

Electric Bike 2000

Project

Prepared for
Transportation Development Centre
Transport Canada

by
Centre for Electric Vehicle
Experimentation in Québec (CEVEQ)

April 2001



Centre
d'expérimentation
des véhicules
électriques
du Québec

CEVEQ

Centre
for Electric
Vehicle
Experimentation
in Québec



ELECTRIC BIKE 2000 PROJECT

By
Véronique Lamy
Centre for Electric Vehicle Experimentation in Quebec
(CEVEQ)

April 2001

The views and opinions expressed in this report are those of the contractor and do not necessarily reflect those of the Transportation Development Centre.

MAIN PROJECT TEAM MEMBERS

Véronique Lamy	Senior Editor	CEVEQ
Pierre Lavallée	Support Group	CEVEQ
Claude Guérette	Support Group	Transportation Development Centre, Transport Canada
René Desaulniers	Support Group	SAAQ
Fernand St-Georges	Analyst	

Ce rapport est disponible également en français : *Projet Vélos Électriques 2000*, TP 13732F.



1. Transport Canada Publication No. TP 13732E		2. Project No. 9889		3. Recipient's Catalogue No.		
4. Title and Subtitle Electric Bike 2000 Project				5. Publication Date April 2001		
				6. Performing Organization Document No.		
7. Author(s) Véronique Lamy				8. Transport Canada File No. ZCD2450-D-730		
9. Performing Organization Name and Address Centre for Electric Vehicle Experimentation in Quebec (CEVEQ) 128 rue de la Gare Saint-Jérôme (Quebec) J7Z 2C2				10. PWGSC File No. MTB-0-00512		
				11. PWGSC or Transport Canada Contract No. T8200-000506/001/MTB		
12. Sponsoring Agency Name and Address Transportation Development Centre (TDC) 800 René Lévesque Blvd. West Suite 600 Montreal, Quebec H3B 1X9				13. Type of Publication and Period Covered Final		
				14. Project Officer Claude Guérette		
15. Supplementary Notes (Funding programs, titles of related publications, etc.) Co-funded by the Program of Energy Research and Development (PERD)						
16. Abstract <p>This report outlines the results and consequent recommendations of an electric bicycle (e-bike) evaluation project held in four Canadian cities – Montreal, Quebec City, St. Jerome, and Toronto – from June 12 to October 7, 2000. The project's main objective was to determine the safety of e-bikes in order to help the authorities decide on appropriate regulations.</p> <p>To achieve this objective, the Centre for Electric Vehicle Experimentation in Quebec (CEVEQ), creator of the project, solicited the support of various partners and bicycle manufacturers. Two categories of e-bikes – electrically assisted bicycles and electrically propelled bicycles – were used and 55 e-bikes in all were made available to 369 volunteers for testing.</p> <p>In Quebec, participants were asked to ride the bicycles to work for two weeks and were also allowed to use them for recreation. At the end of this period, they had to complete a detailed questionnaire and submit their comments. In Ontario, users had opportunities to try out the e-bikes on rides of one hour or more and then completed a shorter questionnaire.</p> <p>The project also had some secondary objectives, including: promoting e-bikes and assessing the level of interest in their use for urban transportation; identifying appropriate sectors for use of e-bikes; stimulating people's interest in using the bicycles to commute to work; and supporting greater use of non-polluting and less energy-consuming modes of transportation.</p>						
17. Key Words Electric bicycles, electrically assisted bicycle, electrically propelled bicycle, CEVEQ				18. Distribution Statement Limited number of copies available from the Transportation Development Centre E-mail: <i>tdccdt@tc.gc.ca</i>		
19. Security Classification (of this publication) Unclassified		20. Security Classification (of this page) Unclassified		21. Declassification (date) —	22. No. of Pages xvi, 46, apps	23. Price Shipping/ Handling



1. N° de la publication de Transports Canada TP 13732E		2. N° de l'étude 9889		3. N° de catalogue du destinataire		
4. Titre et sous-titre Electric Bike 2000 Project				5. Date de la publication Avril 2001		
				6. N° de document de l'organisme exécutant		
7. Auteur(s) Véronique Lamy				8. N° de dossier - Transports Canada ZCD2450-D-730		
9. Nom et adresse de l'organisme exécutant Centre d'expérimentation des véhicules électriques du Québec (CEVEQ) 128, rue de la Gare Saint-Jérôme (Québec) J7Z 2C2				10. N° de dossier - TPSGC MTB-0-00512		
				11. N° de contrat - TPSGC ou Transports Canada T8200-000506/001/MTB		
12. Nom et adresse de l'organisme parrain Centre de développement des transports (CDT) 800, boul. René-Lévesque Ouest Bureau 600 Montréal (Québec) H3B 1X9				13. Genre de publication et période visée Final		
				14. Agent de projet Claude Guérette		
15. Remarques additionnelles (programmes de financement, titres de publications connexes, etc.) Projet cofinancé par le Programme de recherche et développement énergétiques (PRDE)						
16. Résumé <p>Ce rapport présente les résultats et les recommandations émanant d'un projet d'évaluation de vélos électriques (vélos É) tenu dans quatre villes canadiennes, soit Montréal, Québec, Saint-Jérôme et Toronto, du 12 juin au 7 octobre 2000. Le principal objectif de ce projet consistait à déterminer l'impact des vélos É sur la sécurité des usagers, afin d'aider les autorités responsables à statuer sur une réglementation appropriée.</p> <p>Pour ce faire, le Centre d'expérimentation des véhicules électriques du Québec (CEVEQ), initiateur du projet, a sollicité l'appui de divers partenaires et manufacturiers de vélos. Au total, 55 vélos É de deux catégories, soit les vélos à assistance électrique et les vélos à propulsion électrique, ont été mis à la disposition de 369 volontaires pour en faire l'essai.</p> <p>Au Québec, les participants étaient invités à utiliser le vélo pendant deux semaines pour se rendre au travail, en plus d'avoir la possibilité de l'utiliser pour les loisirs. À la fin de cette période, ils devaient remplir un questionnaire détaillé et formuler leurs commentaires. Du côté de l'Ontario, les utilisateurs avaient l'occasion de faire l'essai d'un vélo É pour une ballade d'une heure ou plus, et par la suite ils remplissaient un questionnaire moins élaboré.</p> <p>Le projet comportait également un certain nombre d'objectifs secondaires, dont : la promotion et l'évaluation de l'intérêt du vélo É comme moyen de transport urbain; l'identification des secteurs d'utilisation; la stimulation de l'intérêt des gens à utiliser le vélo pour se rendre au travail; l'appui à l'émergence de moyens de transport moins énergivores et non polluants.</p>						
17. Mots clés Vélos électriques, assistance électrique, propulsion électrique, CEVEQ				18. Diffusion Le Centre de développement des transports dispose d'un nombre limité d'exemplaires. Courriel : tdccdt@tc.gc.ca		
19. Classification de sécurité (de cette publication) Non classifiée		20. Classification de sécurité (de cette page) Non classifiée		21. Déclassification (date) —	22. Nombre de pages xvi, 46, ann.	23. Prix Port et manutention

