

5-2019

How E-Bike Incentive Programs are Used to Expand the Market

Michael McQueen
Portland State University

John MacArthur
Portland State University, macarthur@pdx.edu

Christopher Cherry
University of Tennessee, Knoxville

Follow this and additional works at: https://pdxscholar.library.pdx.edu/trec_reports



Part of the [Transportation Commons](#), [Urban Studies Commons](#), and the [Urban Studies and Planning Commons](#)

Let us know how access to this document benefits you.

Recommended Citation

McQueen, M., MacArthur, J., and Cherry, C. How E-Bike Incentive Programs are Used to Expand the Market. Portland, OR: Transportation Research and Education Center (TREC), 2019. <https://doi.org/10.15760/trec.223>

This Report is brought to you for free and open access. It has been accepted for inclusion in TREC Final Reports by an authorized administrator of PDXScholar. Please contact us if we can make this document more accessible: pdxscholar@pdx.edu.



How E-Bike Incentive Programs are Used to Expand the Market

Michael McQueen
John MacArthur
Christopher Cherry, PhD



LEVER
Light Electric Vehicle Education + Research Initiative



How E-Bike Incentive Programs are Used to Expand the Market

A WHITE PAPER

MAY 2019

Michael McQueen

John MacArthur

*Transportation Research and Education Center
Portland State University*

Christopher Cherry, PhD

University of Tennessee, Knoxville



ACKNOWLEDGEMENTS

The authors would like to thank the following individuals for their time and resources: Lindsey McDougall and Caitlin Bullock of Austin Energy, Casey Lamont and Jennifer Green of the Burlington Electric Department, Ross Saxton of Local Motion, Sue Schooley of the City of Roseville, CA, Brad Smith of Boulder County, CO, and Miles Rytting of Utah Clean Energy. This material was funded with a grant from the Bicycle Product Suppliers Association (BPSA) and PeopleForBikes. This paper was prepared by the Transportation Research and Education Center (TREC) at Portland State University, and lead by research team members behind the LEVER Initiative.



people**for**bikes

ABOUT TREC

The Transportation Research and Education Center (TREC) at Portland State University (PSU) is first and foremost an interdisciplinary center. Our research initiatives combine the voices and expertise of a wide range of backgrounds that collectively shape the ways we move through the world. We support collaborative research and education that provide a unique lens on transportation insight for vibrant communities. TREC is home to the U.S. DOT funded National Institute for Transportation and Communities (NITC) consortium, the Initiative for Bicycle and Pedestrian Innovation (IBPI), and other transportation grants and programs. We produce impactful research for transportation decision makers, and support the education of future transportation professionals through curriculum development and student participation in research.

trec.pdx.edu

ABOUT LEVER

The Light Electric Vehicle Education and Research (LEVER) Initiative is a consortium of Light Electric Vehicle (LEV) researchers and educators that currently includes faculty and staff from University of Tennessee, Portland State University, and Monash University. LEVER started in 2014 to bring together some of the leading researchers in the field to collectively answer some of the biggest questions related to these emerging vehicles. The mission of the LEVER is to bring a collective focus through interdisciplinary research directed at LEV adoption, system integration, societal impacts, and related policy. UTK's LEVER center will initiate the formation an international cooperative research center on LEVs, bridging academia, industry, government, and non-government organizations.

www.levresearch.com

INTRODUCTION

The electric bicycle (e-bike) is a low emission mode of transportation that offers communities benefits in the areas of health, planning, time, cost, street safety, congestion, air pollution, noise pollution, and energy security (Blondel, Mispelon, and Ferguson 2011). In a recent study conducted by Portland State University, e-bikes have been found to enable more people to ride a bicycle for longer distances despite physical limitations, difficult terrain, and the presence of cargo (MacArthur et al. 2018). However, overall e-bike adoption in the United States remains limited due in part to high purchase cost (Dill and Rose 2012; Popovich et al. 2014). The Bicycle Product Suppliers Association (BPSA) states that the average e-bike in America has a wholesale cost of \$2,000 (Bicycle Retailer and Industry News 2018). A survey of self-selected e-bike owners in North America found that, on average, an e-bike costs \$2,600 to purchase (MacArthur et al. 2018). For comparison, a mountain bike has an average wholesale cost in U.S. of \$620 (Bicycle Retailer and Industry News 2018). A conventional bicycle purchased at a specialty store costs \$753 on average in U.S., and a conventional bicycle purchased at a department, discount, or chain toy store costs \$89 on average (National Bicycle Dealers Association 2015). Clearly, a price disparity exists.

