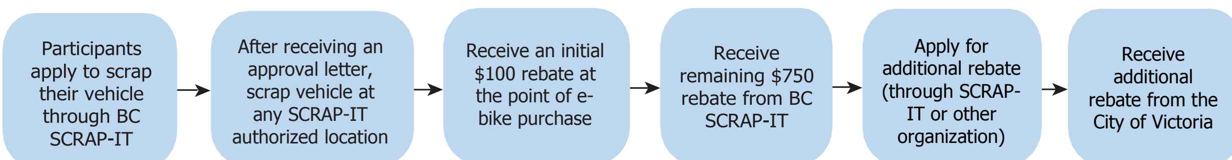
No additional requirement for a local rebate

Option 1a: One application with no additional requirements for local rebate



This option allows applicants to apply for both rebates at the same time. This simple process may appeal to the applicants as additional requirements are not necessary to receive the local rebate. Administering organizations will also benefit from this simple process as it does not require much change from the existing application process.

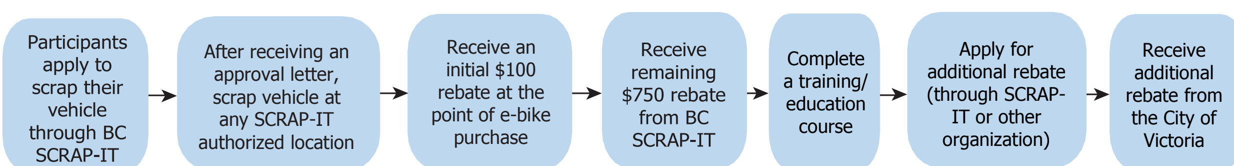
Option 1b: Two applications with no additional requirements for local rebate



In comparison to Option 1a, applicants may find this two-step application process inconvenient. Moreover, having to process two applications adds another layer of organization and coordination required for the administering organization.

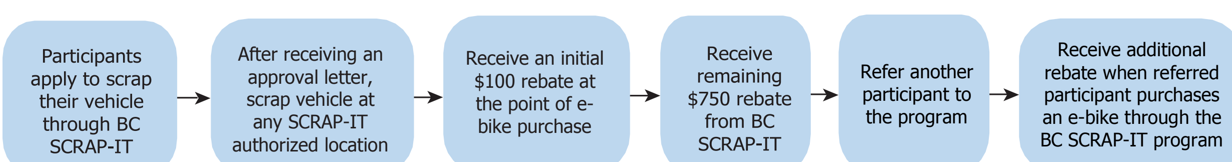
Education/training requirement for a local rebate

Option 2: Two applications with education/training requirement for local rebate



Referral requirement for a local rebate

Option 3: One application with referral requirement for local rebate



To maintain a level of simplicity, the requirements for the additional rebate are designed for after the initial rebate. Therefore, both Option 2 and 3 propose a two-step application process.

This way, there is a clear connection between the final two steps of meeting the requirement for the additional rebate and receiving the additional rebate.

Rebate Amounts

Programs similar to the BC-SCRAP IT program which provide e-bike incentives in exchange for polluting vehicles are summarized below:

Table 8. Rebate programs similar to the BC SCRAP-IT program

Program	Location	E-bike Types	Rebate Amount (CAD)	Program Budget (CAD)
Participants who hand in their car number plate receive the grant	Ghent, Belgium	Electric bikes	$383	Not available
		Electric cargo bikes	$612	Not available
If you abolish your old moped or old scooter and buy an e-bike, you can apply for a subsidy from the city	Tubingen, Germany	Electric scooter or e-bike	$306 to $765 (depending on age and class of the scrapped two-wheeler)	$38,265

Given the limited data from BC SCRAP-IT regarding the maximum number of e-bike rebates available and the number of e-bike rebates issued annually, rebate amounts under this option were created to follow a similar structure as the rebate amounts proposed in the new rebate program after receiving the $850 rebate. Therefore, similar to the new rebate program, a flat rebate structure and a tiered rebate structure are explored below.

Flat rebate structure

Table 9 gives an example of three possible levels of additional rebates under an enhanced SCRAP-IT program. Note that under the BC SCRAP-IT program, the purchased e-bike must be at least $1,000 to qualify for the $850 rebate. In keeping with this maximum rebate relative to e-bike price, the total rebates in Table 9 are not to exceed 85% of e-bike price. Table 10 gives the number of rebates available under each rebate level and budget scenario.

Table 9. Low, medium, and high rebate amounts for an enhance BC SCRAP-IT model

Rebate Level	BC SCRAP-IT Rebate (CAD)	Additional Rebate (CAD)	Total Rebate[1] (CAD)
Low	$850	$150	$1,000
Medium	$850	$650	$1,500
High	$850	$1,150	$2,000

[1] Not to exceed 85% of total e-bike price

Table 10. Number of rebates available, by rebate amount and program budget

Rebate amount (CAD)		Number of rebates available, based on program budgets		
		$50,000	$75,000	$100,000
Low	$150	333	500	667
Medium	$650	77	115	154
High	$1,150	43	65	87

<u>Tiered rebate structure</u>

After the initial rebate offered by BC SCRAP-IT, the tiered additional e-bike incentives follow a similar pattern to those in the tiered new rebate program. Due to the minimum e-bike price of $1,000 under SCRAP-IT, the ranges of e-bike prices begin from $1,000. The low to high rebate levels are designed to align with the flat rebate program given in Table 9.

Table 11. **Low, medium, high rebate amounts for a tiered rebate structure (CAD)**

E-bike price range	BC SCRAP-IT Rebate	Low Level		Medium Level		High Level	
		Additional Rebate	Total Rebate	Additional Rebate	Total Rebate	Additional Rebate	Total Rebate
$1,000 to $1,999	$850	$50	$900	$100	$950	$150	$1,000
$2,000 to $2,999	$850	$100	$950	$200	$1,050	$400	$1,250
$3,000 to $3,999	$850	$150	$1,000	$400	$1,250	$650	$1,500
$4,000 to $4,999	$850	$200	$1,050	$650	$1,500	$900	$1,750
Over $5,000	$850	$250	$1,100	$850	$1,700	$1,250	$2,100

Eligibility

E-Bike Types

E-bike definition in BC

Prior to exploring the e-bike typologies eligible for rebate under this program, it is important to understand the regulations and definition surrounding e-bikes in BC. Currently, e-bikes are referred to as 'motor-assisted cycles' in the Motor Vehicle Act. The description of a motor assisted cycle is outlined below:

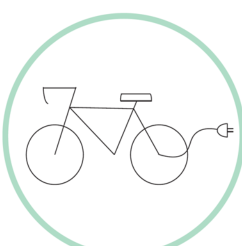
Description of a Motor Assisted Cycle (MAC)

- The electric motor must be 500 watts or less and be capable of propelling the cycle no faster than 32 km/h on level ground without pedaling.
- The vehicle must be equipped with a mechanism that either:
    - allows the driver to turn the motor on and off, or
    - prevents the motor from turning on or engaging before the MAC attains a speed of 3 km/h
- The motor must disengage when the operator:
    - stops pedaling, or
    - releases the accelerator or
    - applies a brake.
- The motor must be capable of being propelled by muscular power using the pedals, but it is not necessary to always be pedaling

(Source: ICBC, n.d.)

The rebate program could include different e-bike typologies that are eligible for rebate to promote different uses and enhance different e-bike benefits. The e-bike types explored below include a pedal-assist e-bike, throttle-assist e-bike, electric cargo bike, scooter-style e-bike, and an enclosed electric trike.

Options for additional e-bike typologies

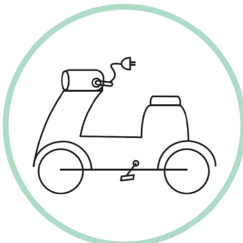


Pedal-assist e-bike

Pedal-assist e-bikes are e-bikes that only provide power assist technology when being pedaled and are also sometimes known as pedelecs in some cities. In Victoria, pedal-assist e-bikes range between $2040 and $5510, and average to approximately $3960 CAD.

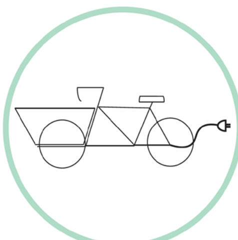
Throttle-assist e-bike

For throttle-assist e-bikes, power is generated by a switch located at the handle. Many e-bikes combine both the pedal-assist and throttle-assist technology so riders have the option to switch the power on and off either through pedaling or an on-demand button. In stores across Victoria, the average price of throttle-assist e-bikes (either with or without the pedal-assist option) range between $1420 and $5850, with an average price of $3490.



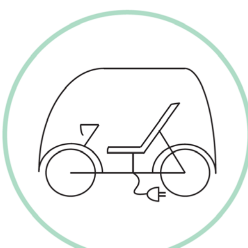
Scooter-style e-bike

Scooter-style e-bikes are designed with throttle-assist technology. Under the BC Motor Vehicle Act, these vehicles are considered as e-bikes due to their pedals and electric power. Although these e-bikes are common in China, the review of e-bike retailers in Victoria found that retailers often did not sell this e-bike type at their local stores.



Cargo e-bike

Another consideration for an additional e-bike type is an electric cargo bike. These e-bikes are designed with cargo space that may appeal to businesses specializing in delivery services.
Moreover, the cargo component may appeal to potential riders that want to replace their car trips with alternative and sustainable transportation modes. From the review of e-bike prices in local retail stores, we found that cargo e-bikes, in general, had higher purchase costs, with the average price amounting to approximately $5570.



Enclosed electric tricycle

Enclosed electric tricycles are a growing form of e-bikes, where protection is provided through their enclosed design. An emerging enclosed electric tricycle in BC is the Veemo vehicle created by VeloMetro. As a new and emerging type of e-bike, enclosed electric bikes have had limited exposure to the e-bike market, thus were not available for sale at the reviewed e-bike retail stores.

Implications for rebate prices

Given the difference in price across these different e-bike types, a tiered rebate structure may be feasible where different rebate amounts are assigned to different e-bike types, based on their average market price.

The E-Rider Individual and Fleet Rebate Program in Texas qualifies e-scooters, e-motorcycles, e-mopeds and Segways as electric riders that are eligible for their rebate program. Although the rebate fee is not categorized by e-bike type, the rebate amount increases with the price of the purchased e-rider, as shown in Table 12.

Table 12. Plug-In Austin Rebate Program Incentives

Price Range (Including tax)	Individual Incentives	Fleet Incentives
Up to $499	$50	$100
$500 to $999	$100	$200
$1,000 to $1,999	$200	$300
$2,000 and up	$300	$400

By diversifying the program with different e-bike options, the rebate program may appeal to a greater profile of users and businesses. However, this will also add a level of complexity to the program as the distribution of the number of rebates and its financial amount will have to be determined by a tiered rebate structure, rather than a flat, uniform rebate structure. Moreover, potential purchasers may be unaware of the regulations, technologies, and the advantages and disadvantages of these different e-bike types.

E-Bike Prices

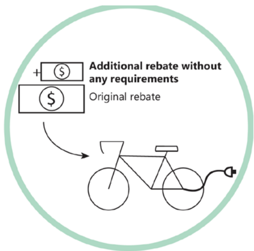
A consideration for the program is the assignment of a minimum e-bike price in order to be eligible to receive a rebate. The BC SCRAP-IT program assigns a minimum of $1000, given their $850 rebate. From our review of e-bike prices, the minimum e-bike price from two retailers based on their websites were below the $1000 mark with $589 and $999, respectively. However, most minimum prices found for e-bikes were sold for approximately $2000. Therefore, this minimum of $1000 remains fairly inclusive of e-bikes sold in the local e-bike market. Given this finding, the same e-bike price minimum of $1000 is used as an eligibility requirement to earn a rebate under this program model.

Number of E-Bikes (Fleet Options)

In order to increase uptake by both individuals and businesses, one consideration is to provide rebates for e-bike fleet purchases. This entails providing rebates for e-bike fleet purchases in addition to individual e-bike purchases. This is implemented by Plug-In Austin where rebates are made available for fleet purchases of any e-riders. Therefore, applicants are eligible to receive these rebates after purchasing 5 to 25 e-bikes. In their program, a tiered rebate structure is used, where the amount of rebate per e-bike increases with the e-bike price as shown in Table 12. It should be noted that a tiered structure is utilized under their Electric Ride Program for non-fleet purchases, however, the rebate incentive for each price range is greater under the fleet program. Following this example, one option for this rebate program is to include a separate rebate structure that applies only to e-bike fleet purchases. This option may appeal to cycling coalitions, businesses, and organizations that want to provide sustainable transportation options for their employees or members

Additional Incentives

The following options outline different requirements for residents to earn an additional rebate from their residing municipality. These options provide a way for the additional incentive to help educate program participants on e-bike riding or help increase the program uptake.

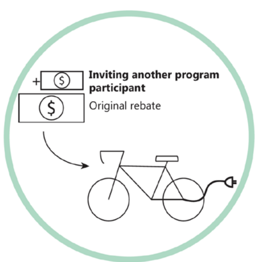


No additional requirement

Firstly, the additional or 'top-up' incentive can be provided without any further requirements. This means the additional incentive from the City of Victoria will be provided with the region-wide rebate.