ACKNOWLEDGEMENTS

The Electric Bike 2000 Project was made possible through each participating organization's contributions of financial support and/or services, staff and other forms of support.

The Centre for Electric Vehicle Experimentation in Quebec (CEVEQ) would like to specially thank all of the suppliers who kindly loaned a large number of electric bicycles for the project, as well as participating organizations for their excellent co-operation.

CEVEQ wishes to thank all of the cyclists who rode e-bikes for this project and carried out their duties with great enthusiasm and conviction.

CEVEQ would especially like to thank Transport Canada's Transportation Development Centre and the Société de l'Assurance Automobile du Québec for making this project possible and the Moving the Economy organization for co-ordinating the project in Toronto.

Lastly, CEVEQ thanks the Interdepartmental Electric Vehicle Group (GIVE) of France for its co-operation with the French partners.

PARTICIPATING ORGANIZATIONS AND REPRESENTATIVES

Transportation Development Centre (Transport Canada)	Claude Guérette
Agence de l'Éfficacité Énergétique	Douglas Labelle
Société de l'Assurance Automobile du Québec	René Desaulniers
Quebec Department of the Environment	Jean-Claude Raymond
Quebec Department of Transport	Marcel Ayoub and Stéphane Campeau
Hydro Quebec, Laurentians	Laurent Martineau and Nicole Audy
Agence Métropolitaine de Transport (AMT)	Luc Couillard
City of Quebec	Claude Larose and Yvon Jobin
City of Montreal	Pierre Le Breux and Mario Bérubé
Moving the Economy (City of Toronto)	Sue Zielinsk and Li-lien Gibbons
City of St. Jerome	Louis Parent
Association Québécoise du Transport et des Routes	Marie-Josée Huot
City of Lachine (GRAMÉ)	Jean-François Lefebvre

In Toronto, the Electric Bike 2000 Project was supported by the following partners:

- Toronto Atmospheric Fund
- City of Toronto
- Human Resources Development Canada
- Transportation Options
- Independent Bicycle Dealers Association
- McBride Cycle Power Sports
- Wheel Excitement

OFFICIAL SUPPLIERS OF ELECTRIC BICYCLES

Procycle

EPS

EV Global Motors

Zapworld

Th!nk Mobility (Ford)

AeroVironment

Renault Sport

Cycleurope (Peugeot)

Honda

Yamaha Motor

Ephrem Busque

Jean-Yves Dubé

James Goraieb
and Mark Lafontaine

Gary Star

Ben Sullivan

Michael Greenish

Olivier Jauffret

Jean-Louis Jean

Peter Berry and Don Zaharia

James Fukada

EXECUTIVE SUMMARY

The Electric Bike 2000 Project is part of an initiative to promote the use of electric bicycles (e-bikes) and to document their performance to assist the federal and Quebec governments as they prepare to regulate the use of this new mode of transportation.

A pioneer in evaluating e-bikes, the Centre for Electric Vehicle Experimentation in Quebec (CEVEQ), together with the Tremblant Resort Association, organized e-bike tests at the world-renowned tourism site in the summers of 1997 and 1998. In 1999, aware that this transportation method has relevance for cities because it reduces traffic and greenhouse gases, CEVEQ suggested to the City of Montreal and other partners that they participate in an e-bike evaluation project. For four months, 120 cyclists assessed the first e-bike built in Quebec – the Elektron, manufactured by Groupe Procycle in Saint-Georges-de-Beauce. The final evaluation report attracted the interest of Transport Canada and the Société de l'Assurance Automobile du Québec (SAAQ).

With strong support from major partners, the Electric Bike 2000 Project quickly expanded worldwide, attracting some of the world's most prestigious manufacturers in Quebec, Canada, the United States, Japan, and Europe (Honda, Ford, Yamaha, Peugeot, Renault, ZAP, EV Global Motors, Groupe Procycle, etc.). Products new to the market (Ford's THINK Bike Fun) were tested by the general public for the first time. The prospect of legislation in Canada generated considerable interest in the evaluation. CEVEQ succeeded in expanding the testing to include four Canadian regions and close to 400 cyclists. The evaluation was held from June 12 to October 7, 2000. Each participant had to complete a detailed questionnaire.

A communication strategy was also implemented to raise awareness of the project and to provide the public and governments with general information on e-bikes and their advantages in urban environments. The resulting heavy press coverage helped to increase public awareness of e-bikes. Various government authorities and participating organizations were also brought into the project and reaped various benefits, depending on their interests and participation.

Regulatory issues

When the project was launched in June 2000, e-bikes were subject to the requirements of the Motor Vehicle Safety Act because they were motorized. In particular, they belonged to a subclass of limited-speed motorcycles under the Motor Vehicle Safety Regulations. Amendments to have electrically assisted bicycles (EABs) removed from the Motor Vehicle Safety Regulations were submitted to Transport Canada for consultation in November 1999. A new version of the regulations was expected in December 2000 and adoption of the new regulations regarding e-bikes is scheduled for spring 2001.