To meet environmental outcomes and increase the number of people cycling, how can e-bikes be shifted out of the early adopter phase? The European Cycling Federation suggests that e-bike incentive programs are an effective part of the solution (Haubold 2016). This white paper explores existing literature on e-bike and related conventional bike incentive programs. Web searches using Google and the TRID database were performed to obtain studies and program information pertaining to incentive strategies. In addition, best practices and lessons learned from select programs within the United States were obtained through phone and email correspondence with program organizers. The goal of this white paper is to provide policymakers, agency leads, and local community leaders with a range of techniques to develop and structure e-bike incentive programs to help meet single occupancy vehicle (SOV) and vehicle miles travelled (VMT) reduction objectives.

BACKGROUND

An e-bike incentive program is a scalable plan established to encourage the uptake of using an e-bike as a primary mode of utilitarian transportation with the goal of simultaneously reducing single occupancy vehicle use. It effectively encourages users to make changes in travel behavior by reducing barriers to entry of using this new mode of travel through offering financial rebates and revealing the latent benefits of using an e-bike. Such programs can be used as a tool to modify the transportation mode split of a region or local jurisdiction such that its transportation system's carbon footprint can be reduced. Incentive programs that have been studied in academia and are explored here include a car/e-bike swap, an annual bike to work event, an e-bike mileage reimbursement program, and an e-bike loan program.

Starting in 2015, Switzerland implemented an annual nation-wide intervention campaign designed to disrupt the transportation habits of car drivers, dubbed "Bike4Car." Over 1,800 participants gave up their car keys in exchange for a free e-bike for use during a two-week trial period. Surveys conducted before and immediately after revealed that such a trial has the potential to at least moderately break transportation mode habits. Participants reported in the post-trial survey that they had a high intention to buy an e-bike and drive less in the future. It was reported that, immediately after the trial, 15% of participants (271) purchased an e-bike (Moser 2016). Approximately one year later, an additional follow-up survey and study revealed that participants had a sustained weaker habitual association with car use, indicating a lasting effect (Moser, Blumer, and Hille 2018). The research surrounding Bike4Car dealt specifically with user intentions and psychological transportation mode associations with certain types of trips, and did not measure actual behavior. However, it was shown that an initial trial experience with an e-bike can lead to purchase by a portion of participants.

A different type of cycling intervention, the ubiquitous Bike to Work Day, already exists in the United States. A research team studied the participants in the 2012 Bike to Work Day held in Denver, CO. Although the event managed to draw cyclists with a wide variety of cycling frequency behaviors, there was no evidence found to suggest that Bike to Work Day caused significant cycling frequency behavior change (Piatkowski et al. 2015). Although this event targets primarily users of conventional bicycles, it is relevant to include here in order to highlight the lack of evidence suggesting that such short-term events generate lasting transportation behavior change.

The Dutch province of North Brabant started a program in 2013, "B-Rider," to incentivize e-bike users with monetary compensation based on the distance traveled on their e-bike. A

study following the program found it to be highly effective in stimulating new utilitarian e-bike use. However, due to the existing bicycle and transit ridership found in the Netherlands, only about half of trips taken by e-bikes replaced car trips (de Kruijf et al. 2018). It is also unclear if the increase in e-bike ridership continued after the incentive program ended.

Various qualitative perception studies suggest and observe that the experience of riding an e-bike in and of itself is rewarding and fun, is freeing for users with limited ability and mobility, and could even lead to a car-free household (Popovich et al. 2014; MacArthur et al. 2017, 2018; T. Jones, Harms, and Heinen 2016). In a study examining an e-bike lending program in Brighton, United Kingdom, eighty participants were loaned an e-bike for six to eight weeks without any financial compensation. About three quarters of the participants used the e-bike about once per week, with an average weekly mileage across all participants between 15-20 miles per week. Commuting was the dominant purpose for these e-bike trips. The mode affected the most by the uptake in e-cycling was car driving, with 43% of participants reporting that they travelled less as a car driver (Cairns et al. 2017). Similarly, a study performed in Portland, OR found that people will use a bicycle more often if it has an e-assist. A sample of employees of Kaiser Permanente at three campuses were provided an e-bike to use for six weeks at a time, again without financial compensation. Compared to before the trial, the amount of people commuting to work by bicycle in the study group doubled from 28% to 59% (MacArthur et al. 2017). Therefore, programs that effectively demonstrate the inherent attractiveness of an e-bike could be a cost-effective way to stimulate uptake for utilitarian purposes. Such programs should shrink barriers preventing potential users from having a positive first experience, the hook that induces a travel behavior change.