Earning a rebate through education and/or training

For additional incentives provided by the local municipality, one potential idea is to incorporate e-bike training and educational programs as part of the rebate program. As done in the E-bike Rebate Program by BikeSGV, an option is to include training or education sessions on proper e-bike use as a mandatory component to earn a rebate. This will ensure the increase in e-bike use resulting from this program is supported by proper knowledge and skills in e-bike riding. However, this option requires either additional funding or a portion of the existing funding to be allocated to organizing an e-bike training/education course. Moreover, this may also require a partnership with a local cycling coalition or e-bike retailer/manufacturer to organize and conduct these courses.



Additional rebates from referrals

To accelerate the uptake of this program, another option is to provide additional rebates when referrals are made by the program participant. This option consists of additional rebates being awarded to the applicant when they introduce another applicant to the program.

Part V:

Estimation of Program Impacts

Introduction

A variety of methods have been used to model the impacts of incentives on vehicle sales or travel mode adoption, depending on the context, objectives, and available data and resources. Past research on e-bike adoption scenarios has used simple sales and adoption assumptions, due to a lack of available information and models. See for example Mason et al. (2015), in which the impacts of e-bike uptake are estimated by *a priori* assumed adoption levels. No known research models e-bike sales or adoption based on price incentives or rebates.

More research has been done on electric vehicle (automobile) sales and adoption in the context of price incentives (rebates and tax breaks). Chandra et al. (2010) assume that rebates have no effect “on the aggregate number of new cars sold”, and hence only model the effects of price incentives on the hybrid electric vehicle (HEV) market share of new car sales. They estimate that 26% of new HEV sales were attributed to a $1,000 rebate. DeShazo et al. (2017) similarly model the effect of an electric vehicle (EV) rebate program based on the market share of EV, using a utility-based demand model estimated from stated preference (survey) data. Diamond (2009) estimated a similar hybrid-electric vehicle market-share model using empirical sales data from the US.

This part of the report presents an economic model to estimate the impacts of price incentives from the program options described in Part IV (a new rebate program or an enhanced SCRAP-IT program) on e-bikes sales, bike shop revenue, and other outcomes. The model draws from transport economics and approaches used to model the effects of electric vehicle incentives, as described in the next section. The results presented are used in the final section of the report to inform the recommended incentive program structure.

Method

Overview of Method

Once the rebate amount for each program model was determined, an aggregate demand model was used to estimate the resulting e-bike uptake from each rebate structure. Figure 1 illustrates the adoption and impact modeling framework. An elasticity-based aggregate demand model is used, based on available data and informed by the literature described above. We do not model e-bike sales as simply a share of new bicycle sales, because e-bikes are expected to increase the size of the total bicycle market, not simply substitute for conventional bicycles. Disaggregate mode choice models are also poorly suited for this scale of analysis because they require detailed information on person-level decision makers/agents. Aggregate demand models have been used well in the past for studies at similar scales (Ortuzar and Willumsen, 2011; Small and Verhoef, 2007).

Additional e-bike sales due to rebate incentives are estimated from program parameters (number and size of rebates), market information (baseline e-bike price and sales estimates), and representative elasticity values from the literature. Direct economic impacts are estimated from increased sales. The broader impacts of the marginal e-bike sales are then estimated using the literature on: mode substitution (the displacement of vehicle travel with e-bike adoption), e-bike usage (the typical amount of usage by e-bike owners), physical activity during e-bike usage, and emissions rates for displaced vehicle travel. These adoption impacts are discussed in Appendix C and presented in Part VI.

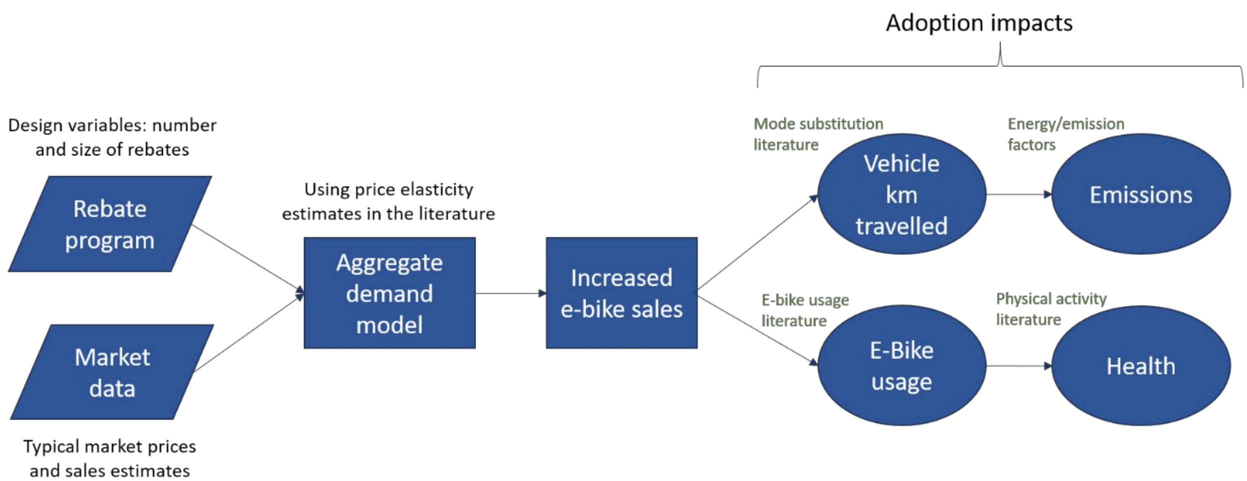


Figure 1. Overview of adoption and impact modelling approach

E-Bike Demand Model

The aggregate demand model is based on extensive literature in transport economics, particularly Ortuzar and Willumsen (2011) and Small and Verhoef (2007). The key variables are summarized here for convenience:

- p Market price of e-bikes (without rebate)
- d_b Baseline demand for e-bikes (sales per year)
- ε Price elasticity of e-bike demand
- r Rebate amount (per rebate)
- n_r Maximum number of rebates available (per year)
- Δd Additional e-bike demand due to rebates (per year)
- s Additional e-bike sales due to rebates (per year)

New demand level with rebate

An individual has a likelihood of purchasing an e-bike in a given year that is dependent on e-bike price p, e-bike characteristics, individual preferences and characteristics, opportunity costs of purchasing for the individual, and other factors. Aggregate demand d for e-bikes is a function of the same set of factors. We will assume two common forms for the aggregate demand functional relationship to price: linear $d = f(p)$ and power $d = f(p^k)$.

Price elasticity of e-bike demand ε expresses the effect of e-bike price on aggregate e-bike sales or demand:

$$\varepsilon = \frac{p}{d}\frac{\partial d}{\partial p}$$

A rebate r will reduce the consumer e-bike price from p to $p - r$. We will assume that all other factors are unaffected by the introduction of the rebate. Using a **linear demand function**, the new total demand with a rebate is

$$d = d_b\left(1 - \frac{\varepsilon r}{p}\right)$$

and the change in demand as a result of the rebate is $\Delta d = d - d_b$ or

$$\Delta d = -d_b \varepsilon \frac{r}{p}$$

Alternatively, using a **power demand function** (which implies constant elasticity across demand levels), the new demand level is

$$d = d_b\left(1 - \frac{r}{p}\right)^{\varepsilon}$$

and the change in demand is

$$\Delta d = d_b\left[\left(1 - \frac{r}{p}\right)^{\varepsilon} - 1\right]$$

<u>Limited rebate availability</u>

The change in demand, Δd, represents the additional *potential* EB sales with the rebate, but may not be achieved if there are a limited number of rebates.

- If $d \leq n_r$, there are enough rebates to satisfy the demand (baseline plus additional sales), and there will be $s = \Delta d$ additional sales and $s + d_b$ total rebates issued.
- If $d > n_r$, there are not enough rebates available to fully satisfy demand.

In the second case where the number of rebates is limited, we assume that we cannot target the marginal purchases, and so an individual's opportunity to receive a rebate is independent of their likelihood of purchasing. Hence, the n_r available rebates are distributed proportionally to baseline and marginal demand such that:

- $\frac{d_b}{d} n_r$ go to baseline individuals who would have purchased without the rebate, and
- $\frac{\Delta d}{d} n_r$ go to new induced (marginal) purchasers, resulting in $s = \frac{\Delta d}{d} n_r$ additional sales (which equates to $s = \Delta d$ at the limiting case $d = n_r$).

Rebate-limited and demand-limited additional sales are illustrated in Figure 2.

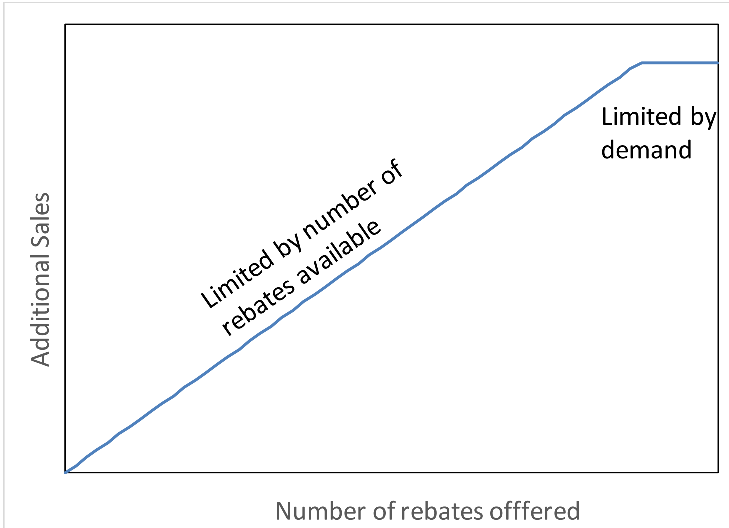


Figure 2. Illustration of rebate- and demand-limited sales

Applying the linear and power demand functions, expressions for additional sales and other values are given in Table 13.

Table 13. Summary of demand functions

	Linear demand function		Power demand function	
	Rebate-limited	Not rebate-limited	Rebate-limited	Not rebate-limited
Total demand with rebate, d	$d_b\left(1-\frac{\varepsilon r}{p}\right)$		$d_b\left(1-\frac{r}{p}\right)^{\varepsilon}$	
Additional demand with rebate, Δd	$-d_b\varepsilon\frac{r}{p}$		$d_b\left(\left(1-\frac{r}{p}\right)^{\varepsilon}-1\right)$	
Rebate-limited test condition	$d_b\left(1-\frac{\varepsilon r}{p}\right)>n_r$		$d_b\left(1-\frac{r}{p}\right)^{\varepsilon}>n_r$	
Rebates issued	n_r	$d_b\left(1-\frac{\varepsilon r}{p}\right)$	n_r	$d_b\left(1-\frac{r}{p}\right)^{\varepsilon}$
Additional sales, s	$\frac{n_r\varepsilon r}{\varepsilon r-p}$	$-d_b\varepsilon\frac{r}{p}$	$n_r\left(1-\left(1-\frac{r}{p}\right)^{-\varepsilon}\right)$	$d_b\left(\left(1-\frac{r}{p}\right)^{\varepsilon}-1\right)$
Portion of rebates to new purchasers (induced demand)	$\frac{\varepsilon r}{\varepsilon r-p}$		$\left(1-\left(1-\frac{r}{p}\right)^{-\varepsilon}\right)$	
Total rebate cost	$n_r r$	$d_b r\left(1-\frac{\varepsilon r}{p}\right)$	$n_r r$	$d_b r\left(1-\frac{r}{p}\right)^{\varepsilon}$
New sales revenue to bike shops (sp)	$\frac{n_r\varepsilon rp}{\varepsilon r-p}$	$-d_b\varepsilon r$	$n_r p\left(1-\left(1-\frac{r}{p}\right)^{-\varepsilon}\right)$	$d_b p\left(\left(1-\frac{r}{p}\right)^{\varepsilon}-1\right)$
Rebate costs to new purchasers	$\frac{n_r\varepsilon r^2}{\varepsilon r-p}$	$\frac{-d_b\varepsilon r^2}{p}$	$n_r r\left(1-\left(1-\frac{r}{p}\right)^{-\varepsilon}\right)$	$d_b r\left(\left(1-\frac{r}{p}\right)^{\varepsilon}-1\right)$

In summary, to estimate the additional sales from rebates, the following model inputs need:

- Program design variables: n_r and r
- Market information: p and d_b
- Consumer attributes (from literature): ε

Selection of these variables is discussed in the next section.