Thousands of kilometres ridden on electric bicycles

During the project, 369 people travelled a total of 25,205 km on the e-bikes. Of this number, 211 Quebec cyclists chalked up 24,343 km, an average of 115 km per user. In Ontario, the project had to deal with the refusal of the Ministry of Transportation of Ontario (MTO) to allow e-bikes on public thoroughfares. The project was modified and the e-bikes were ridden in parks and on bicycle paths within the exclusive jurisdiction of the City of Toronto. A total of 158 users accumulated 862 km on rides of one hour or more.

Feeling of safety

Eighty-three percent of respondents felt as safe on an e-bike as on a conventional bike. Ninety-five percent of those who rode electrically propelled bicycles (EPBs) and 96 percent of those who rode electrically assisted bicycles (EABs) felt they had full control of their bicycles when the motor was running. Reducing the weight of the e-bike and improving the braking system on certain models were the main elements that would contribute to an increased feeling of safety.

Electrically assisted bicycles and electrically propelled bicycles

The findings demonstrated that the two e-bike systems – electrically propelled and electrically assisted – were equally safe. Therefore, the new regulations should not include restrictions on the motor's operating apparatus. In addition, users also noted that e-bikes encourage users to obey the Highway Safety Code more strictly (for example, they are more likely to stop at mandatory stops) because the bikes' motor power makes standing starts easier.

E-bike performance

In general, respondents were highly satisfied with the user-friendliness, braking and reliability of the e-bikes, whether they were EPBs or EABs. However, they clearly disliked the weight of the bikes and wanted more power assistance in some circumstances, such as on steep hills.

The survey findings also clearly indicated the cyclists' dissatisfaction with the electric motor's power-assist limit being set at 24 km/h, which was below their usual speed on a conventional bicycle. Above that speed, they had to exert much more effort than on a conventional bicycle, because of the e-bike's weight. Users said that an increase in the power-assist speed to 30 km/h would provide more latitude without compromising safety.

Interest in e-bikes as a mode of urban transportation

According to 79 percent of the cyclists surveyed, exercise was the main reason that would encourage them to use an e-bike to commute to work. Reduced pollution (51 percent) and low cost (41 percent) were other significant reasons. Participants also saw an advantage in being able to deal more easily with adverse travel conditions.

Sixty-four percent of all participants said they would use an e-bike to travel to work; 65 percent of those who usually travel to work by car said they would opt for the e-bike; and 71 percent of conventional bicycle enthusiasts expressed interest in using e-bikes to get to work. Obviously, many people find this new technology very attractive.

Conclusion

E-bikes are a great success when judged by the level of user interest and the media's e-bike infatuation. Participants' comments indicated their potential to become popular and, for some, to replace the automobile as a mode of transportation to work, particularly from May to October. Overall, respondents thought that the federal government (Transport Canada) and the Quebec government (SAAQ) should legislate and permit the use of electric bicycles.

The project results also identified the expectations of potential clients, namely:

- An e-bike that can reach 30 km/h in power-assist mode;
- A high-performance, ergonomic product that is, most importantly, lighter, and that can assist the user on steep hills and provide good acceleration;
- Useful accessories providing greater safety in urban environments;
- Anti-theft devices and workplace facilities to help ensure bicycle security in all circumstances.

TABLE OF CONTENTS

1.	INTRODUCTION	1
1.1	Objectives.....	1
2.	BACKGROUND	3
2.1	General	3
2.2	Electric bicycles	3
2.3	Types of electric bicycles.....	4
2.3.1	Electrically assisted bicycles (EABs)	4
2.3.2	Electrically propelled bicycles (EPBs)	4
2.4	Regulations applicable to e-bikes.....	5
2.5	Canadian situation.....	6
2.6	CEVEQ's mission and objectives	6
2.7	1999 Electric Bicycle Evaluation Project	6
2.8	Special study framework	7
3.	METHODOLOGY	9
3.1	Project method	9
3.2	Project implementation	9
3.2.1	CEVEQ: Project designer and manager	9
3.2.2	Partners.....	10
3.2.3	Suppliers	11
3.2.4	Implementation	12
3.3	Selecting the target clientele	13
3.4	Data gathering	14
3.4.1	Overall method.....	14
3.4.2	Questionnaire	15
3.4.3	Cyclists' comments.....	15
3.4.4	Special characteristics of the Ontario tests	16
3.5	Approvals.....	16
3.5.1	Transport Canada approval	16
3.5.2	Authorization from the Société de l'Assurance Automobile du Québec	17
3.5.3	Special problems in the Ontario evaluation	17
3.6	Communication strategy	17
3.6.1	Promotional tools	17
3.6.2	Press conferences.....	18
4.	LIST OF TESTED BICYCLES AND SPECIAL CHARACTERISTICS	19
5.	EVALUATION RESULTS	23
5.1	General	23
5.1.1	Distance travelled by cyclists.....	23
5.1.2	Cyclist profile	24

5.2	E-bike safety	25
5.2.1	General	25
5.2.2	Comparison of EPB and EAB handling capabilities	25
5.2.3	Impact of speed on e-bike safety	28
5.2.4	Impact of ergonomics on e-bike safety	29
5.2.5	Protective helmets	30
5.2.6	Minimum age	31
5.2.7	E-bikes versus conventional bicycles on bicycle paths	31
5.2.8	Highlights	32
5.3	E-bike performance.....	33
5.3.1	Overall performance.....	33
5.3.2	Motor power.....	34
5.3.3	Maximum e-bike speed	35
5.3.4	Highlights	36
5.4	E-bikes as a mode of urban transportation	36
5.4.1	Cyclists' current modes of transportation	37
5.4.2	Reasons for commuting to work on e-bikes.....	37
5.4.3	E-bikes advantages.....	38
5.4.4	Influence of external factors	38
5.4.5	E-bike parking.....	39
5.4.6	Use of bicycle paths	39
5.4.7	Highlights	39
5.5	Project impact.....	40
5.5.1	Impact on the public and cyclists.....	40
5.5.2	Impact on government authorities	40
5.5.3	Impact on participating organizations.....	40
6.	CONCLUSIONS	43
6.1	E-bike safety	43
6.2	E-bike performance.....	43
6.3	E-bikes as a mode of urban transportation	43
6.4	Future of e-bikes.....	44
7.	RECOMMENDATIONS	45
7.1	Cyclists' needs.....	45
7.2	Government regulations.....	45
Appendix A	Summary of Qualitative Analysis of Cyclists' Comments	
Appendix B	List of Newspaper Articles and Radio/Television Coverage	