HOW CAN INCENTIVES BE DETERMINED?

Theoretical Strategies

In the previously referenced study of Kaiser Permanente employees in Portland, OR, participants were surveyed about what they thought an e-bike should be worth. The mean price respondents said they were willing to pay was \$1,339. After completing the e-bike trial period, fewer than a third of respondents felt that an e-bike costing \$2,000 was overpriced (MacArthur et al. 2017). An incentive could therefore be developed such that it lowers the customer's cost to an optimized value determined by a similar but localized study.

One cost efficient method to incentivize uptake of electric two-wheelers is proposed by a stated preference survey of households in Hanoi, Vietnam. The study discovered that a change in sales tax has a stronger effect on vehicle choice than an equivalent change in purchase price. On average, a respondent would spend the base (untaxed) vehicle cost plus 1.64 times the sales tax if the sales tax was waived (L. R. Jones et al. 2013). This means that a local government could better conserve incentive funds through simply waiving the sales tax instead of providing a rebate equivalent to the sales tax. For example, if an e-bike in California were sold for \$2,000, an 8.25% sales tax would bring the total to \$2,165. However, if the \$165 sales tax were waived, it could have the same incentivizing effect as taking \$270 off the purchase price plus sales tax (a new total equivalent price of \$1,895), based on the rate suggested by the Vietnam study. Further investigation would be necessary to measure the magnitude of an American aversion to sales tax to determine if this is a viable strategy. In addition, the resulting equivalent price would still need to be within the "acceptable" price range as determined by a study similar to the one discussed in the previous paragraph.

Strategies in Practice

The Burlington Electric Department (BED) offers an e-bike incentive that is calculated based on Vermont state statute 30 V.S.A. § 8005, an effort to monetize environmental impact. Per the statute, utility companies must offset a growing amount of fossil fuel use, up to the equivalent of 12% of annual electricity sales by 2032. An alternative compliance penalty charge of \$0.06/kWh will otherwise be assessed by the state. A consensus process estimated that an e-bike in Vermont replaces approximately 10,000 automobile vehicle miles traveled over its 8-year life span. The resulting fuel savings is converted to equivalent heat units (BTUs). This

avoided energy expenditure from fossil fuels is multiplied by the average electricity generation efficiency of fossil fuel power plants in the United States to obtain an equivalent produced kWh avoided. The resulting total is then multiplied by the legislated penalty rate, resulting in about \$300 of avoided penalty charges per e-bike lifetime. The savings created from the use of an e-bike is mostly passed on to the customer through a \$200 e-bike purchase incentive. During the first year of the program in 2018, BED set aside \$40,000 for 200 incentives and provided \$9,000 to Local Motion, the local bicycle advocacy group, to grow its e-bike lending library to seven e-bikes. In addition, through November 2018, BED paid Local Motion an additional \$3,200 in administrative funding to process the rebates on their behalf¹.

The City of Roseville, CA incentive program exists based on a general municipal desire to reduce SOV trips. The city wants to help encourage the purchase of a bicycle without paying for it in its entirety. To determine the amount of the incentive, they looked to existing incentive programs for comparison. Ultimately, they chose \$200 as the incentive to balance how many bicycle purchases they could subsidize with how much money was available in the budget².

Similarly, the Austin Energy program in Austin, TX is not a result of special legislation, and exists due to a general desire to electrify transportation in an accessible and equitable way³. The dollar amounts for e-bike incentives are set based on budget constraints and the goal of assisting as many citizens as possible.

¹ personal communications: Jennifer Green, Oct 10, 2018 and Casey Lamont, Nov 14, 2018, Ross Saxton, Oct 9, 2018

² personal communication: Sue Schooley, Nov 14, 2018

³ personal communication: Lindsey McDougall, Nov 14, 2018

INCENTIVE PROGRAM STRUCTURES

Past and presently ongoing e-bike incentive programs will be discussed next. The information compiled here was obtained through personal communication and publicly accessible documents and websites. Four main program structures were identified: 1) partial purchase subsidies, 2) vendor-funded discounts, 3) employer-sponsored programs, and 4) government sponsored loans. An overview of all programs analyzed for this report is located in Table 1. If data does not exist for a column in the table, an entry of “ND” is used.

Partial Purchase Subsidies

The most common format that has appeared in this inventory is a partial purchase subsidy. In this type of program structure, participants receives a purchase rebate funded by the program organizer.