<u>Summary of major assumptions embedded in the method</u>

1. Supply prices are assumed to be unaffected by the introduction of rebates (i.e., bike shops do not adjust their prices in response to the rebates or the induced demand).
2. Rebates are arbitrarily allocated to purchasers, so that there is an equal likelihood of rebates going to marginal purchasers (those who would only purchase with the rebate) versus pre-existing purchasers (those who would have purchased an e-bike without the rebate).
3. Potential positive spill-over effects of additional e-bike sales are not included. For example, each new e-bike purchaser may increase the likelihood of that person's acquaintances purchasing an e-bike through social network effects; or they may increase the general likelihood of e-bike purchases through norming. Such effects have been reported but not quantified.
4. Similarly, the effects of an initial e-bike purchase induced by the incentive program on the likelihood of future e-bike purchases by the same person are not modeled.
5. Price subsidies can influence both consumption quantity and market price, with the magnitude of changes in each dependent on the relative elasticities of supply and demand to price, among other factors. This analysis assumes that retail prices for e-bikes in Victoria are not substantially impacted by the introduction of the proposed rebates. We believe this is a realistic assumption because the number of rebates issued will be for a relatively small share of total e-bike sales (under 10%, as shown below). This assumption will be further supported if rebate eligibility is not limited to local bike shop purchases; competition from retailers covering a wider geography (including online retailers) would tend to keep prices in Victoria consistent with broader market levels. Still, the final part of this report suggests price monitoring as a component of the program evaluation.
6. It is assumed that demand is influenced by price changes of any size, and there is no threshold rebate amount below which demand is completely unaffected. This assumption is supported by a minimum rebate amount of $200.

Program Variables

Modeled program characteristics are drawn from Part IV of this report. The base annual program budget for rebates is $50,000; budgets of $75,000 and $100,000 are also modeled for comparison. The modeled programs begin in 2020, and a 10-year horizon is included to model demand out to 2030 with varying demand and prices.

Rebate amounts for the flat and tiered rebate programs are given in Part IV: Table 3, Table 5, and Table 7. Rebate amounts for the flat and tiered enhanced SCRAP-IT programs are given in Part IV: Table 9 and Table 11.

For the Enhanced SCRAP-IT program, an additional assumption is needed to account for the fact that not all potential e-bike buyers have a motor vehicle to scrap. Due to this requirement, the e-bike demand that is eligible for SCRAP-IT incentives is likely much lower than general e-bike demand. In addition, SCRAP-IT participants are eligible for a range of incentives (ranging from $200 cash to $6,000 for a new electric car) so there is an opportunity cost of using the e-bike incentive. The investigation of e-bike prices in Victoria (see Appendix B) involved contacting all local retailers involved in the SCRAP-IT e-bike incentives. Through those conversations, it was found that current utilization of the e-bike SCRAP-IT incentive is very low; we could not obtain an exact number directly from SCRAP-IT, but the retailers indicated that they rarely had customers using this incentive. For the modeling, we proceed with a base assumption that SCRAP-IT eligible e-bike demand is 5% of overall demand, and explore levels from 1% to 10%.

Input Data and Assumptions

E-bike sales

Details of the e-bike sales estimation method are given in Appendix A. Baseline e-bike sales (d_b) are estimated by scaling US annual sales by population and bicycle commute mode share. Future-year sales are estimated by trend extrapolation, with ±20% variation between low and high estimates to account for uncertainty. See Table 14 for d_b values used in the analysis.

Table 14. Baseline annual e-bike sales estimates for Victoria

Year	Low estimate	Middle estimate	High estimate
2018	1,073	1,342	1,610
2020	1,244	1,556	1,867
2025	1,633	2,041	2,449
2030	1,984	2,480	2,976

E-bike market size is difficult to estimate at this scale, but note that if program effects are rebate-limited, then the additional sales (s) are independent of d_b. Hence, the results will not be sensitive to this variable in a market of sufficient size to satisfy the rebate scarcity constraint: $d > n_r$.

E-bike prices

E-bike sales prices were obtained through a survey of e-bike retailers in Victoria. See Appendix B for a description of the data and method. Based on those data, representative low, medium, and high e-bike prices are given as $2,500, $4,500, and $6,500, respectively. Demand is assumed to be uniformly distributed across these price levels. The given are 2018 prices, and scenarios are estimated with price trends ranging ±5% annually.

Price elasticity of e-bike demand

Due to limited information on e-bike demand and price sensitivity, we pull values from the broader literature on bicycles and electric cars. Table 15 summarizes relevant studies with reported price elasticity. Based on these studies, we apply a broad range of elasticity values, with a central value of -2.0, but ranging from -1.0 to -3.0.

Table 15. Relevant Elasticity Values in the Literature

Authors	Title	Price Elasticity	Elasticity Value
Derksen and Rombouts (1937)	The demand for bicycles in the Netherlands	Bicycles	-1.3
Kerr (1987)	Demographic and energy effects on the U.S. demand for bicycles	Bicycles	-2.7
Glerum et al. (2013)	Forecasting the demand for electric vehicles: Accounting for attitudes and perceptions	Electric vehicles	-0.9 to -1.0
Mabit & Fosgerau (2011)	Demand for alternative-fuel vehicles when registration taxes are high	Electric vehicles	-2.1
DeShazo et al. (2017)	Designing policy incentives for cleaner technologies: Lessons from California's plug-in electric vehicle rebate program	Electric vehicles	-1.8 to -2.3

Income effects on e-bike demand

Lower-income individuals tend to have higher marginal utilities of income, and hence be more sensitive to price and rebates (DeShazo et al., 2017). Thus, rebates are more cost-effective if targeted to lower-income consumers, and equity and efficiency outcomes can align. We estimate potential price effects by segmenting the potential e-bike market into three income categories (low/medium/high), and applying 20% changes to price elasticities across segments, informed by DeShazo et al. (2017) and Small and Verhoef (2007). We also distribute the baseline demand disproportionally across the income segments, as shown in Table 16, to account for the high income of early e-bike adopters reported in the literature (Fishman and Cherry, 2016; MacArthur et al., 2014). The elasticities and baseline demand distributions by income tier are highly uncertain, and would benefit from a rigorous evaluation in a pilot program.

Table 16. Income-Segmented Model Inputs

Income Segment	Price Elasticity	Baseline Demand
Low	$1.2 \cdot \varepsilon$	$0.20 \cdot d_b$
Medium	ε	$0.35 \cdot d_b$
High	$0.8 \cdot \varepsilon$	$0.45 \cdot d_b$

Forecasting inputs

We estimate adoption over a ten-year horizon using the following assumptions:

- Baseline demand (d_b) from historical trends (see above)
- Price changes over time are difficult to predict. As a new technology, e-bike prices may fall as battery technology advances. At the same time, prices are rising in the bicycle market in general, and the future trend for e-bike prices is unknown. We estimate scenarios with price trends ranging ±5% annually.

Results

The program effects are estimated using a program budget of $50,000, baseline e-bike demand of 1556 for 2020, evenly distributed across e-bike prices of $2,500, $4,500, and $6,500, and demand elasticity of -2.0. The following scenarios are modeled to investigate program options, and to understand the range of possible effects given uncertainty in the input parameters.

Region-wide rebate program

- Flat rebates of $200 to $1,600
- Tiered rebates (varying by e-bike price and rebate level)
  - $150 to $1,400
  - 10% to 30% of e-bike prices

Enhanced SCRAP-IT program

- Flat additional rebates of $150 to $1,150 (on top of the $850 base rebate)
- Tiered additional rebates of $50 to $1,250 (varying by e-bike price and rebate level)

Annual program budget

- Budgets of $50,000 to $100,000

Forecasting

- Baseline demand growth, from trend extrapolation
- Price trends of ±5% annually

Income effects

- Elasticity ±20% by income level (decreasing with income)
- Base demand of 20% to 45% of total sales by income segment (increasing with income)

Parameter uncertainty

- Baseline demand ±20%
- Demand elasticity of -1.0 to -3.0
- Baseline BC SCRAP-IT e-bike demand 1% to 10% of total e-bike demand

New Rebate Program

Flat Rebates

Table 17 gives the estimated effects of the flat rebate program with fixed rebates of $200 to $1,600. The number of available rebates decreases with higher per-rebate values. At the same time, higher rebate amounts increase total and induced (marginal) e-bike demand.

Table 17. Estimated impacts of flat rebate program

Rebate amount	Number of rebates available	Total e-bike demand	Induced e-bike demand	Additional sales	New bike shop revenue	Rebates to additional purchasers	
$200	250	1,720	160	23	$90,600	$4,700	9%
$400	125	1,880	320	21	$83,900	$8,600	17%
$600	83	2,040	480	20	$76,300	$11,800	24%
$800	63	2,200	640	18	$70,700	$14,600	29%
$1,000	50	2,360	810	17	$65,900	$17,000	34%
$1,200	42	2,520	970	16	$61,700	$19,200	38%
$1,400	36	2,680	1,130	15	$58,000	$21,000	42%
$1,600	31	2,840	1,290	14	$54,700	$22,600	45%

These are all rebate-limited cases (i.e., all available rebates are used), and so the additional sales are limited by the number of rebates available to marginal purchasers (those who will only purchase with the rebates). At higher rebate amounts, the induced demand increases, as does the portion of rebates going to marginal purchasers. However, the additional e-bike sales fall slightly with rebate amount, as fewer rebates are available. New revenue to bike shops falls as well with fewer additional sales. Still, because induced demand is a higher share of total e-bike demand at higher rebate levels, the amount and share of rebates going to marginal purchasers increases with rebate amount.

In short, there is a general trade-off, where higher rebate amounts yield fewer additional e-bike sales (because fewer rebates are available at a fixed program budget), but a higher proportion of the rebate funds go to marginal purchasers. Also note that the new bike shop revenue (induced by the rebates) exceeds the program costs in all cases.

Tiered Rebates

Table 18 gives the estimated effects of tiered rebate programs, with rebates of $150 to $1,400 (first 3 rows) and rebates of 10% to 30% of e-bike prices (last 3 rows). These are again rebate-limited cases, with all available rebates used. The estimated effects are similar to the flat rebate program, where higher rebate levels yield slightly fewer additional purchases, but a greater share of rebates going to marginal purchasers. In addition, the magnitude of the effects is similar, if comparing to similar flat rebates in Table 17 to the average remounts in Table 18.

Table 18. Estimated impacts of tiered rebate programs

Rebate level	Average rebate	Number of rebates available	Total e-bike demand	Induced e-bike demand	Additional sales	New bike shop revenue	Rebates to additional purchasers	
Low	$426	117	1,890	340	21	$82,300	$8,900	18%
Medium	$632	79	2,070	510	19	$75,300	$12,300	25%
High	$835	60	2,240	680	18	$69,500	$15,300	31%
10%	$387	129	1,870	310	22	$83,300	$8,300	16%
20%	$773	65	2,180	620	18	$71,400	$14,300	29%
30%	$1,160	43	2,490	930	16	$62,500	$18,800	38%

Enhanced SCRAP-IT Program

Table 19 gives the estimated effects of the enhanced SCRAP-IT program with fixed additional rebate amounts of $150, $650, and $1,150. Due to the lower demand for SCRAP-IT rebates, the $150 rebate level yields a demand-limited scenario: not all 333 available rebates are expected to be used. The $650 and $1,150 rebate levels, however, yield rebate-limited situations in which the additional sales fall with higher rebate amounts. The higher rebate amounts yield new sales and revenue estimates slightly higher than those of the rebate program described above – as long as demand is sufficient.

Table 19. Estimated impacts of enhanced SCRAP-IT with flat additional incentives

Additional incentive amount	Number of rebates available	Total e-bike demand	Induced e-bike demand	Additional sales	New bike shop revenue	Rebates to additional purchasers	
$150	333	86	8	8	$30,300	$1,200	10%
$650	78	110	36	24	$89,100	$15,700	31%
$1,150	43	140	63	19	$71,800	$22,400	45%

Table 20 gives the estimated effects of the enhanced SCRAP-IT program with tiered additional rebate amounts of $50 to $1,250, increasing with e-bike price, at three rebate levels (low, medium, and high). Similar to the flat enhanced SCRAP-IT rebates, the lowest rebate amounts lead to a demand-limited situation, whereas the higher rebate amounts are rebate-limited and similar to the other program results.

Table 20. Estimated impacts of enhanced SCRAP-IT with tiered additional incentives

Additional incentive level	Average rebate amount	Number of rebates available	Total e-bike demand	Induced e-bike demand	Additional sales	New bike shop revenue	Rebates to additional purchasers	
Low	$183	274	86	8	8	$35,600	$1,500	9%
Medium	$573	87	100	23	20	$93,100	$12,000	24%
High	$846	59	120	37	19	$84,300	$15,900	32%

Table 21 gives the estimated effects of the enhanced SCRAP-IT program with flat additional rebates of $150, $650, and $1,150, varying the baseline e-bike demand within the SCRAP-IT program from 1% to 10% of all e-bike demand. The lowest rebate amount ($150) is demand-limited at all three baseline demand levels; the higher two rebate amounts are both demand-limited at the lowest baseline demand level.