LIST OF PHOTOS

Photo 1	Presentation to the media of several models of electric bicycles at a press conference on June 12, 2000	2
Photo 2	Electrically assisted bicycle (EAB)	5
Photo 3	Electrically propelled bicycle (EPB)	5
Photo 4	A group of e-bike users being trained at the Agence de l'Efficacité Énergétique	13
Photo 5	Two e-bikes on display during taping of the "Technofolies" television show	18

LIST OF TABLES

Table 1	Summary of Study Parameters.....	14
Table 2	Official E-bike Suppliers	19
Table 3	Characteristics of Electric Bicycles on the Market.....	20
Table 4	Distribution of E-bikes by Identification Number and Partner Organization	22
Table 5	Distances Travelled and Number of Cyclists.....	23
Table 6	Percentage Breakdown of Cyclists with Reasons for Feelings of Insecurity	26
Table 7	Evaluation of E-bike Versus Conventional Bicycle Safety – Ontario Cyclists.....	27
Table 8	Preferred Maximum Power Assist Speed – Ontario Cyclists	28
Table 9	Percentage Breakdown of Satisfied Cyclists by Motor Power Output.....	34

LIST OF FIGURES

Figure 1	Breakdown of Cyclists by Age Group.....	24
Figure 2	Satisfaction with E-bike Handling Capability	26
Figure 3	Perceptions of Maximum Power Assist.....	29
Figure 4	Feelings of Safety at Higher Power Assist Speeds.....	29
Figure 5	Perceptions of Greater Safety by Motor Start-Up Method	30
Figure 6	Suggested Minimum Age for Riding E-bikes	31
Figure 7	Perceptions of Electric and Conventional Bicycle Speeds on Bicycle Paths	32
Figure 8	Preferred Maximum Power Assist Speed	36

1. INTRODUCTION

This report summarizes the results of an electric bicycle evaluation project conducted by the Centre for Electric Vehicle Experimentation in Quebec (CEVEQ) in co-operation with partners and bicycle manufacturers. The project targeted a specific type of cyclist and involved tests in four Canadian cities (Montreal, Quebec City, Toronto and St. Jerome) in the summer of 2000.

1.1 Objectives

The primary objective of this study, initiated at the request of Transport Canada, the project's principal funding partner, was to determine the impact of e-bikes on the safety of users in order to help responsible authorities decide on appropriate regulations.

Other project objectives included the following:

- Promote e-bikes and assess interest in them as a mode of urban transportation;
- Identify appropriate sectors for e-bike use;
- Stimulate people's interest in commuting to work on e-bikes and making less use of cars;
- Promote greater use of less polluting and energy-consuming modes of transportation.

The project enabled CEVEQ and its partners not only to ascertain cyclists' perceptions of safety when riding e-bikes but also to identify from their comments what they thought about the advantages, disadvantages and marketing potential of e-bikes. More specifically, answers were sought to the following questions: Should the e-bike be considered a motorbike or a conventional bicycle? Should the electrically propelled bicycle be classified in the same category as the electrically assisted bicycle? Should the motor's power assist disengage at 24 km/h, 30 km/h or 32 km/h? How much power output should the motor have?

Fifty-five e-bikes were tested in an urban setting largely because of the significant voluntary commitment of ten participating manufacturers, who kindly agreed to lend their products.

This report provides an overview of the role of e-bikes throughout the world and of the international regulations currently in force. It also covers the evaluated products as well as the methodology adopted by CEVEQ to ensure that the 55 e-bikes were used by cyclists in a co-ordinated fashion.

Based on the data collected with respect to the tested products, an analysis of the responses was carried out to identify cyclists' perceptions of e-bikes and feelings of safety. The report ends with conclusions and recommendations.

Photo 1



Presentation to the media of several models of electric bicycles at a press conference on June 12, 2000

2. BACKGROUND

2.1 General

The automobile is the mode of transportation used by most Canadians to commute to work. In 2000, the rate of automobile use in Canada was 524 automobiles per 1,000 inhabitants.

Although the transportation industry continues to be a major employer that contributes significantly to the national economy and provides countless services for the travelling public, it is unfortunately still responsible for about 38 percent of greenhouse gas emissions.

Since the green movement emerged in the 1980s, bicycles have generated keen interest and made a real comeback in Canada, primarily in Quebec. The bicycle market across Canada is soaring with 656,000 bicycles sold in 1995.

The bicycle fad should gain momentum if parallel measures, such as the building of bicycle paths and bicycle parking areas, as well as the adoption of policies promoting the inclusion of bicycles in community transportation systems, are developed and widely implemented.

According to a Vélo Québec study on the status of bicycles entitled *L'état du vélo au Québec en 1995 et 1996*, 79 percent of cyclists use their bicycles only for recreation, 13 percent occasionally use them as a mode of transportation and 8 percent use them as a primary mode of transportation. The study also says that the use of bicycles for physical exercise decreases with age and that only 12 percent of cyclists are over 65. Although generally used by active people and for recreation, bicycles would improve the physical fitness and efficiency of the population and help lower health costs by reducing city pollution and smog levels.

2.2 Electric bicycles

Because of technological advances in storage cells and electric propulsion systems in recent years and in response to the growing demand for clean, efficient methods of transportation in our urban communities, electric bicycle development and marketing has surged ahead, especially in Asia and Europe.

E-bikes are not a replacement for conventional bicycles. However, they allow a greater number of people to travel on two-wheeled vehicles. In the future, they could even become a means of locomotion that could substitute for the automobile, particularly in warmer weather.