The city of Paris, France, currently offers its citizens a partial purchase subsidy of 33% towards the purchase of an e-bike. The offer, available since 2017, is capped at 400 € (\$460) for a personal e-bike and 600 € (\$700) for a cargo bike. In addition, up to 400 € (\$460) can be awarded for the purchase of equipment necessary to convert a conventional bike to an e-bike. The program also offers commercial entities no larger than 50 employees a 400 € (\$460) incentive towards an e-bike or conversion kit and up to 1,200 € (\$1,300) towards the cost of a cargo bike (“Lutte contre la pollution : les aides financières à la mobilité” 2018).

The provincial government of British Columbia began a program in 1996 called “BC-Scrap It” targeting “super polluting” vehicles. In exchange for retiring an old vehicle, participants can obtain money towards a new vehicle, transit pass, car share and ride share service, or e-bike. Currently, the program offers a flat rate of \$850 CAD (\$660) towards the purchase of an e-bike. A stipulation not found in other programs is that the e-bike must cost at least \$1,000 CAD (\$770) to receive the incentive. In addition, it must be purchased from an approved local retailer (“The BC SCRAP-IT Program Backgrounder” 2014). According to a 2011 study, the program has been successful in causing mode shift away from private vehicles as only about half of participants opted for the new vehicle incentive between 2008 and 2010 (Antweiler and Gulati 2011). Scrap-It continues to be funded because it helps the province achieve its greenhouse gas reduction goals in a significant way (Rogoza 2018).

Since 2007, Austin Energy in Austin, TX has offered incentives for e-ride devices, including e-bikes, scooters, mopeds, and motorcycles. They offer a flat rate that is variable based on the price of the e-ride vehicle. For example, an e-bike under \$500 would receive a \$50 rebate

whereas an e-bike over \$2000 would receive a \$300 rebate (“Austin Electric Ride Program Guidelines” 2018). The program has seen relatively high levels of participation, averaging about 100 rebates per year since the program began, with almost all of the awarded rebates having been for e-bikes⁴.

Luxembourg’s e-bike incentive program offers a flat rate tax deduction for the purchase of a conventional bike or an e-bike limited to 250 watts and 25 km/hour. Citizens can claim a 300 € (\$340) tax deduction for their purchase (“Portail Du Développement Durable et Des Infrastructures: Frequently Asked Questions” 2018).

Vendor-Funded Discounts

Instead of a government funded flat rate rebate, some programs offer a discount that is unique to each specific model at the point of purchase and is funded exclusively by preferred retailers. One such discount program removed government from the picture entirely. For two months during the fall of 2018, the Live Electric incentive program offered discounts of 10%-20% on e-bikes from select retailers in conjunction with an electric vehicle discount for State of Utah employees and Rocky Mountain Power customers within Utah. The program was a collaboration between the Utah Clean Energy NGO, the Utah Clean Air Partnership NGO, the Utah Governor’s Office of Energy Development, the Utah Department of Administrative Services, and Rocky Mountain Power, a business unit of PacifiCorp, a subsidiary of Berkshire Hathaway. E-bike retailers were solicited using a request for proposals (RFP) process that assessed their ability to participate in the program based on inventory, customer support, staffing, length of time in business, relevant certifications, and proposed discounts to be offered. Utah Clean Energy, Rocky Mount Power, and the state of Utah were responsible for reaching an estimated total of 482,000 people using a mixed marketing approach consisting of internal outreach, social media, radio, and physical presence at local events with high visibility. The discounts themselves were fully covered by the participating e-bike vendors. In addition to the sale of 73 2018 Nissan LEAF electric vehicles, 43 e-bikes were sold because of the program. These are similar results to a previous incentive program offered in Utah for six weeks in spring 2017, during which 44 e-bikes were sold⁵.

Over the last five years, Boulder County, CO, has facilitated the sale of over 400 e-bikes in conjunction with additional discounts for solar generation systems and electric vehicles. Participants were offered discounts of 10%-25% from two preferred retailers located within the

⁴ personal communication: Caitlin Bullock, Oct 11, 2018

⁵ personal communication: Miles Rytting, Oct 31, 2018

county, and the discounts were applied at the point of sale. Public money was only used to fund outreach to the e-bike vendors from the county; the vendors privately funded discounts in exchange for free marketing by the county⁶.

Although this is an inexpensive way for communities to host e-bike subsidy programs, there is a limit to the number of discounts that can be awarded. Vendors may lose their motivation to continue offering the discounts once sales reach a certain level. Boulder County's program was recently discontinued because the vendors thought that the privately funded incentives were no longer increasing purchases⁷.