Table 21. Estimated impacts of enhanced SCRAP-IT with varying baseline demand

Baseline demand (% of e-bike demand)	Additional incentive amount	Total e-bike demand	Induced e-bike demand	Additional sales	New bike shop revenue	Rebates to additional purchasers	
1%	$150	17	2	2	$6,100	$200	10%
5%	$150	86	8	8	$30,300	$1,200	10%
10%	$150	170	16	16	$60,700	$2,500	10%
1%	$650	23	7	7	$26,300	$4,600	31%
5%	$650	110	35	24	$89,100	$15,700	31%
10%	$650	230	71	24	$89,100	$15,700	31%
1%	$1,150	28	13	13	$46,500	$14,500	45%
5%	$1,150	141	63	19	$71,800	$22,400	45%
10%	$1,150	282	130	19	$71,800	$22,400	45%

The baseline demand within the SCRAP-IT program is a key uncertainty in the analysis, and one with substantial impacts on estimated program impacts. Lower baseline demand creates demand-limited scenarios even at high rebate levels, with lower uptake and smaller impact on sales and revenue. *Thus, it is essential to examine the baseline demand for e-bike incentives within the SCRAP-IT program before undertaking the proposed enhanced program.* If current demand for e-bike SCRAP-IT incentives is too low, it is unlikely to be a program worth pursuing. If this program is pursued, higher rebate amounts would reduce the likelihood that the program is under-used (demand limited).

Program Budget

The effects scale linearly with budget, so doubling the budget essentially doubles the impact of the program. This happens because even at $100,000, the program is still rebate-limited (i.e., there is ample demand to take up all the available rebates). Table 22 illustrates this outcome with additional sales from rebate programs with budgets of $50,000 to $100,000, and flat rebate amounts of $200 to $1,400.

Table 22. Additional sales from flat rebate program by budget and rebate amount

Rebate amount	Budget		
	$50,000	$75,000	$100,000
$200	23	35	46
$600	19	29	38
$1,000	16	25	33
$1,400	14	22	29

Forecasted Effects

The effects of the baseline demand growth for e-bikes has no effect on most of the estimated program impacts because, as described above, as long as the program is rebate-limited (i.e., all the rebates are used), the baseline demand drops out of the model. This includes the analysis of uncertainty of ±20% in the base and forecasted e-bike demand. This result is favorable for the modeling approach, given the large uncertainty in estimating e-bike demand at a local scale (see Appendix A).

The results are, however, sensitive to potential price changes over time. Table 23 gives estimated additional sales from a flat $700 rebate program over time, with annual price factors of ±5%. Without price changes, the annual additional sales are constant because they are unaffected by baseline demand growth (as described above). On the other hand, rising prices reduce the program effects, while falling prices amplify program effects. This results from changes in the size of the rebates relative to e-bike prices. Thus, if e-bike prices fall (due to market growth and improvements in battery technology, for example), then that will enhance the program outcomes.

Table 23. Additional sales from rebate program with falling and rising e-bike prices

Year	Annual price factors		
	-5%	No change	+5%
2020	18	18	18
2025	22	18	15
2030	26	18	13

Income Effects

A common approach to assess allocative equity is to examine the distribution of rebate dollars by income strata (DeShazo et al., 2017). Income effects were tested by varying the price elasticity of potential purchasers in low, medium, and high income segments, and by varying the distribution of baseline e-bike demand, as described in the Method section above (page 64 and Table 16). Table 24 gives the results of both of those analyses for flat rebate programs of \$200 to \$1,400. “Equal baseline demand” scenario assumes 33% of baseline demand from each income level, and the “unequal baseline demand” scenario assumes 20%, 35%, and 45% of baseline demand from low, medium, and high income segments, respectively (consistent with Table 16).

Table 24. Share of rebates by income level with equal and unequal baseline demand

Rebate amount	Income Level (equal baseline demand)			Income Level (unequal baseline demand)		
	Low	Medium	High	Low	Medium	High
\$200	34%	33%	33%	20%	35%	44%
\$600	35%	33%	32%	21%	35%	43%
\$1,000	36%	33%	31%	22%	36%	43%
\$1,400	36%	33%	31%	22%	36%	42%
Reference (share of baseline demand)	33%	33%	33%	20%	35%	45%

Table 24 gives the percentage of rebates allocated to each income segment for each scenario. The results show that the program overall can be progressive with respect to income, with higher proportions of rebates going to lower-income purchasers compared to the baseline reference shares. The effect is amplified with higher rebate amounts. This finding results from the fact that lower-income purchasers tend to have higher price elasticities, which means they are more responsive to price incentives. Although the program tends to increase rebates to lower-income purchasers relative to baseline demand, if the baseline demand is highly skewed toward higher-income purchasers (the unequal baseline demand scenario), then a large share of rebates will still go to high income segment, despite the program helping to shift the distribution toward lower income purchasers. Overall, the program is expected to make e-bikes more affordable for low-income purchasers, although it may not cancel out disparities in baseline demand by income.

Another factor related to income equity is budget allocation to price tiers in the tiered rebate programs. In an open competition across tiers, a larger share of the budget will go to higher-tiered rebates, yielding fewer total rebates, lower additional sales, and likely a greater portion of rebates to higher-income purchasers. Alternatively, the budget could be apportioned across price tiers to yield greater impacts on sales and improve equity rebate allocation.

Parameter Sensitivity Analysis

Baseline demand

Results are not sensitive to baseline demand assumptions. Varying baseline demand ±20%, the additional sales are the same, because the modeled programs are rebate-limited (not demand-limited).

Demand elasticity

Results are highly sensitive to demand elasticity, as demonstrated in Table 25, which shows effects of a flat $700 rebate program at different assumed elasticity values.

Table 25. Flat $700 rebate program effects with varying demand elasticity

Demand elasticity	Number of rebates available	Total e-bike demand	Induced e-bike demand	Additional sales	New bike shop revenue	Rebates to additional purchasers	
-3.0	71	2,401	845	24	$99,056	$16,981	34%
-2.5	71	2,260	704	22	$87,338	$15,065	30%
-2.0	71	2,120	564	18	$74,217	$12,891	26%
-1.5	71	1,979	423	15	$59,399	$10,401	21%
-1.0	71	1,838	282	11	$42,490	$7,510	15%
-0.5	71	1,697	141	6	$22,949	$4,101	8%

Demand model functional form

As described above, both linear and power demand functions were used in the model. The results are moderately sensitive to this factor, as demonstrated in Table 26. The power model generates higher sales estimates because of the assumed function form. Hence, effects estimate in the rest of this section are conservative, and could be higher, depending on the true demand response to price incentives.

Table 26. Additional sales from flat rebate programs, estimated with linear and power demand models

Rebate amount	Demand model	
	Linear	Power
$200	23	25
$600	19	24
$1,000	16	22
$1,400	14	20

Discussion and Limitations

The demand modeling approach applied here has a number of uncertainties and sensitivities, described above and summarized in Table 27. A more precise estimate of program effects would require a disaggregate analysis of e-bike adoption. The key for such an undertaking is availability of revealed or stated preference data. A more detailed adoption model could be built on pilot program data, or could be inferred from stated preference data elicited in a survey (which was outside the scope of this project).

Table 27. Summary of demand estimate uncertainties and sensitivities

Parameter	Description
Baseline demand	Results are generally not sensitive to this value, because it does not affect additional sales in rebate-limited scenarios (most modeled programs); higher baseline demand will reduce the likelihood of encountering demand-limited scenarios, and it will increase program effects if they do occur
Demand trends	Similar to baseline demand for 2020, results are generally not sensitive to the trend in e-bike demand
SCRAP-IT demand	Results are highly sensitive to this assumption, because it determines whether there is sufficient demand for all available rebates, which substantially influences the program effects
Demand elasticity	Results are sensitive to this assumption; estimated additional sales can vary ±35% with demand elasticity ranging from -1 to -3 (the range suggested by the literature)
Demand model form	Results are moderately sensitive to this modeling assumption; estimated additional sales can vary ±30% between linear and power demand model functional forms
Price trends	Results are moderately sensitive to this assumption; estimated additional sales after 10 years can vary ±35% with annual price trends of ±5%

While any exact number should be viewed with caution, the modeling provides the following insights, among others:

1. Program selection and design
    a. The modeled programs are estimated to induce similar numbers of additional e-bike sales, around 15-25 annually at the $50,000 budget level
    b. *Additional* bike shop revenues are expected to exceed the *total* rebate amounts in most scenarios

c. Program impacts are expected to increase proportionally with budget
d. Higher rebate amounts (at a fixed budget) generally yield fewer additional sales and lower additional bike shop revenues
e. On the other hand, a larger share of rebates go to new (marginal) purchasers at higher rebate levels
f. There were no significant differences in modeled impacts between flat and tiered rebate structures, so that design decision could be made based on other factors

2. Key uncertainties
   a. The results for the new rebate program are robust to uncertainty in current and future baseline e-bike demand
   b. However, unknown baseline demand is a key vulnerability for the enhanced SCRAP-IT program; if baseline SCRAP-IT demand is low (a realistic possibility), then the program will have little impact
   c. Program effects will be amplified if e-bike prices fall over time, and diminished if they rise
3. Income effects
   a. If baseline e-bike demand is unequally distributed across income levels, the rebates will similarly be unevenly distributed
   b. However, the program does *improve* access to e-bikes for lower-income residents due to higher price sensitivity
   c. Allocation of available budget to price tiers in tiered rebate programs will likely yield greater impacts and income equity than an open competition

Summary of Options

New Rebate Program

Advantages	Disadvantages	Key Questions
•**Open to all residents** •Open to applicants who do not own a SCRAP-IT eligible automobile or who do not want to scrap their vehicle; this will lead to a higher demand •**Flexibility in rebate structures** •Tiered or other rebate structures will be easier to implement because it is not tied to an existing rebate program	•**Program administration** •As a standalone program, it may require significant administration, which will create coordination and financial costs •**New program design and promotion** •As a new program, many design options must be evaluated and decided, such as eligibility, rebate structures, and administration; the program also must be promoted to retailers and the public	•**Should scooter-style e-bikes be eligible?** •Some programs limit rebates to pedal-assist e-bikes, but scooter-style e-bikes are not differentiated under the Motor Vehicle Act in BC; how exactly will e-bike eligibility be defined? •**How would a regional program be structured?** •Differeing municipal contributions and allocations add complexity to a program, but provide opportunities for munipalities to enhance local adoption

Enhanced SCRAP-IT Program

Advantages	Disadvantages	Key Questions
• **Builds on an established program** • Application processes and overall administration are simplified, and a widely-recognized program brand can be built upon • **Rebates cover a larger percentage of e-bike price** • Combined with the basline SCRAP-IT e-bike rebate of $850, the program rebates will cover a sufficient percentage of total e-bike prices	• **Limited pool of potential applicants** • The program is limited to individuals who are able and willing to scrap an older, high-polluting motor vehicle • **Competes with other SCRAP-IT incentives** • Not only is the pool of potential applicants limited, but the e-bike incentives must compete against six other incentives from the SCRAP-IT program, which range up to $6,000 for a new electric vehicle	• **What is the demand for e-bike incentives in SCRAP-IT?** • Current demand for e-bikes within SCRAP-IT is unknown, but local retailers suggest it is low; given the vulnerability of the program to baseline demand discussed above, demand could be a major issue for pursuing this program option • **Would a SCRAP-IT partnership work at local and regional scales?** • At this stage it is unclear whether and how a partnership could be cradfted with SCRAP-IT at the local and regional scales; this engagement would be essential to program viability

Final Evaluation

After consultation with City of Victoria staff regarding findings from Parts I through V of this report, the decision was made to proceed with refinement of the new rebate program. The data limitation on current SCRAP-IT performance is a significant obstacle to pursuing that program design. In addition, the limited potential applicant pool and the vulnerability of an enhanced SCRAP-IT program to low baseline demand are significant shortcomings of that approach. The next part of this report provides more details toward proposing a new rebate program for Victoria, with opportunities to scale to the region.

Part VI:

Recommended E-bike Rebate Program

Introduction

Building on the new rebate program development described in Parts IV and V of this report, the key program design elements are discussed in the next section, followed further estimation of program impacts and recommendation for a pilot program evaluation plan. The recommended program described below is for a pilot project at the municipal scale in Victoria, with opportunities to expand to a regional scale.

Program Design

Eligibility requirements

<u>E-bike types</u>

It is recommended to accept all e-bike types, as defined under the Motor Vehicle Act, as eligible in the pilot program implementation. The complexity of defining new e-bike types would be a significant challenge in program development, administration, and comprehension by the public. Based on the local e-bike market survey results (Appendix B), most e-bikes available and sold in the CRD are similar to conventional bicycles with a pedal-assist motor (i.e., few scooter-style or enclosed e-bikes). E-bike type and price information should be collected as part of regular program monitoring and evaluation; those data can be analyzed in the future to assess the portion of rebates going toward the purchase of unconventional e-bikes, and potential implications for program objectives can be subsequently examined. Note that if rebates are used to purchase scooter-style or enclosed e-bikes, it may not hinder project mode shift and sustainability objectives because those types of e-bikes could be closer substitutes for auto travel. Finally, it is recommended that the city support calls for refinement of the Motor Vehicle Act to more clearly differentiate e-bike types, which already has broad industry support (Aono and Bigazzi, forthcoming). This would enable a finer definition of e-bike type eligibility for rebates. It is recommended that the program *not* provide rebates for e-bike conversion kits.