E-bikes are for everybody, especially those who are not very active in sports, those with physical disabilities and seniors. They are also for veteran cyclists who commute to work on conventional bicycles to save money on fuel but wish to avoid arriving at the office covered in perspiration.

Growth in e-bike use has skyrocketed since the electrically assisted bicycle (EAB) was introduced in 1997 by the Japanese firm Yamaha. This version of the e-bike has a small motor mounted on the back wheel to double the power generated by the cyclist. In 1998, the company scored a major commercial success by selling 500,000 units worldwide, making Japan the e-bike market leader.

The European market is growing as well, with more than 100,000 units sold in 1999. However, there are no clear, standardized regulations for all European Economic Community countries.

2.3 Types of electric bicycles

Today there are many types of e-bikes, which can be classified into two main groups: electrically assisted bicycles (EABs) and electrically propelled bicycles (EPBs).

2.3.1 *Electrically assisted bicycles (EABs)*

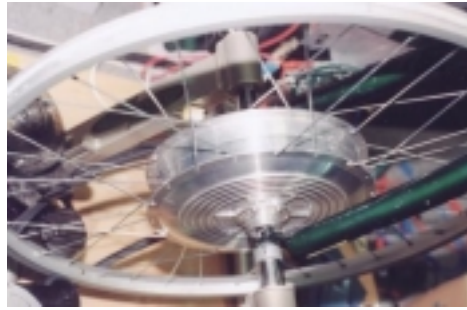
An EAB works like a conventional bicycle with an electric motor added to assist the pedalling action. It is simple to use: press the start switch and the electric motor assists you when you apply pressure on the pedals. The motor increases the amount of power transmitted to the wheel. A special characteristic of the EAB is that it only runs when pedalled.

2.3.2 *Electrically propelled bicycles (EPBs)*

When the electric motor is not providing assistance, the EPB also works like a conventional bicycle. When the cyclist turns the function switch to "on" and presses the hand accelerator, the cyclist is propelled effortlessly by the electric motor without having to pedal. The propulsion of this type of e-bike is similar to that of a moped.

EABs and EPBs are divided into several categories depending on the maximum power output ratio (1:1, 1:2, 1:3), the power output rating (average 250 W) and the speed limit at which the power assist cuts out.

Photo 2



Electrically assisted bicycle (EAB)

Photo 3



Electrically propelled bicycle (EPB)

2.4 Regulations applicable to e-bikes

Japan was the first country to consider EABs to be conventional bicycles provided the power assist was limited to a speed of 30 km/h. The Japanese now consider e-bikes a full-fledged mode of transportation.

In France, EABs are considered to be conventional bicycles if the power assist is limited to 24 km/h. At speeds beyond that limit, current French regulations require the rider to wear a moped helmet.

In the United States, manufacturers and consumers are more interested in electrically propelled bicycles (EPBs). In 1995, ZAP was the first American company to offer EPBs and has been distributing its products worldwide ever since. In 1999, EV Global Motors, headed by Lee Iacocca, entered the market with the launch of a line of futuristically designed e-bikes.

The National Highway Traffic Safety Administration (NHTSA) recognizes that the EAB has specific characteristics that distinguish it from a moped. It defines it as a bicycle equipped with a low capacity electric motor that weighs less than 100 lb. (about 45 kg)

and is capable of reaching a maximum speed of 20 mph (about 30 km/h) with assistance from the motor.

2.5 Canadian situation

Canadians are still unfamiliar with electric bicycles because of the newness of the product and lack of regulations in Canada to allow or encourage their marketing and use.

In Canada, the importing of and interprovincial trade in e-bikes is prohibited by the Motor Vehicle Safety Act. Under this Act, each province or territory may allow e-bikes to be sold and used in its jurisdiction. Groupe Procycle was thus able to obtain special authorization to sell the Elektron model (100-W motor and power assist up to 24 km/h) in Quebec only. Transport Canada is currently studying amendments to the Motor Vehicle Safety Regulations that would permit the marketing and use of EABs and EPBs upon agreement among the provinces. To promote the marketing of these bicycles, it is crucial that the future regulations governing e-bikes correspond to the needs of the product's potential customers.

2.6 CEVEQ's mission and objectives

The Centre for Electric Vehicle Experimentation in Quebec (CEVEQ) is a private, non-profit company founded in 1996. Its mission is to promote the use of electric vehicles or hybrid electric vehicles from the perspective of the environmental, economic and energy-saving benefits they may generate.

CEVEQ's overall objectives include the following:

- Manage EV evaluation and demonstration projects;
- Participate in industrial development projects;
- Test EVs or components in actual-use climate conditions;
- Promote efficient and non-polluting modes of transportation;
- Develop expertise in EV maintenance;
- Help develop technical training with specialized organizations.

2.7 1999 Electric Bicycle Evaluation Project

In the summer of 1999, CEVEQ conducted an EAB demonstration and evaluation project in the Montreal area. The project's main objective was to assess the relevance of electric bicycles in urban environments and whether they were in a position to occasionally replace cars for commuting to work.

With the co-operation of financial partners and cyclists (Agence de l'Énergie; Transport Quebec; Hydro Quebec; City of Montreal; Groupe de Recherche Appliquée en Macroécologie (GRAMÉ); Transports 2000 Québec; and Citizens on Cycles), 16 identical EABs were assigned to the cyclists. A total of 120 people participated in the evaluation and filled out a comprehensive questionnaire at the end of the test period.

When the test results were analysed, it was found that the tested bicycles could meet the needs of a clientele of moderately physically active working people travelling a distance of less than 20 km, but were not suited to the needs of a clientele of regular cyclists because their speed limit was restricted to 24 km/h. The cyclists particularly liked the reduced physical effort required in more strenuous situations. Overall, they found the bicycles' strong points to be user-friendliness, reliability and riding pleasure, and elements in need of improvement to be weight, speed and range. Most cyclists felt safe on these e-bikes.