Employer-Sponsored

Since 1999, the UK has offered a unique program, Cycle to Work, which enables employees to borrow an employer-owned bike or e-bike. Any employer is able to purchase a bike and accessory equipment for the program as a capital expenditure that can be written off against its taxable profits. The bike and accessories can be offered to an employee for use with the stipulation that the majority of trips performed with the bike be for commuting purposes. The employer can also choose to implement a salary sacrifice agreement, which results in a reduction in salary for the employee in exchange for the ability to use the bike for a certain period of time. The motivation in this case for the employer is that it is then responsible for a reduced amount of National Insurance taxes, proportional to the employee's reduced income. In addition, the employer can also benefit from a potentially healthier employee ("Cycle to Work Guidance" 2011).

Government Sponsored Loan

The country of Scotland went a step further in June 2018 by initiating a comprehensive e-bike incentive and publicity program worth £1.3 million (\$1.7 million). Interest-free loans were introduced to provide private citizens with up to £3,000 (\$3,900) towards the purchase of e-bikes. £700,000 was made available to councils, public sector bodies, and community groups for the creation of e-bike pool schemes, construction of secure parking, and the purchase of safety equipment. An additional £100,000 was set aside to fund e-bike demonstrations at community centers around the country (Sutton 2018).

⁶ personal communication: Brad Smith, Oct 8, 2018

⁷ personal communication: Brad Smith, Oct 8, 2018

Table 1: Overview of E-Bike Incentive Programs Explored

Location	Funding Entity	Type	Discount Rate	Minimum Purchase	Maximum funding	Total earmark	Time Period	Total Participation	Notes
Sweden	National Government	Partial purchase subsidy with cap	25%	ND	\$1100 (10000 SEK)	\$118 million (1050 m. SEK)	2018-2020	ND	Must be at least 15 years old, can only buy one e-bike per year
Paris, France	Municipal Government	Partial purchase subsidy with cap	33%	ND	\$460- \$700 (€400-)	ND	2017-	ND	
Oslo, Norway	Municipal Government	Partial purchase subsidy with cap	25%	ND	\$1200 (10,000)	\$600,000 (5 m.)	2017-	ND	
Spain	National Government	Partial purchase subsidy with cap	ND	ND	\$230 (€200)	\$230,000 (€200,000)	2016	ND	
British Columbia, CAN	Provincial Government	Partial purchase subsidy flat rate	ND	\$770 (\$1000)	\$660 (\$850 CAD)	ND	2017-2020	ND	
Burlington, VT	Municipally Owned Utilities	Partial purchase subsidy flat rate	ND	ND	\$200	\$52,000	May 2018-	60	Motivation is compliance with state law for energy transformation minimums.
Roseville, CA	Municipal Government	Partial purchase subsidy	50%	ND	\$200	\$3,000	2018	0	Money comes from Congestion Mitigation Air Quality funds
United Kingdom	National Government	Emp. sponsored e-bike lending	100%	ND	ND	ND	1999-	ND	
Luxembourg	National Government	Partial purchase subsidy flat rate	ND	ND	\$350 (€300)	ND	ND	ND	
Scotland	National Government	Interest free loan with cap	ND	ND	\$3900 (£3,000)	ND	2018-	ND	
California	State Government	Partial purchase subsidy with cap	50%	ND	\$500: bikes & \$1000: e-	\$10 million	Proposed	ND	Spearheaded by California Bicycle Coalition (CalBike)
France	National Government	Partial purchase subsidy flat rate	ND	ND	\$230 (€200)	ND	2017-2018	ND	
San Gabriel Valley, CA	Municipal Govt/ Highway tolls	Partial purchase subsidy flat rate	ND	ND	\$700	\$70,000	2017	100	
Boulder County, CO	Select private businesses	Public/private agree. - discounts	10%-25%	ND	ND	ND	2013-2018	439	
Austin, TX	Municipal Utilities Company	Partial purchase subsidy flat rate	ND	ND	\$300 ind., \$400 com. fleets	ND	2007-	1,196	
Utah	Select private businesses	Com./priv. agree.- discounts	10%-20%	ND	ND	ND	Sep-Nov	43	

BEST PRACTICES

As part of the phone interviews and email correspondence conducted for this report, representatives from several programs within the United States were asked for anecdotal qualitative recommendations for a successful e-bike incentive program.