<u>E-bike prices</u>

It is recommended that the program adopt a minimum e-bike price of $500 for rebate eligibility. This is based on a similar maximum rebate percentage to the SCRAP-IT program (which is 85%) for a rebate amount of $400 (see below). In effect, this will not be a real constraint because the lowest-priced retail e-bike found in the local price survey was $589. Still, this can be monitored using pilot program data.

<u>Other factors</u>

- It is recommended that applicants must provide proof of residence in the relevant geography (initially, the municipality of Victoria). Verification would be the responsibility of the program administrators, and could be based on B.C. identification cards or an existing database. It is not recommended to use voter registration data, to avoid excluding non-citizen residents.

- It is not recommended to have an additional requirement of e-bike purchase from a local retailer. The primary objectives are cycling promotion, not simply e-bike sales, so purchaser residency should be the sole geographic constraint. At the same time, it is recommended to partner with local retailers so that they can acquire the rebates at the point of sale (see below), which will encourage transactions through local businesses.

- Rebates should be limited to one per person, per year (or longer), in accordance with the project objectives of increasing bicycle usage and mode shift away from automobiles – not simply purchases of e-bikes. Additional bicycle ownership per person is expected to have little effect on cycling frequency or displacement of auto travel. This will also ensure broader access to rebates, since demand is expected to exceed the number of available rebates, at least at the pilot program scale. Opportunities for fleet purchases can be pursued as the program grows.

- No education program requirement is recommended for the pilot program. Such a requirement has been implemented in the past (see Part II), but would add a great deal of complexity to the program as there are no clear local options for integrating an existing education program.

- It is recommended to consider an upper income threshold for some or all of the rebates. This would have direct equity benefits, in addition to increasing program impacts, since low-income purchasers are expected to be more price-sensitive (see elasticity discussion in Part V). Income limits would also help mitigate risks of price inflation.

Administration and allocation

Applications for the pilot program should be administered through a third-party organization. Potential administering organizations are described in Part IV; several plausible administering partners already exist, including the Fraser Basin Council, City Green, and BC Healthy Communities. The Fraser Basin Council, for example, already has relevant experience through the Plug in BC program. The municipality would go through a public procurement process to secure a partnership agreement.

A potential solution for verifying residency and low-income status (if income thresholds are implemented) while buffering access to some private information is to leverage the existing LIFE (Leisure Involvement For Everyone) Program in Victoria. This program is used for other municipal purposes and can be used to verify both residency and income status.

The application process for the pilot program should be a single-step application, submitted to the third-party administering organization (i.e., Option 1a described in Part IV). The allocation of limited rebates will likely be an issue, because program demand is expected to significantly exceed rebate availability for the pilot program (by a factor of 10 or more – see Part V). The pilot program will be at the municipal scale, and rebates should be allocated on a “first-come, first-served” basis (i.e., in the order in which applications are received).

To avoid the situation in which an e-bike purchaser is denied a rebate that they were expecting due to limited availability, it is recommended to have an option to pre-apply and reserve a rebate for a period of up to 30 days, during which a rebate is guaranteed if an eligible e-bike is purchased. Funds would not actually be transferred until after a purchase is made. If no purchase is made, the rebate returns to the available pool. The pre-application would not be required: residents may also submit an application after purchase, but they assume the risk that a rebate may not be available. To reduce uncertainty, the availability of rebates should be provided as public information on a website, including the date at which more rebates will be available.

It is also recommended to partner with local retailers to enable point-of-sale allocation of rebates. This would reduce burden on purchasers, and also encourage purchases through local businesses. Retailers would be incentivized to partner as a service to customers. Retailers would be responsible for ensuring purchaser eligibility, and would be able to secure a rebate allocation over the phone or internet and then provide it directly to the customer at the point of sale. This would be similar to the processing of electric vehicle incentives, and a portion of the SCRAP-IT e-bike incentives.

Another allocation recommendation is to make rebates available quarterly, so that a portion is available throughout the year. Given the high expected demand, the rebates could reasonably be exhausted within the first month of availability if released annually. To avoid this situation, a portion would be released once every three months. The portions may be unequal throughout the year, to match expected seasonal demand for e-bikes.

In timing rebate availability, the program should not disincentive e-bike purchases by making the apparent costs higher when rebates are unavailable – thus motivating customers to delay. At the same time, periodic releases of rebates could help the program accomplish two objectives:

- **Target rebates to induced demand**
  Rebates are more important for the buying decisions of marginal purchasers (those who would not purchase without the rebates). If rebates are only periodically available, the marginal purchasers are more likely to wait and purchase when they are available. Hence, a larger portion of the rebates would go to the marginal purchasers, and the program would have a larger impact on adoption.

- **Income equity**
  Lower-income potential e-bike purchasers are also expected to be more price-sensitive (i.e., have a higher price elasticity of demand – see discussion in Part V). Hence, periodic availability of rebates would have a stronger effect on the purchase timing of lower-income purchasers, and a larger share of rebates would likely go to them.

Both of these effects can be evaluated as part of the pilot program, and timing of rebate availability can be modified in future years based on feedback from retailers and the public.

Rebate amounts

Based on the estimation results in Part V, flat rebates of around $400 are recommended for the pilot program. A flat rebate program is simpler than tiered rebates, which reduces administrative costs and can also be good for adoption because program simplicity is an important factor for the effectiveness of incentives (DeShazo et al., 2017). Flat rebates also are preferable from an equity perspective, to avoid larger rebates going to higher-priced e-bikes (which are more likely to be purchased by higher-income individuals).

The selection of a $400 rebate amount is a balance of several factors, and other values could also be readily justified. A rebate amount in the lower range is recommended based on the expectation of greater additional sales (see Part V). Lower rebate amounts are also expected to yield greater additional bike shop revenues. Rebates of $400 will allow for 125 rebates given a $50,000 rebate budget; lower rebates may be considered if scarcity is a major concern. A rebate of $400 is sufficiently large to provide a meaningful incentive with respect to typical e-bike prices of $3,000 to $6,000, although it is on the low end of typical percentage rebates (which are around 20 % to 30% - see Table 6). Finally, a lower rebate amount is also expected to have a larger impact on the purchase of lower-priced e-bikes, which tend to be lower-power, pedal-assist e-bikes akin to conventional bicycles, rather than scooter-style e-bikes.

On the other hand there are several arguments for somewhat higher rebate amounts. Larger rebate amounts will lead to fewer rebates issued, which will decrease overall administrative costs. This could also decrease the risk of price inflation, as the number of rebates issued would be a smaller share of total e-bike sales.

Estimated Program Impacts

The following estimated program impacts are based on a flat rebate amount of $400 and program rebate budget of $50,000, assuming baseline annual e-bike demand of 1556 evenly distributed across e-bike prices of $2,500, $4,500, and $6,500 (see Part V for a discussion of the model and uncertainty). Estimated additional sales and new bike shop revenue are given in Figure 3. The figure shows how impacts may vary with modeling method, where the shaded area gives the range of results using price elasticity of e-bike demand ranging from -1 to -3, and both linear and power demand functional forms. As described in Part V, results are not sensitive to baseline demand.

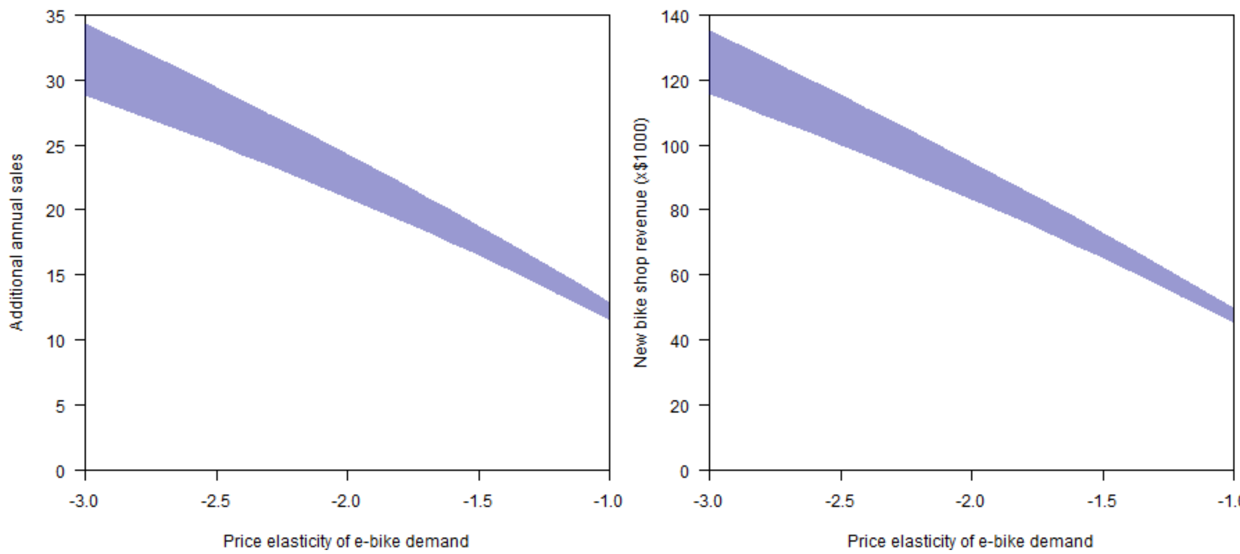


Figure 3. Additional sales and bike shop revenue with varying demand model parameters

To estimate further program impacts of e-bike adoption, a study of the literature was undertaken, as described in Appendix C. The summary impacts of each additional e-bike sale are given in Table 28 for weekly, annual, and 5-year (e-bike lifespan) periods. As described in the Appendix, effects on safety and expenditures could not be quantified from existing literature. E-bikes were estimated to yield a small net decrease in weekly physical activity, but the change was small compared to the uncertainty in the estimates so that value was excluded from Table 28. Note that there is significant uncertainty in all of these estimates, and they should be interpreted as central approximations only.

Table 28. Estimated impacts of each additional e-bike

Impact	Weekly	Annually	Lifespan (5 years)
Displaced car travel (VKT)	38	1,980	9900
Displaced public transit travel (PKT)	10	520	2600
Reduction in lifecycle CO_2 emissions (kg)	8.9	460	2300

Applying the impacts in Table 28 per additional e-bike sold, estimated program impacts are given in Table 29. Five-year lifespan effects are attributed in the year sold, although this would not be necessary for an ongoing program. The table uses central estimates from above: demand elasticity of -2, and the average between the linear and power demand model results.

Table 29. Estimated annual program impacts from e-bike adoption

Impact type	Lifespan (5 year) impacts per additional e-bike	Total annual impacts
Additional annual e-bike sales	NA	23
New bike shop revenue	NA	$89,000
Displaced car travel (VKT)	9,900	230,000
Displaced public transit travel (PKT)	2,600	60,000
Reduction in lifecycle CO_2 emissions (kg)	2,300	53,000

Pilot Evaluation Plan

It is strongly recommended that a pilot rebate incentive program be accompanied by a robust evaluation study. E-bike incentive programs are under-studied in general, and more information is needed on the effects of price incentives (rebates) on adoption and usage of e-bikes. A pilot rebate program in Victoria would provide an ideal venue to gain insights about how rebates influence uptake of e-bikes, which can then be used to generate a clearer understanding of program impacts, modify the program design to better address program goals, and provide evidence for expansion to a larger geographic scale or other cities.

Some of the key questions and uncertainties that can be addressed in a pilot evaluation study include:

1. Baseline demand for e-bikes and e-bike rebates
2. Price sensitivity of demand for e-bikes, differentiated by socio-demographics
3. Equity effects of rebates, particularly with regard to income distribution
4. Temporal distribution of e-bike demand
5. Impacts of induced e-bike purchases on cycling activity
6. Further impacts of e-bike adoption on mode shift, displaced auto travel, and physical activity
7. Potential effects of rebates on e-bike prices in Victoria

To address these questions, a suitable study design would include a 3-phase online survey of rebate applicants, delivered at the time of application, 3 months after application, and then again 12 months after application. The survey would address motivation for e-bike purchases, and travel patterns before, immediately after, and one year after e-bike purchases. Comparison cases would be generated by recruiting individuals at bike shops who 1) have purchased an e-bike without a rebate, and 2) have purchased a conventional bicycle without a rebate. Price surveys should be conducted at 4 times of the year in Victoria and at a comparison location (Nanaimo, for example) where rebates are not available.

In addition to the survey, full rebate program data can be used to evaluate the characteristics of e-bikes purchased with rebates (type and price) and the timing of e-bike purchases. To accomplish this, a data sharing agreement must be part of the partnership agreement with a third-party administrator, to allow some level of access to the program data by the municipality or party conducting the evaluation study. In addition, the partnership agreement should specify a set of minimum data that must be recorded for every rebate issued: particularly e-bike price and type. And the agreement must provide some mechanism for recruiting rebate participants for the evaluation survey. Again, comparison data would be generated by bike shop intercept surveys to gather data on non-incentivized purchases. This would provide a comparable group for equity analysis. Working with local retailers to enable point-of-sale rebate application (see above) would provide an avenue for generating the comparison dataset on non-incentivized purchases. Finally, semi-structured interviews should be conducted with retailers and a subset of rebate recipients to identify other issues in program implementation and barriers to e-bike purchase or usage.