CEVEQ was able to use this study to identify consumer needs and potential market niches for electric bicycles. It also provided Transport Canada with relevant information for drafting new regulations for power-assisted bicycles.

2.8 Study framework

To permit the possible marketing and use of electric bicycles in Canada, Transport Canada published a proposed amendment to Canada's Motor Vehicle Safety Act in the *Canada Gazette*, Part I, in November 1999. Under this proposed amendment, electric bicycles would be excluded from the limited-speed motorcycle category, provided they met the following principal criteria:

- Maximum speed of 24 km/h;
- Maximum power of 500 W;
- Maximum pedal-to-power assistance ratio of 1:1;
- Pedal-activated motor (Pedal Assist (PAS)).

Many manufacturers and consumers commented that this proposed amendment was too restrictive and would not allow the marketing of EPB-type electric bicycles, while others thought the maximum permitted speed was too low, among other things.

The Electric Bike 2000 Project was therefore developed partly in response to the observations and comments that were made. To expand the scope of the project beyond a regional or Quebec frame of reference, it was agreed to carry out the evaluation project in four Canadian cities, including one in Ontario.

3. METHODOLOGY

3.1 Project method

This study was planned and developed to achieve the objectives described in section 1.1 while keeping in mind the specific interests of the various partners. The expertise acquired in the 1999 Electric Bicycle Evaluation Project was used to set up the study and ensure that a representative sample of bicycle models and users, as well as valid test periods were considered.

The following were key elements of the method used to define the content of the project:

- Define the scope of the project with the partners;
- Request and receive co-operation from technical and financial partners to participate in the project;
- Determine the number and types of e-bikes required to assess the merits of various characteristics that have an impact on safety, such as the following: two or three-wheel bicycles, motors with outputs ranging from 200 to 500 W, EABs versus EPBs, power-assist ratios from 1:1 to 1:3 and maximum speeds ranging from 25 to 35 km/h;
- Obtain bicycles from manufacturers on either a loan or lease basis;
- Solicit the participation of employers whose employees would use the bicycles;
- Prepare questionnaires and logbooks to be used for information gathering;
- Make necessary logistical arrangements to set up the project and manage it on a daily basis;
- Prepare a report to update the final content of the project.

3.2 Project implementation

The Electric Bike 2000 Project was made possible through each participating organization's contributions of financial support and/or services, staff and other forms of support.

3.2.1 CEVEQ: Project designer and manager

CEVEQ was the creator and manager of the project. Its mandate for this study included the following:

- Define a project in co-operation with the planning partners and e-bike suppliers;
- Look for e-bike suppliers that are developing innovative, interesting technologies and are favourable to the idea of participating in tests;
- Determine the impact of e-bikes on the safety of potential e-bike users in actual cycling situations;
- Manage the operating budget;
- Target potential users in various categories of people in the labour force;
- Manage cyclist training and supervision;
- Co-ordinate media relations;
- Develop and propose promotional tools;

- Design questionnaires and logbooks;
- Produce an evaluation report based on the data gathered from questionnaires filled out by participants.

3.2.2 Partners

Planning and financial partners

The main planning and financial partners of this study were the Transportation Development Centre of Transport Canada, the Agence de l'Efficacité Énergétique and the Société de l'Assurance Automobile du Québec (SAAQ).

As the federal government institution responsible for transportation, Transport Canada was interested in obtaining information on the various types of electric bicycles as well as their characteristics, advantages and disadvantages in order to focus its associated policies, programs and regulations more effectively. For Transport Canada, this project was an excellent opportunity to promote e-bikes, evaluate interest in them as a clean mode of urban transportation, identify the most promising areas for their use and, most importantly, to ask cyclists for their perceptions concerning the safety aspects of these bicycles.

The SAAQ's interest in the project consisted of determining the impact and issues involved in possibly implementing e-bike legislation in the province of Quebec. From the SAAQ's standpoint, the project's objective was to gather information on electric bicycle use on roads and bike paths that the organization would use as a guide in establishing standards for the use of these bicycles.

Quebec's Agence de l'Efficacité Énergétique supported the project as part of the Energy Efficiency Partnership Program. Also to be highlighted are the contributions of the Moving the Economy (MTE) organization and the City of Toronto, which conducted the evaluation in Toronto.

In co-operation with CEVEQ, MTE carried out the following activities:

- Co-ordination of the project in Toronto;
- Evaluation, by means of a questionnaire, of a minimum of five electric bicycles made available to the public;
- Promotion and awareness campaigns for the media and the general public;
- Organization of a press conference in Toronto;
- Co-ordination of a working group to study possible legislation on e-bike use in Toronto and throughout the province of Ontario.

The following is a list of all of the financial partners involved in the project:

- Agence de l'Efficacité Énergétique
- Agence Métropolitaine de Transport
- Hydro Quebec
- Quebec Department of the Environment
- Quebec Department of Transport
- Société de l'Assurance Automobile du Québec

- Transport Canada
- City of Montreal
- City of Quebec
- City of St. Jerome
- City of Toronto

Organizations participating in the evaluation

Following the 1999 Electric Bicycle Evaluation Project, which was conducted in the Montreal area in the summer of 1999, CEVEQ contacted the participating organizations – the City of Montreal, Transport Quebec and the City of Lachine (GRAME) – and obtained their enthusiastic agreement to become involved in this new project.

So that the evaluation could be carried out in various regions of Quebec and the rest of Canada, Quebec City, St. Jerome and Toronto were invited to participate in the project and they promptly accepted.

In keeping with the project's objectives, financial partners such as Transport Canada, the SAAQ, the Quebec Department of the Environment and Quebec's Agence de l'Efficacité Énergétique also expressed interest in being directly involved in the evaluation.

The following organizations participated in the evaluation project:

- Agence de l'Efficacité Énergétique
- Association Québécoise du Transport et des Routes
- Hydro Quebec
- Quebec Department of the Environment
- Quebec Department of Transport
- Société de l'Assurance Automobile du Québec
- Transport Canada
- City of Lachine (Groupe de Recherche Appliquée en Macroécologie (GRAME))
- City of Montreal
- City of Quebec
- City of St. Jerome
- City of Toronto

3.2.3 Suppliers

It was important to select and procure certain types of e-bikes in order to obtain evaluation results that were valid and representative of all products that might be considered by potential users. A number of manufacturers were contacted based on the types of bicycles sought for the project.