To begin, it is important to implement experience-based education and outreach schemes in order to boost program participation. One program leader said, “When people hop on bikes, that’s when everything changes.” Another program leader referred to the experience of riding an e-bike as “joyful.” It seems that just getting people on the bike in the first place is an effective hook, as confirmed by previous research (Cairns et al. 2017; MacArthur et al. 2017). One format of such an experience-based campaign is the e-bike lending library, which is offered by Vermont’s Local Motion active transportation advocacy group in conjunction with the Burlington Electric Department’s incentive program. This program saw 106 week-long e-bike loans in a 9-month period, with a 6 to 12-month post-loan e-bike purchase rate of 17%. One participant noted, “I definitely wouldn’t have gotten the cargo e-bike if I hadn’t borrowed Local Motion’s first. Now I ride to commute every day with my sons in tow.” Other experience-based campaigns include test ride events held by private e-bike dealers at community locations (such as grocery store parking lots in Portland) and large-scale events such as the Electric Bike Expo, which was held annually in several cities around the United States.

It is also necessary to consider program partners strategically. A representative from Utah Clean Energy found that they experienced higher participation levels when they partnered with the University of Utah compared to other recent partners. The university offered a robust marketing campaign and was described as a trusted source of information for the surrounding community, all contributing to high participation. These marketing partner traits can also be used to encourage private e-bike dealers to participate in offering privately funded discounts, as was seen in several recent programs in Utah. The Boulder County, CO program also used this strategy, except that the organizer (county government) also acted as the marketing entity that attracted vendors. In any case, establishing strong relationships between all participating organizations and creating a mutually beneficial situation for everyone involved is important in running a successful program.

Along these lines, it is advantageous to limit e-bikes eligible for an incentive to those sold by local preferred vendors who are vetted in advance by the program organizer. A representative from Austin Energy noted that requiring approved dealers minimizes fraud, ensures product safety levels, and gives participants a reliable resource for assembly and service needs.

Preferred vendors also enable the convenient application of the incentive at the point of purchase, as in the Burlington Electric Department's program.

It is also advantageous to seek out previously untapped sources of funding for e-bike incentive programs. The BikeSGV (San Gabriel Valley) advocacy group, located outside of Los Angeles, holds bicycle safety classes and open street events and runs a bicycle coop and education center. In 2017, BikeSGV was awarded \$70,000 in a competitive grant process through the City of El Monte, CA to begin an e-bike subsidy program. The funding for the program came from the revenue of newly added toll lanes on I-10. This toll revenue was required by law to be reinvested along the I-10 corridor, of which 40% was earmarked for active transportation initiatives such as the grant received by BikeSGV. Through this grant, BikeSGV funded 100 e-bike incentives of \$700 each. To be eligible, applicants were required to take a bike safety course and live within three miles of I-10 (Curry 2018).

CONCLUSIONS

This white paper began by exploring existing peer reviewed literature on e-bike incentive programs. The research points to the latent attractiveness of e-bikes and monetary rewards as motivating factors to use e-bikes, however long-term travel behavioral change has not been studied. In order to create an incentive program with satisfactory participation levels, it could be useful to optimally determine the value of the incentive or the target price of the e-bike. This evaluation could be accomplished through surveys measuring purchase price limits and the equivalent value of waived sales taxes. E-bike incentives can also be determined in order to meet specific environmental goals, similar to the technique used by the Burlington Electric Department to calculate the dollar value of reduction in fossil fuel consumption. Other entities such as Roseville, CA and Austin Energy simply set the incentive as a function of budget and the number of incentives they wish to provide.

A variety of incentive program formats already used in practice were discussed, revealing that partial purchase subsidies are the most popular type of program currently in use. Vendor-funded discounts offer a method to minimize the usage of tax dollars, but have their limits, as vendors may lose the motivation to continue offering such discounts once sales reach a certain threshold. Bike financing and employer-sponsored lending programs can also be found in the UK.

Finally, a set of best practices developed from the analysis of incentive programs and correspondence with several program leaders was identified. Experience-based education is an important tool to increase participation. Strategic partnerships can provide advantages for program leaders, participants, and vendors. Pre-approved preferred vendors can provide participants with a trusted resource and a quality product, ensuring a positive experience throughout the lifetime of the e-bike. Lastly, inventive sources of funding such as new toll-road revenue can reduce the burden on local governments to fund such programs.

Of the e-bike programs that were explored, none appeared to apply equity considerations in determining eligibility or rebate amount. To incorporate equity into an e-bike incentive program, organizers could limit eligibility or vary rebate amounts based on participant association with locally determined communities of concern or target income brackets. For example, the Oregon Clean Vehicle Rebate Program limits eligibility to “low or moderate income” households, the definitions of which vary by region (“Oregon Clean Vehicle Rebate Program Frequently Asked Questions” n.d.).