As an important research question with clear policy implications, there are several ways in which an evaluation study could be funded. The Canadian Tri-Council agencies provide funding for partnerships between universities and applied partners, particularly the SSHRC (Social Sciences and Humanities Research Council) Partnership Grants. Those grants will at least match partner funds for studies such as described here. In addition, the Pacific Institute for Climate Solutions funds applied studies such as this seeking real-world strategies to address carbon emissions through the Opportunity Projects Program.

Expansion Opportunities

Although the pilot program is designed for implementation in the City of Victoria, the rebate program model is scalable to the region (see discussion in Part IV). A regional rebate could be developed based on the evaluation of the pilot incentive program, with a few additional considerations. One important issue is the geographic allocation of rebates within the region. If a regional or higher-level funding source is identified to generate rebates at the regional level, they could be simply allocated on a “first-come, first-served” basis within the region. Alternatively, the region could set up a rebate-match structure, wherein the region matches (in number, not amount) any rebates provided by the municipality to enhance the program at a local scale. The rebates would still be centrally administered, but certain numbers would be reserved for residents of municipalities who had contributed to the rebate pool. For example, if 400 rebates were available for the region at large, a municipality could contribute an additional 50 rebates from municipal funds, enlarging the total number to 450 and ensuring at least 100 for that municipality. Given the degree to which current demand is expected to exceed the number of rebates for a municipal program, such a matching system could help to expand rebate access across the region.

The program described in this part of the report is based on individual e-bike purchases, and is limited to one rebate per purchaser. As the rebate program matures and grows, it could be expanded to incentive e-bike fleet purchases by certain types of organizations (non-profits, for example). While price effects on individual travel are uncertain, the effects of rebates on fleet purchases, and consequent implications for travel, are even more uncertain. Hence, further study of fleet-targeted options is needed.

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Appendix A: E-bike Sales Estimates

Introduction

E-bike sales and ownership numbers are difficult to obtain, particularly at fine spatial scales. After an extensive search, no publicly available e-bike sales or ownership data were found for Victoria, British Columbia, or even Canada. E-bike sales estimates at the national level are typically made through customs records, which itself is challenging due to a lack of clarity in filing categories (Benjamin and Poynter, 2014; Wild and Woodward, 2018). There is no known large-scale survey that collects e-bike ownership data.

A recent background report for the Capital Regional District (CRD) on the *Electric Vehicle (EV) and Electric Bicycle (E-Bike) Infrastructure Planning Project* acknowledged "limited ownership data that is [sic] publicly available" for e-bikes (Watt Consulting Group, 2018). They instead conducted phone interviews with five regional bicycle shops, and found that e-bikes were estimated at 1% to 33% of total bicycle sales, by shop, and that e-bike sales were estimated to be growing at 20% in one shop. No more specific sales or ownership data were reported.

We undertook an exhaustive search of scientific and "grey" literature, but found no statistics on e-bike sales or ownership in Victoria or BC. The geographically closest sales data available were from the USA. Thus, we applied a scaling method that makes use of available data to estimate e-bike sales in Victoria based on two factors: population and bike commute mode share.

Method

The core assumption behind the sales estimate is that *per capita* e-bike sales are proportional to bicycle commute mode shares. Annual e-bike sales for Victoria, S_V, are estimated from annual US national sales, S_U, the population of each geography, P_V and P_U, and the bicycle commute mode share of each geography, M_V and M_U. The core assumption can be written:

$$\frac{S_V}{P_V M_V} = \frac{S_U}{P_U M_U}$$

and rearranged to solve for S_V:

$$S_V = S_U \frac{P_V M_V}{P_U M_U}$$

Base Year (2018) Data

Base year data are given in Table 30. Population data for the US and Victoria are taken from each country's census and growth estimates (US Census Bureau, Statistics Canada, and UNData). US and Victoria bicycle commute mode share data come from the Alliance for Biking & Walking

(2016) and Statistics Canada (2018), respectively. Population and mode share were extrapolated to 2018 from 2016 data using linear growth rates over the previous 5 years.

Table 30. Base Year (2018) Data

	Victoria	USA
Population	87,863	330,655,202
Bicycle commute mode share	11.3%	0.61%
Annual e-bike sales	unknown	272,567

US e-bike sales estimates were compiled from the following sources:

1. Benjamin and Poynter (2014)
2. Citron and Gartner (2016)
3. Fishman and Cherry (2016)
4. MacArthur et al. (2014)
5. McFarland (2018)
6. Sutton (2017)
7. Takiff (2017)
8. The NDP Group, Inc. (2017)

Compiled sales estimates from all seven sources are shown in Figure 4, along with a linear trend-line indicating annual growth of 28,534. The 2018 estimate is based on an extrapolation of this trend-line.

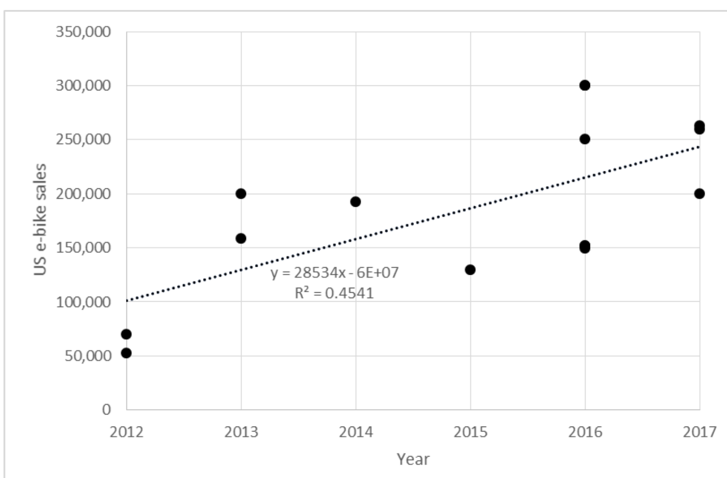

Figure 4. Summary of US e-bike sales estimates

Forecasting

The US and Victoria growth rates in Table 31 were extracted from the same sources based on the last 5-year period.

Table 31. Annual growth rate estimates

	Victoria	USA
Population	1.2%	0.7%
Bicycle commute mode share	0.100%	0.022%
Annual e-bike sales	unknown	28,534

Baseline future year e-bike sales in Victoria are estimated by the same method as for 2018, but using forecasted inputs for the other variables, compounded annually at the rates given in Table 31. Forecasted inputs are given in Table 32.

Table 32. Forecast population, mode share, and sales estimates

Year	Victoria		USA		
	Population	Mode share	Population	Mode share	E-bike sales
2018	87,863	11.3%	330,655,202	0.61%	272,567
2020	89984	11.5%	335,300,577	0.65%	329,635
2025	95515	12.0%	337,647,681	0.76%	472,305
2030	101385	12.5%	340,011,215	0.87%	614,975

Results

Total sales and sales per 1,000 population estimates are given in Table 33. Victoria is estimated to have around 20 times higher per capita sales, based on the much higher commute mode share. US and Victoria sales are expected to increase over time, both with total population and per capita. For comparison, the US and Europe are estimated to purchase non-electric bicycles at a rate of about 50 and 30 per 1,000 persons per year, respectively (Benjamin and Poynter, 2014). The projected sales growth in Victoria is at a rate of 4% to 8% per year, consistent with several industry estimates reporting expected US and worldwide non-China e-bike market growth in this range.[1]

[1] https://www.bikebiz.com/business/ebike-market-growth,
https://www.statista.com/statistics/674381/size-global-market-electric-bicycles/,

Table 33. E-bike sales estimates

Year	Victoria		USA	
	Total sales	Sales per 1,000 population	Total sales	Sales per 1,000 population
2018	1,342	15.3	272,567	0.8
2020	1,556	17.3	329,635	1.0
2025	2,041	21.4	472,305	1.4
2030	2,480	24.5	614,975	1.7

Summary

Given the large uncertainties in the sales estimates, Table 34 gives the baseline annual e-bike sales estimates to be used in the analysis, with a range of $\pm$20% from the central estimates.

Table 34. Victoria baseline sales estimates for analysis

Year	Low estimate	Middle estimate	High estimate
2018	1,073	1,342	1,610
2020	1,244	1,556	1,867
2025	1,633	2,041	2,449
2030	1,984	2,480	2,976

Appendix B: E-bike Prices in Victoria

Introduction

Similar to e-bike sales data, an extensive search revealed no public dataset of e-bike sales prices in Victoria or British Columbia. Still, unlike total sales, representative prices can be estimated from a sample of shops. In the recent background report for the Capital Regional District (CRD) on the *Electric Vehicle (EV) and Electric Bicycle (E-Bike) Infrastructure Planning Project* (Watt Consulting Group, 2018), e-bike prices were surveyed from five regional bicycle shops, yielding ranges of $2,000 to $8,000.

Data collection and analysis of local e-bike prices

We undertook a similar survey of nine bicycle shops in the City of Victoria in July and August, 2018. The surveyed shops are listed below and on the map in Figure 5, which includes all local participating e-bike retailers in the BC Scrap-It Program. E-bike prices were obtained from shop websites.

1. Oak Bay Bike (http://oakbaybikes.com/e-bikes/electric-bikes/)
2. Pedego Victoria (http://pedegovictoria.ca/)
3. Fair Field Bicycle Shop (https://fairfieldbicycle.com/new/)
4. Trek Bike Store of Victoria (http://www.trekbikesvictoria.com/)
5. Cit-E-Cycles (https://www.citecycles.com/see-all-products/)
6. Ride the Glide (https://www.ridetheglide.ca/products/)
7. Coastal Cycle (http://www.coastalcycle.com/bikes/)
8. Giant Victoria (http://www.giantvictoria.com/ca/e-bikes)
9. Russ Hay's the Bicycle Shop (https://russhays.com/)

E-bike prices were categorized according to:

1. Style (mountain, cargo, road, etc.), and
2. Motor assist type (pedal-assist, throttle-assist, etc.).

Median and ranges of prices are given in the following tables. Across all types, the prices ranged from $589 to $12,372.

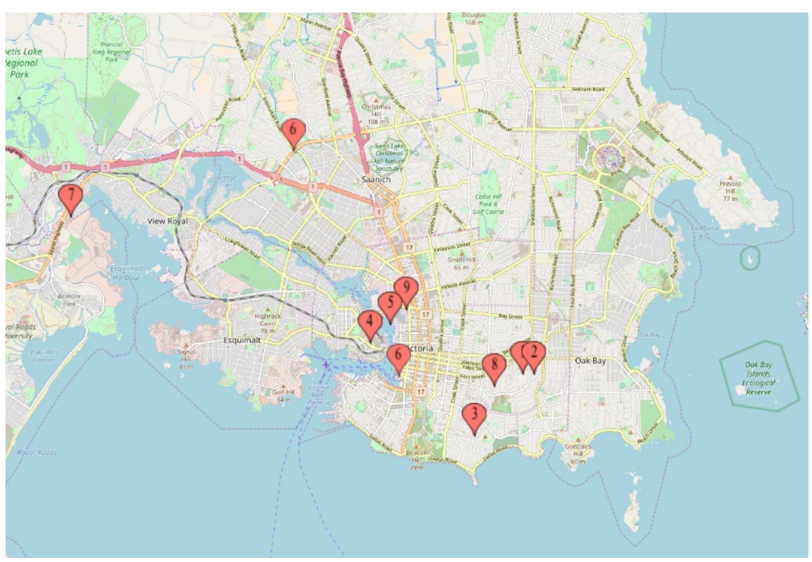

Figure 5. Locations of Surveyed Retailers

Table 35. Surveyed Prices by Bicycle Type

Shop	Number of models	Types	Price(CAD)		
			Minimum	Median	Maximum
1	12	Electric Hybrid Bikes	$2,799	$4,074	$5,599
	1	Electric Cargo Bikes	$5,900	$5,900	$5,900
	6	Electric Mountain Bikes	$3,000	$4,333	$6,700
	7	Electric City Bikes	$2,899	$3,457	$3,900
2	1	Electric Hybrid Bikes	$6,395	$6,395	$6,395
	6	Electric Cargo Bikes	$3,795	$4,278	$4,795
	2	Folding Electric Bikes	$3,295	$3,495	$3,695
	1	Electric Tricycles	$3,895	$3,895	$3,895
	5	Electric Mountain Bikes	$3,695	$5,335	$6,995
	51	Electric City Bikes	$2,595	$4,249	$5,690
3	1	Electric Cargo Bikes	$5,849	$5,849	$5,849
	4	Electric City Bikes	$2,450	$3,050	$3,900
	1	Electric Touring Bikes	$3,000	$3,000	$3,000
4	8	Electric Hybrid Bikes	$3,000	$3,475	$4,700
	4	Electric Mountain Bikes	$4,600	$5,475	$6,700
5	14	Electric Hybrid Bikes	$2,799	$3,735	$5,999
	8	Electric Cargo Bikes	$4,395	$7,919	$12,372
	9	Folding Electric Bikes	$2,599	$4,285	$7,461
	1	Electric Tricycles	$3,695	$3,695	$3,695
	76	Electric Mountain Bikes	$2,499	$5,453	$11,999
	102	Electric City Bikes	$1,899	$5,641	$11,999
	1	Electric Road Bikes	$4,299	$4,299	$4,299
	13	Electric Touring Bikes	$2,595	$6,116	$8,863
6	3	Folding Electric Bikes	$999	$1,380	$1,845
	1	Electric Mountain Bikes	$3,495	$3,495	$3,495
7	2	Electric Cargo Bikes	$1,962	$3,924	$5,887
	9	Electric City Bikes	$589	$1,608	$3,926
8	3	Electric Mountain Bikes	$4,399	$5,732	$7,299
	6	Electric City Bikes	$2,899	$3,266	$4,399
	2	Electric Road Bikes	$3,899	$4,199	$4,499
9	2	Electric Mountain Bikes	$5,299	$5,299	$5,299
	11	Electric City Bikes	$2,900	$3,952	$5,120