The following manufacturers kindly provided the e-bikes used for this project:

- Procycle
- EPS
- EV Global Motors
- Zapworld
- Th!nk Mobility (Ford)
- Yamaha Motors
- AeroVironment
- Renault Sport
- Cycleurope (Peugeot)
- Honda

3.2.4 Implementation

Set-Up

Upon their arrival in Canada and after having cleared customs, the bicycles were assembled, adjusted and inspected by specialized dealers.

CEVEQ made sure each e-bike was working properly and familiarized itself with the various products. Small, simple user manuals were prepared in French for later distribution to cyclists.

The e-bikes were then distributed among the participating organizations, depending on model availability, and tested in the order in which they arrived (in several stages).

Information meeting

Potential cyclists were selected beforehand and a meeting was held with the cyclists from each participating organization. The meetings, facilitated by the Project Manager, were held to inform the cyclists of the project issues, introduce them to the products (and allow them to try out the bicycles) and outline their role and responsibilities in the project.

For the purposes of the project, each cyclist was given a bicycle helmet to wear during the evaluation period and each volunteer received a T-shirt printed with the slogan *Je roule électrique au travail* or *Biking Electric to Work*.

Technical monitoring

Throughout the project, CEVEQ's Technical Unit made sure the e-bikes were in good operating condition and corrected any technical or electrical problems. Nine bicycles were temporarily withdrawn from the project because of missing spare parts. In most cases, replacement e-bikes were assigned so that the evaluation could proceed smoothly.

Supervision

Each participating organization assigned a resource person to supervise its group of cyclists and act as a liaison person with CEVEQ, which co-ordinated and oversaw the project.

Photo 4



A group of e-bike users being trained at the Agence de l'Efficacité Énergétique

3.3 Selecting the target clientele

The cyclist selection criteria were based on distance from home to work (between 5 and 20 km), physical condition (low or moderate level of fitness), age and sex so that a representative sample could be obtained. Special priority was given to people who usually commuted to work by car.

The 1999 Electric Bicycle Evaluation Project results had shown that, in the case of Montreal area residents in the labour force, while age was not a significant criterion for acquiring an e-bike, physical condition was a major criterion. For this study, in selecting people in the labour force between the ages of 25 and 60, it was important to give initial priority to moderately fit people who were active in sports and likely to fit the profile of potential buyers.

A mini-questionnaire was sent to the resource people of the organizations that had expressed interest in participating in the Electric Bike 2000 Project. Cyclists had to promise to follow certain instructions: ride the e-bikes to work every day for a two-week period; record the number of kilometres travelled each day and average speed maintained; and fill out the logbook and detailed questionnaire at the end of the test period.

Table 1
Summary of Study Parameters

Study Parameter	Description
Number of bicycles	55 e-bikes
Number of participants	369
Locations	Montreal, Quebec City, St. Jerome and Toronto
Period	June 12 to October 7, 2000
Bicycle characteristics	<ul style="list-style-type: none"> • Electrically assisted bicycles • Electrically propelled bicycles
Terms and Conditions	<ol style="list-style-type: none"> 1. Test electrically assisted and electrically propelled bicycles for two weeks (Quebec) and test e-bikes loaned to the general public for short rides (Toronto). 2. In Quebec, cyclists had to commute to work by e-bike every day, fill out a logbook and complete a detailed questionnaire at the end of the two-week test period. 3. In Ontario, cyclists could try out an e-bike for two hours, then filled out a short questionnaire.

3.4 Data gathering

3.4.1 Overall method

Data was compiled using the answers provided by the cyclists to the questionnaire developed by CEVEQ. The questionnaire was based in part on the 1999 e-bike evaluation.

3.4.2 Questionnaire

The questionnaire sent to the Quebec cyclists consisted of 126 questions and an additional page reserved for comments. The questions were grouped into nine sections covering the following topics: Overall User Profile (9 questions); E-Bike Use (20 questions); E-Bike Comfort, Design and Economy (15 questions); E-Bike Performance (7 questions); E-Bike Technical Follow-Up (5 questions); E-Bike Personal Safety (38 questions); E-Bike Anti-theft Measures (9 questions); Overall Evaluation (6 questions); and Purchasing (17 questions).

The data obtained from some of the questions were not analysed for this report because their subject matter did not pertain to the study's main objectives. However, this data was gathered for informational purposes and for possible future use.

The questionnaire was structured according to the profile of the volunteers and designed to take into account the elements required to achieve the project's main objective. It was intended to provide respondents with a maximum number of choices while controlling the way in which the questions could be answered. Replies were accurate and objective because the questionnaire was carefully controlled, except for the comments section.

This approach was adopted to ensure consistency in the cyclists' answers as well as to facilitate data entry and use. Cyclists were asked to answer Yes/No questions and multiple-choice questions. They were then free to give specific comments at the end of the questionnaire.

A database was developed based on the Yes/No and multiple-choice questions. The data from the questionnaires were then entered into a relational database. MS Office software was used to integrate all of the data in order to reproduce the questionnaire profile. All analysis results were prepared using a query generator and tables produced by a spreadsheet program.

The results entered in the database were obtained from the information provided by cyclists following their e-bike testing. Among the operations carried out was a comparison of the data for electrically propelled bicycles and data for electrically assisted bicycles. This comparison made it possible to assess the various impacts, including the impact on safety, which was a primary objective of this study.

These results were also expressed as ratios (percentages) to indicate the relationship between a specific group of cyclists and the entire pool of evaluators. In some cases, cyclists chose not to answer questions, which explains why the accumulated totals of various percentages do not always add up to 100 percent.

3.4.3 Cyclists' comments

As mentioned in section 3.4.2, the questionnaire included space for entering additional comments or observations in addition to the objective multiple-choice questions.