Even though there are only a few U.S. examples, e-bike incentive programs are being actively used to assist in expanding the e-bike market by shifting e-bikes out of the early adoption phase. These programs are accomplishing their objectives by lowering the financial barrier to entry and by advocating the inherent attractiveness of e-bikes. It is the authors' goal that this report will serve as a reference tool kit of several strategies that can be used to craft a successful e-bike incentive program for any region.

FURTHER RESEARCH

In the existing e-bike incentive programs examined here, the data required to determine to what extent trips taken by e-bike replace trips taken by car was not obtained, and therefore it is difficult to determine the impact on VMT. While data from the Portland State University-led survey (MacArthur et al. 2018) can be used to approximate mode substitution with current behavior of e-bike users in North America, there is still room for regional refinement. Future e-bike incentive programs should make use of robust traveler behavior surveys before and after the e-bike incentive is delivered such that the overall effect can be clearly observed.

There is also opportunity for more localized studies to determine an e-bike price range that would achieve a city's specific e-bike ridership goal, similar to the reasonable price question posed in the 2017 Kaiser Permanente study (MacArthur et al. 2017). This would allow an incentive program to be constructed such that it lowers e-bike prices to within an optimal price range. In addition, a localized quantified understanding of citizens' aversion to sales taxes, similar to the Hanoi study (L. R. Jones et al. 2013), could enable cities to construct an incentive program using sales tax waivers for possible savings. An e-bike adoption curve model that is a function of price could then be generated. This would allow community leaders to make an informed decision about the exact monetary value of the subsidy to be offered based on adoption rate goals.

Another tool that could be useful to incentive programs is a consumer level cost/benefit analysis calculation. Although not observed in any of the programs investigated in this report, education about the lifetime transportation cost savings associated with e-bikes could encourage greater participation. E-bike savings that should be considered in transportation cost calculations in comparison to automobiles are fuel, maintenance, insurance, tolls, parking, and health care. These savings could be presented on a per day or per annum basis so that a better sense of scale of potential savings can be easily understood.

It would also be beneficial to better quantify the effects of short e-bike test ride events and extended e-bike loans, such as those offered by the Local Motion E-bike lending library in Burlington, VT. It would be useful to compare these approaches on how they increase the likelihood of an e-bike purchase and use.

Future travel surveys should break out e-bikes as a separate mode of transport in order to more accurately determine adoption and utilitarian use cases.

REFERENCES

- Antweiler, Werner, and Sumeet Gulati. 2011. "An Analysis of British Columbia's SCRAP-IT Program: Emissions Savings, Participation, and Transportation Choice," 36.
- "Austin Electric Ride Program Guidelines." 2018. <https://austinenergy.com/ae/green-power/plug-in-austin/more-ways-to-go-electric/more-ways-to-go-electric>.
- Bicycle Retailer and Industry News. 2018. "BPSA: Wholesale Bike Sales Continue Dollars-up/Units-down Trend through October," November 21, 2018. <https://www.bicycleretailer.com/studies-reports/2018/11/21/bpsa-wholesale-bike-sales-continue-dollars-units-down-trend-through#.XBQUHVxKi70>.
- Blondel, Benoît, Chloé Mispelon, and Julian Ferguson. 2011. "Cycle More Often 2 Cool down the Planet!: Quantifying CO2 Savings of Cycling." November 2011.
- Cairns, S., F. Behrendt, D. Raffo, C. Beaumont, and C. Kiefer. 2017. "Electrically-Assisted Bikes: Potential Impacts on Travel Behaviour." *Transportation Research Part A: Policy and Practice* 103 (September): 327–42. <https://doi.org/10.1016/j.tra.2017.03.007>.
- Curry, Melanie. 2018. "BikeSGV Tests Idea of E-Bike Rebates," February 14, 2018. <https://cal.streetsblog.org/2018/02/14/bikesgv-tests-idea-of-e-bike-rebates/>.
- "Cycle to Work Guidance." 2011. UK Department of Transport. <https://www.gov.uk/government/publications/cycle-to-work-scheme-implementation-guidance>.
- Dill, Jennifer, and Geoffrey Rose. 2012. "Electric Bikes and Transportation Policy: Insights from Early Adopters." *Transportation Research Record: Journal of the Transportation Research Board* 2314 (1): 1–6. <https://doi.org/10.3141/2314-01>.
- Haubold, Holger. 2016. "ECF E for All."
- Jones, Luke R., Christopher R. Cherry, Tuan A. Vu, and Quang N. Nguyen. 2013. "The Effect of Incentives and Technology on the Adoption of Electric Motorcycles: A Stated Choice Experiment in Vietnam." *Transportation Research Part A: Policy and Practice* 57 (November): 1–11. <https://doi.org/10.1016/j.tra.2013.09.003>.
- Jones, Tim, Lucas Harms, and Eva Heinen. 2016. "Motives, Perceptions and Experiences of Electric Bicycle Owners and Implications for Health, Wellbeing and Mobility." *Journal of Transport Geography* 53 (May): 41–49. <https://doi.org/10.1016/j.jtrangeo.2016.04.006>.
- Kruijff, Joost de, Dick Ettema, Carlijn B.M. Kamphuis, and Martin Dijst. 2018. "Evaluation of an Incentive Program to Stimulate the Shift from Car Commuting to E-Cycling in the Netherlands." *Journal of Transport & Health*, July. <https://doi.org/10.1016/j.jth.2018.06.003>.
- "Lutte contre la pollution : les aides financières à la mobilité." 2018. <https://www.paris.fr/services-et-infos-pratiques/deplacements-et-stationnement/deplacements/lutte-contre-la-pollution-les-aides-a-la-mobilite-5373>.