Table 36. Surveyed Prices by Motor Assist Type

Shop	Number of models	Types	Price(CAD)		
			Minimum	Median	Maximum
1	21	Pedal-assist	$2,799	$4,133	$6,700
	5	Throttle-assist	$2,899	$3,640	$4,300
2	11	Pedal-assist	$4,495	$5,493	$6,995
	55	Throttle-assist	$2,595	$4,107	$6,395
3	5	Pedal-assist	$2,450	$3,040	$3,900
	1	Throttle-assist	$5,849	$5,849	$5,849
4	12	Pedal-assist	$3,000	$4,142	$6,700
5	141	Pedal-assist	$1,899	$5,508	$11,999
	55	Throttle-assist	$2,295	$3,940	$7,249
	30	Speed pedelec	$2,499	$8,133	$12,372
6	2	Pedal-assist	$1,295	$2,395	$3,495
	2	Throttle-assist	$999	$1,422	$1,845
7	10	Pedal-assist	$589	$2,036	$5,887
	1	Throttle-assist	$1,962	$1,962	$1,962
8	5	Pedal-assist	$2,899	$4,619	$7,299
	6	Speed pedelec	$2,899	$3,682	$4,499
9	12	Pedal-assist	$2,900	$4,231	$5,299
	1	Speed pedelec	$3,300	$3,300	$3,300

Summary and Comparison

Combined price data using six different averaging methods are given in Table 37. Suggested representative price ranges are given in Table 38. For comparison, industry information suggests average US sales prices of $3,200 CAD, with 40% of US sales from e-bikes over $4,000, 30% from e-bikes in the range $3,300 to $4,000, and 30% from e-bikes below $3,300 (CAD) (The NDP Group, Inc., 2017). Also, as mentioned above, a recent report for CRD suggested regional e-bike price range of $2,000 to $8,000 (Watt Consulting Group, 2018).

Table 37. Averaged Price Ranges

Averaging method	Weighting	Price(CAD)		
		Minimum	Median	Maximum
Across shops	None	$2,237	$3,745	$6,733
Across use types and shops	None	$3,387	$4,383	$5,818
Across motor types and shops	None	$2,646	$3,979	$5,891
Across shops	Number of models	$2,145	$4,873	$10,055
Across use types and shops	Number of models	$2,544	$4,887	$8,822
Across motor types and shops	Number of models	$2,335	$4,902	$9,009

Table 38. Suggested Representative E-bike Prices

Low	Middle	High
$2,500	$4,500	$6,500

Appendix C: E-bike Adoption Impacts

This appendix examines the broader impacts of e-bike adoption through literature review to assess e-bike usage, displaced auto travel, reduced emissions, improved health and safety, and economic outcomes.

E-bike Usage

Table 39. Literature on e-bike usage in terms of trip distance, trips per week, and speed

Study	Study Area	Results
(Popovich et al., 2014)	US	On average in a week with good weather participants rode 44 miles a week and they rode e-bikes on average 4.3 days a week
(Rios, Golab, & Keshav, 2016)	Canada	Average trip duration per trip is 16.8 minutes
(Ling, Cherry, MacArthur, & Weinert, 2017)	US	E-bike respondents on average rode 3.6 (only e-bike owners)/ 3.7 (both e-bike and bike owners) days per week and in the same order 14.9 and 16.0 miles a day
(Gorenflo, Rios, Golab, & Keshav, 2017)	Canada	Average trip duration 11.3 minutes. Average speed of 18.9 km/hr
(Fyhri & Sundfør, 2014)	Norway	E-bike users cycle 68 km per week
(Hiselius & Svenssona, 2014)	Sweden	Average trip distance cycled per week is 71 km
(Wolf & Seebauer, 2014)	Austria	Riding e-bike on average 794 km per year
(Kairos,2010)* [Non English]	Austria	For individuals, cycling e-bike 1400 km per year and for organizations on average 1432 km per year
Drage and Pressl (2012)* and Eddeger et al. (2012)*	Austria	1500km in total in one month. And each participant does an average of 12 trips per week
Mobiel 21 (2015)	Belgium	Average trip of 14.5 km, men speed of 42km/h and 21 km/h women
Cappelle et al. (2003)*	Belgium	Ridden an average of 4.2 km per day
(Engelmoer, 2012)	Netherlands	Commuting on average 9.8 km
Helms et al. (2015) [Non English]*	Germany	Average trip distance 11.4 km
(Cairns, Behrendt, Raffo, Beaumont, & Kiefer, 2017)	UK	Commuting trips to work: 2 days a week cycling 15-20 miles a week
(Allemann & Raubal, 2015)	Switzerland	Downhill the average velocity of e-bikers: 23.7 km/h, uphill average trip velocity 19.6 km/h)
(Lopez Aguirre, Astegiano, Tampère, Gautama, & Beckx, 2015)	Belgium	Average trip distance is 5.4 km with average speed of 14.6 km/h
(Kroesen, 2017)	Netherlands	E-bike owners travel on average 3 km by e-bike which is more than cyclists (2.6 km)
(Christopher Robin Cherry, 2007)	China	Average trip distances of 9 to 10 km
(Montgomery, 2010)	China	Trip distance in morning peak 5.3 km
(Weinert, Ma, Yang, & Cherry, 2007)	China	Between 2-4 trips per day, on average 5.8 km per trip, speed of 14 km/hr

The literature on typical usage of e-bikes from studies is given in Table 39. The literature can be summarized in the following recommended approach to estimating typical e-bike usage:

1. Average trip speed for e-bikes of 18 km/hr (this is used to convert between travel time and travel distance)
2. Average riding frequency of 3.3 days per week, and 3 trips per day on days ridden (this is used to convert between weekly and daily travel)
3. Average single trip distances of 6.1 km and weekly usage of 60 km

Trip Displacement

Table 40. Literature of e-bike impacts on trip displacement

Study	Country	Trip displacement (portions of e-bike trips that were made by other modes before purchasing an e-bike)
(Hiselius & Svenssona, 2014)	Sweden	3-12% walking; 4–16% public transport; 15–26% conventional bike; and 47–67% car trip. Induced trips in terms of distance per person per week: 1 km and in terms of 5: approximately 1-5%.
(Hiselius & Svensson, 2017)	Sweden	In urban trips across different trip purposes, 54% car, 21% bus, 28% conventional bicycle
(Kairos,2010)* [Non English]	Austria	52% conventional bike, 35% car. It was estimated that approximately 230,000 car kilometers per year were substituted for e-bike use.
Drage and Pressl (2012)*	Austria	Approximately 55% car. (equal to 44 km weekly per participant)
Mercat (2013)*	France	Annually, 1.2 million km were made by e-bike that were otherwise made by car.
(Hendriksen et al., 2008) [Non English]	Netherlands	Commute trips, 33% bicycle, 16% car, 8% public transport, 5% motorbike/scooter and 38% induced trips
(Dekker, 2013)	Netherlands	28% car, 12% public transport, 25% conventional bicycle, induced transport 16%. In terms of km travelled replaced per week by car 520.5 km (33%) and by bus 77.5 km (yearly riding on e-bike 3500 km)
Helms et al. (2015)* [Not English]	Germany	41% car; 38% conventional bike; 7% public transport; 4% walking. In terms of distance, 45% of distance travelled was previously done by car. For commuting, 62% of trips were previously made by car.
(Christopher Robin Cherry, 2007)	China	Approximately: 52% bus, 18% bicycle, walking 11%, car 2%
(Montgomery, 2010)	China	49% bus, 36% bicycle, 7% walk, 1 % car, 1% induced trips.

The literature on displacement of travel by other modes after e-bike adoption is summarized in Table 40. According to Capital Regional District origin and destination survey 2017[2], 42% of trips in Victoria are by car, 7% by public transit, 9% by bicycle, and 41% walking. Compared to

[2] https://www.victoria.ca/EN/main/residents/transportation.html

China (Cherry, 2007), Victoria has more car trips which makes it more analogous to European cities. Thus, for trip displacement share, only European studies are considered.

Excluding China, on average (N=number of studies, SD= standard deviation):

- 41% of e-bike trips replaced car trips (N=7, SD=15.5)
- 33% of e-bike trips replaced trips by conventional bicycle (N=6, SD=11.3)
- 12% of e-bike trips replaced trips by public transit (N=5, SD=5.6)
- 6% of e-bike trips replaced walking trips (N=2, SD=2.8)
- The remaining trips (8%) are assumed to be induced (additional) trips

These numbers, illustrated in Figure 5, are slightly higher than past estimates of induced e-bike trips, which ranged from 1-5% (Hiselius & Svenssona, 2014) to up to 38% in the Netherlands (Hendriksen et al., 2008; Dekker, 2013).

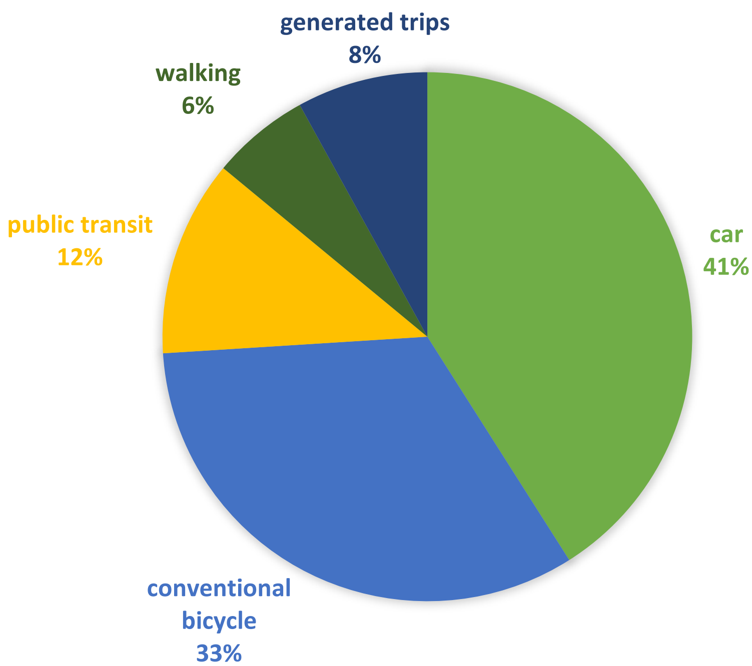

Figure 6. E-bike mode substitution summary

The relevance of these estimates from past studies for Victoria is dependent on trips patterns and a number of other factors. In addition, each study has its own assumptions and limitations. Hence, these estimates should be applied with caution.

Distance displacement

Several studies report driving distance displaced by e-bike adoption – see Table 40. Synthesizing the findings of Drage and Pressl (2012), Dekker (2013), and Hislius and Svenssona (2014), around 38 km of driving per week is displaced by e-bike adoption, on average (ranging around from 25 to 50 km).

For other transportation modes, a similar synthesis yields the following average displacement from e-bike adoption:

- Public transit: 10 km displaced per week
- Conventional bicycle: 20 km displaced per week
- Walking: 4 km displaced per week

Summarizing, each e-bike adoption can be estimated to yield 60 km of e-bike usage, displacing 38 km of driving, 10 km of transit, 20 km of conventional cycling, and 4 km of walking, on average.