- MacArthur, John, Michael Harpool, Daniel Schepke, and Christopher Cherry. 2018. "A North American Survey of Electric Bicycle Owners." Transportation Research and Education Center. <https://doi.org/10.15760/trec.197>.
- MacArthur, John, Nicholas Kobel, Jennifer Dill, and Zakari Mumuni. 2017. "Evaluation of an Electric Bike Pilot Project."
- Moser, Corinne. 2016. "Getting Started on a Car Diet: Assessing the Behavioural Impacts of an E-Bike Trial in Switzerland," 13.
- Moser, Corinne, Yann Blumer, and Stefanie Lena Hille. 2018. "E-Bike Trials' Potential to Promote Sustained Changes in Car Owners Mobility Habits." *Environmental Research Letters* 13 (4): 044025. <https://doi.org/10.1088/1748-9326/aaad73>.
- National Bicycle Dealers Association. 2015. "Industry Overview 2015." National Bicycle Dealers Association. <https://www.nbda.com/articles/industry-overview-2015-pg34.htm>.
- "Oregon Clean Vehicle Rebate Program Frequently Asked Questions." n.d. State of Oregon Department of Environmental Quality. Accessed April 24, 2019. <https://www.oregon.gov/deq/FilterDocs/zev-faq.pdf>.
- Piatkowski, Daniel, Rachael Bronson, Wesley Marshall, and Kevin J. Krizek. 2015. "Measuring the Impacts of Bike-to-Work Day Events and Identifying Barriers to Increased Commuter Cycling." *Journal of Urban Planning and Development* 141 (4): 04014034. [https://doi.org/10.1061/\(ASCE\)UP.1943-5444.0000239](https://doi.org/10.1061/(ASCE)UP.1943-5444.0000239).
- Popovich, Natalie, Elizabeth Gordon, Zhenying Shao, Yan Xing, Yunshi Wang, and Susan Handy. 2014. "Experiences of Electric Bicycle Users in the Sacramento, California Area." *Travel Behaviour and Society* 1 (2): 37–44. <https://doi.org/10.1016/j.tbs.2013.10.006>.
- "Portail Du Développement Durable et Des Infrastructures: Frequently Asked Questions." 2018. 2018. <http://www.developpement-durable-infrastructures.public.lu/fr/developpement-durable-infrastructures/zz-mobilite-durable-en/faq/index.html>.
- Rogoza, Dennis. 2018. "Re: Submission to the Province of BC - Towards a Clean Growth Future for B.C. - Clean Transportation," August 23, 2018. <https://engage.gov.bc.ca/app/uploads/sites/391/2018/08/BC-SCRAP-IT.pdf>.
- Sutton, Mark. 2018. "Scotland Leads UK with £1.3 Million Incentive on Electric Bike Uptake," June 14, 2018. <https://cyclingindustry.news/scotland-leads-uk-with-1-3-million-incentive-on-electric-bike-uptake/>.
- "The BC SCRAP-IT Program Backgrounder." 2014. BC Scrap-It. https://scrapit.ca/wp-content/uploads/2014/10/BC-SCRAP-IT-Backgrounder_FINAL-DR.pdf.