Environmental Impacts

Table 41. Literature on environmental impacts of e-bikes

Study	Country	Environmental impact
(Popovich et al., 2014)	US	CO_2 emissions for a daily round trip for trip distance of 5 miles: 0.18 lb per year.
(Hiselius & Svensson, 2017)	Sweden	Emission factor for a car is 0.14 kg CO_2/km per person. Consequently, the average distance (person-kilometer) travelled by e-bike per person per week that was formerly made by car is multiplied by this factor. Each person in a week replaces 55.28 km (in urban setting) travelled by car with e-bike.
(Engelmoer, 2012)	Netherlands	Emission rates per passenger-kilometer (g/pax-km): CO_2=40, SO_2=0.018, PM=0.011, NO_x=0.003 Average emissions for commuter traffic including production, fuel well to tank and tank to wheel phases are considered. (numbers are ballpark)
(Dave, 2010)	USA	Emission rate: CO_2-equivalent kg/pax-mile=33 Life cycle assessment of e-bike comprising fuel production, infrastructure, maintenance, manufacturing and operation.
(Dekker, 2013)	Netherlands	33%,33%,6% of 3500 km driven on an e-bike per year formerly was made on car, conventional bicycle and public transit.CO_2 reduction for total number of e-bikes and because of trip displacement 29.9 kilotonnes
(Christopher Robin Cherry, 2007)	China	Life cycle emission (production, vehicle use and disposal for e-bike: 1.104 Tonne CO_2 equivalent, 6.17 kg SO_2, 6.26 PM Kg.
(Christopher R Cherry, Weinert, & Xinmiao, 2009)	China	Emission rates per passenger-kilometer for production and use phases (g/pax-km): CO_2=15.6, SO_2=0.07, PM=0.07, CO=0.007, HC=0.027, NO_x=0.01. Life-span of e-bike is considered to be 50,000 km.

Past studies on the environmental impacts of e-bike adoption are summarized in Table 41. Estimated weekly emissions displacement attributable to e-bike adoption is summarized in Table 42. Per passenger kilometer traveled (PKT) lifecycle CO_2 emissions of travel by conventional and electric bicycles, as well as car and transit travel, are drawn from Engelmoer (2012). Displaced travel is based on the previous section of this report. E-bikes are expected to displace approximately 460 kg CO_2 emissions per year, on average.

Table 42. CO_2 emission reductions from displacing trips with e-bikes

Travel	Weekly travel	Lifecycle CO_2 emissions (g/PKT)	Weekly CO_2 (kg/PKT)	Annual CO_2 (kg/PKT)
Car (displaced)	38 km	260	-9.9	-515
Public transit (displaced)	10 km	100	-1.0	-52
Conventional bicycle (displaced)	20 km	20	-0.4	-21
Walking (displaced)	4 km	0	0	0
E-bike	60 km	40	2.4	125
Total	-12 km	NA	-8.9	-463

Health Impacts

Common health guidelines recommend at least 150 minutes per week of moderate to vigorous physical activity (MVPA). Table 43 summarizes the literature on physical activity during different modes of travel, including e-bikes. Based on the e-bike studies and the summary of typical e-bike usage above, e-bike trips can regularly achieve a physical activity level of at least 3 MET (metabolic equivalent), qualifying as MVPA. Note that physical activity will vary greatly by individual, trip, and environmental factors.

Synthesizing the studies, typical MVPA per 10 minutes of travel by car, transit, conventional bicycle, walking, and e-bike are 1.0, 1.7, 4.5, 6.6, and 4.0, respectively. Applying average speeds, these can be converted to 0.2, 0.4, 1.7, 9.9, and 1.3 minutes of MVPA per PKT by car, transit, conventional bicycle, walking, and e-bike, respectively.

Table 44 summarizes the physical activity estimates, indicating a net decrease of 26 minutes of MVPA per week per e-bike adopter. This net effect is relatively small and possibly within the uncertainty of the estimate. The 60 km of e-bike riding per week is estimated to achieve about half of the target minutes of MVPA (150 per week).

These estimates are subject to a number of important limitations. Different trip purposes, time of trip (peak vs non-peak hour), interpersonal characteristics, terrain and travel speeds (particularly for active transportation) will influence physical activity levels. Level of power assistance for e-bikes is also expected to affect activity level. Additionally, the MPVA for cycling varies greatly among studies.

Table 43. Literature on physical activity during different modes of travel

Study	Country	Health Impacts
(Simons, Van Es, & Hendriksen, 2009)	Netherlands	13 minutes cycling on a 4.3 km flat track with e-bike power mode set on light support yields on average 5.7 METs (unit of intensity of physical activity) which falls into interval of moderate intensity 3-6 MET. While fully support mode of e-bike gains 5.2 METs while cycling 11 minutes on the same track. When e-bike was set at no support mode it yields 6.1 METs during 14 minutes cycling
(Gojanovic, Welker, Iglesias, Daucourt, & Gremion, 2011)	Switzerland	18 sedentary subjects spent 19 (e-bike set at high power assistance) and 21 (e-bike set at standard power assistance) minutes on 5.1 km track which yield 6.1 and 7.3 METs. Compared to 30 minutes cycling on same track that gives 8.2 METs
(Sperlich, Zinner, Hébert-Losier, Born, & Holmberg, 2012)	Germany	8 sedentary women cycled 9.5 km on a track with varying grade with and without power assistance at their own pace. 36 minutes on e-bike yields 5.2 METs while 42 minutes on conventional bicycle results in 7.1 METs
(Sisson & Tudor-Locke, 2008)	France	Based on 6164 trips, association between transportation mode and MVPA is obtained. MVPA per 1 km of trip: An additional 1.2 minutes for public transport, 0.5 minutes for cycling and 9.6 minutes for walking of MVPA is obtained compared to car travel per 1 km of trip. For every 10 minutes of a trip, an additional 1.8 minutes MVPA for public transport, 0.4 minutes for cycling and 4.3 minutes for walking is obtained compared to car travel.
(Ferrer, Cooper, & Audrey, 2018)	UK	During commute trips, mean daily time spent in MVPA during commute (minutes) is 7.3 in car, 34.3 in walk and 25.7 in public transport. Mean daily commute time (minutes) 86.6 in car, 53.8 in walk and 116.5 in public transit.
(Costa et al., 2015)	UK	Median journey time (minutes) is 31 for car, 45.5 for bus, 47 for car and walking combined, 35 for car and cycling combined, 14 for walking, 27 for cycling. Median MET in same order: 1.28, 1.67, 1.78, 2.21, 4.61, and 6.44. Median percentage of journey duration spent in moderate and vigorous activity in same order (approximately): car 0, bus 20%, car + walk: 20%, car and cycling: 20%, walk: 100%, cycling: 30% (55% in vigorous). Average cycling speed is reported as 10 km/h Compared to car-only commuting: on average, additional gain of MET is 0.7 for bus users, car and walking 0.6, car and cycling 1.58, walking 2.49, cycling 3.9.

Table 44 Estimated MPVA from trip displacement

Travel	Weekly travel	Minutes MVPA per PKT	Weekly minutes MVPA
Car (displaced)	-38 km	0.2	-8
Public transit (displaced)	-10 km	0.4	-4
Conventional bicycle (displaced)	-20 km	1.7	-34
Walking (displaced)	-4 km	9.9	-39
E-bike	+60 km	1.3	+78
Total	-12 km	NA	-7

Safety Impacts

Table 45. Literature on safety impacts of e-bikes

Study	Country	Safety Impacts
(Feng et al., 2010)	China	Through police reports from 2004-2008 on e-bike related road casualty, they found casualties rate per 100000 registered e-bikes decreased over 4 years period (average=20.25, SD=2.28)
(Du et al., 2013)	China	In rural setting, e-bike injuries account for 57% of road traffic hospitalization in 6 months.
(Hu, Lv, Zhu, & Fang, 2014)	China	According to hospitalization data from June 2009 to June 2011, 205 cases were caused by e-bike and bicycle crashes. Of this, 146 were from e-bike collisions.
(Papoutsi, Martinolli, Braun, & Exadaktylos, 2014)	Switzerland	From April 2003 to September 2013, 23 patients treated in a hospital that were involved in e-bike accidents.
(Fishman, Wolt, & Schepers, 2018)	Netherlands	Controlling for age, gender, health status and cycling frequency, cycling on e-bike increases the odds of being treated at emergency departments (ED). Crashes with e-bikes are more often single-bike crashes and less often with other road users. Road situation that collisions occur were not different between e-bikes and bicycles. Odds of e-bike riders being treated at EDs was 1.24 higher than bicyclist. While controlling for cycling exposure in terms of natural log of km cycling per year, the difference between e-bikes and bicycle disappears. About e-bike collision injury severity, this study shows e-bike riders are equally often hospitalized as bicyclists after treatment at EDs. It is noteworthy that cruising speed between bicycles and e-bikes in Netherlands is not significantly different.

Table 45 summarizes the literature on the safety impacts of e-bike use. E-bike riders have been shown to have greater safety risks than conventional cyclists in China (Weinert, et al., 2007, Bai et al., 2013, Yao and Wu, 2012, Cherry, 2007) and the Netherlands (Schepers et al., 2014), but that has not been found in the US (Langford et al., 2013, Rodier et al., 2003). There is a mismatch between perceived and actual safety of e-bike users. E-bike riders in North America feel safer riding and perceive that e-bike helps avoid incidents (MacArthur, Dill, & Person, 2014). In China, in a perception-based survey, women expressed that they feel safer riding on e-bikes while passing intersections (Weinert, Ma, Yang, et al., 2007). Overall, there is a lack of research on the safety impacts of e-bikes, particularly in the Canadian context. Given this gap, we do not attempt to quantify the impacts of e-bike adoption on safety outcomes.

Lifespan of e-bike

Table 46. Literature on lifespan of e-bikes

Study	Estimate
(Christopher R Cherry et al., 2009)	Lifespan of an e-bike is 50,000 km. As e-bike in this study is applied to electric two-wheelers it includes e-scooters too. It mentions that lifecycle of an e-bike lead battery is 10,000 km or one-two years and an e-bike uses five batteries in its life span which implies 5 years lifespan.
(Weinert, Ma, & Cherry, 2007)	In this study, vehicle lifetime for e-bike is considered to be 5 years and battery lifecycle is about 1.9 years (300 cycles). This study definition of e-bike includes e-scooters too.
(C. Cherry, 2007)	Assumed life-span of e-bike (both e-bicycles and e-scooters) is considered 50,000 km resulted from interviews with manufactures.
(Masih-Tehrani, Esfahanian, Esfahanian, Nehzati, & Esfandiari, 2015)	Assumed lifespan of e-bike in this study is 10 years.
(Tian, Wu, Gong, Agyeiwaa, & Zuo, 2015)	This Chinese study states e-bike lifespan is 4-5 years.
(Montgomery, 2010)	Lifetime of e-bike is roughly 5 years.
(Engelmoer, 2012)	This study in Netherlands assumes lifespan of e-bike equal to 50,000 km.
(Leuenberger & Frischknecht, 2010)	This study distinguishes between e-bicycle and e-scooter. Life expectancy of e-bicycle is 15,000 km.

Table 46 summarizes the literature on the lifespan of e-bikes. According to these studies, a lifespan of approximately 5 years can be assumed. The lifespan of an e-bike greatly depends on usage pattern, power assistance, charging, maintenance and characteristics of e-bike that varies based on type of e-bike. While most e-bikes in China work with lead batteries, e-bikes in Europe use lithium ion battery. The former has 1-2 years of lifetime while latter is expected to have 2-3 times more durability.

Economic impacts of cycling

Table 47. Literature on economic impacts of cycling on local businesses

Study	Estimate
(Clifton et al., 2012) (Clifton, Muhs, Morrissey, & Currans, 2016)	A study in Portland shows at convenience stores cyclists spend the most per trip and per month ($8 and $81). At bars, they spent under $17 per trip but $82 per month (greater visits per month but less expenditure per trip). At restaurants they pay on average per trip $11 and monthly average of $48. At restaurant and bars that goods are consumed on site, cyclists and patrons who arrive by motorized modes of travel are not different regarding expenditure at restaurants and bars when controlled for demographic characteristics. At convenience stores, cyclists' expenditure per trip does not differ than cars while controlling for frequency of visits per month and socio-economic factors.
(Popovich & Handy, 2014)	A study in Davis, California, residents were asked about their shopping behavior. Grocery shopping, eating, drinking and entertainment trips were excluded, cyclist compared to drivers spent more but not significantly different than drivers. Average spending per trip for: $59.16 for cyclist and $53.83 for drivers, monthly spending (last trip spending*frequency) $248.62 for cyclist, $182.10 for drivers. In shopping frequency model, biking on last shopping trip was not significant. Spending model shows that cyclists spent more than drivers but not significantly.

Table 47 summarizes the scant literature on expenditures of cyclists compared to other modes. There is not sufficient evidence to conclude significant differences in expenditures by mode.

Summary of e-bike adoption impacts

Summarizing the previous sections in this appendix, adoption of one e-bike results in following impacts (Table 48). As described above, effects on safety and expenditures cannot be quantified from existing literature. Although e-bikes were estimated to yield a net decrease in weekly physical activity, the change was small enough compared to the uncertainty in the estimates that we exclude it from the summary impacts. Note that there is significant uncertainty in all of these estimates, and they should be interpreted as approximations only.

Table 48. Estimated impacts of each additional e-bike

Impact	Weekly	Annually	Lifespan (5 years)
Change in car travel (VKT)	-38	1,980	9900
Change in public transit travel (PKT)	-10	520	2600
Net change in lifecycle CO_2 emissions (kg)	-8.9	460	2300

Sources for Appendix C

NOTE: References indicated by * could not be found in full-text English; their results were derived from the literature review by Cairns et al. (2017).

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