These comments were grouped by topic according to a table outlining ten different subject areas to which the questionnaire questions related. They were also grouped according to whether they applied to EABs or EPBs.

Appendix A presents a qualitative analysis of these groupings. The analysis sought to determine whether some of these comments confirmed or qualified the data obtained through the questionnaire questions or provided additional information. It also tried to establish the significance of these comments, depending on the subject area, in relation to the complete set of data, or whether they were only isolated remarks made by just a few cyclists. It is important to note that not all cyclists provided comments.

A meeting was held on November 23, 2000 to validate some of the analysis elements and results. This meeting involved a very small group of cyclists who had tested several types of e-bikes. This report refers to them where relevant.

3.4.4 Special characteristics of the Ontario tests

Table 1 shows that a total of 369 people answered the questionnaire. Of this number, 211 were Quebec residents and 158 were Ontario residents.

Because the e-bikes were tested under different conditions in Quebec and Ontario, care had to be taken in the final comparison of results.

It must be noted that adjustments had to be made to the Ontario project. The questionnaire filled out by Ontario cyclists was much shorter because of the more limited scope of the tests. It consisted of 31 questions and included space for comments. The questions covered the following topics: Overall Profile (8 questions); E-Bike Use (4 questions); E-Bike Performance (4 questions); Personal Safety (8 questions); Overall Evaluation (4 questions); and Purchasing (3 questions).

The 158 Ontario cyclists rode the e-bikes for one to two hours on bicycle paths before filling out the questionnaires. In Quebec, the 211 cyclists kept the e-bikes for two weeks and used them on weekdays on public thoroughfares to commute to work and on weekends for personal or recreational use.

Obviously, the two sets of results could not be compared directly. To ensure accuracy and avoid distorting the results, attention was focused primarily on the Quebec test data. If necessary, a separate analysis of the Ontario tests may be conducted to confirm the Quebec results.

3.5 Approvals

3.5.1 Transport Canada approval

Once an agreement had been reached with the American, European and Japanese manufacturers, CEVEQ submitted a request to bring e-bikes into Canada temporarily for demonstration and test purposes in accordance with the Motor Vehicle Safety Act.

Transport Canada's approval was essential in order to bring the e-bikes into Canada temporarily and, of course, carry out the project.

3.5.2 Authorization from the Société de l'Assurance Automobile du Québec (SAAQ)

The SAAQ allowed the e-bikes to be used in Quebec under certain conditions in the context of a pilot project. It classified the project's e-bikes as conventional bicycles subject to all of the requirements, obligations and privileges of the Highway Safety Code and the Automobile Insurance Act.

3.5.3 Special problems in the Ontario evaluation

When the evaluation project was developed for the fourth participating Canadian city – Toronto – authorization to ride e-bikes on public thoroughfares could not be obtained from the Ontario Ministry of Transport (OMT). Despite the efforts of CEVEQ and its partners, the OMT refused, citing the Highway Traffic Act which, in the current wording of one its Regulations, places electric bicycles in the Motorcycle category and thus requires users to take a recognized motorcycle driver training course to obtain a permit. The project had to be modified and the e-bikes were ridden in areas under municipal jurisdiction, such as parks and bicycle paths. Two bicycle rental stores made the e-bikes available to the public for test periods varying from one to several hours.

3.6 Communication strategy

The two main objectives of the project were to promote the bicycle as a mode of urban transportation with the potential to replace the automobile, and to raise public and government awareness. A communication strategy was implemented, which helped significantly to promote this project across Canada.

3.6.1 Promotional tools

Bicycle identification

For identification purposes, the bicycle seats were fitted with licence plates sporting the project colours along with an individual number to simplify co-ordinating activities.

Information brochure

A colour brochure printed on glossy stock – 4,000 copies of the French version and 1,000 of the English version – was distributed at all activities throughout the summer. The slogan *Biking Electric to Work* underlined the environmental impact and generated interest.

T-shirts

Four hundred and fifty colour T-shirts with the project logo were produced: 350 with the French slogan *Je roule électrique au travail* and 100 with the English slogan *Biking*

Electric to Work for Toronto participants. The logos of the partners were printed on the backs of the T-shirts.

A T-shirt was given to each cyclist as well as to organizers, media representatives, and others.

Posters

One hundred large-format colour posters printed on glossy paper were produced in French and each participating organization received a copy. Thirty additional posters in English were printed.

A 24" x 36" poster on stiff-backed paper was also produced for use at special events and press conferences.

3.6.2 Press conferences

Four press conferences were held in the participating cities on the following dates:

- Quebec City, June 13, 2000;
- St. Jerome, June 22, 2000;
- Montreal, July 11, 2000;
- Toronto, August 17, 2000.

Photo 5



Two e-bikes on display during filming of the television show "Technofolies"

4. LIST OF TESTED BICYCLES AND SPECIAL CHARACTERISTICS

For the purposes of the Electric Bike 2000 Project evaluation program, it was vitally important to test a large sample of products. It was a priority to obtain a sufficient number of EABs and EPBs from Canadian, American, European and Japanese manufacturers so that the two technologies could be tested by a large number of people.

CEVEQ also tried to obtain e-bikes with power output ratios greater than 1:1 to study whether the extra power supplied by the motor would place cyclists at risk when the ratio was higher than human power output (power output ratios of 2:1 and 3:1).

Given that motor power output would be a key parameter in future regulations, products equipped with motors whose power outputs ranged between 200 and 750 W were requested.

Ten manufacturers from around the world answered the call and provided 55 e-bikes in 15 different models, making the Electric Bike 2000 Project one of the world's biggest e-bike evaluation projects.

Owing to production and delivery delays (ship transport and customs clearance), the e-bikes were introduced into the evaluation project at different times.

Table 2 lists the manufacturers by the date on which products were delivered and made available for the project.

Table 2
Official E-Bike Suppliers

	Country	Propulsion Method	Quantity	Delivery Date
EV Global	U.S.	EPB	10	End of May
ZAP	U.S.	EPB	6	June 10
AeroVironment	U.S.	EAB	2	July 1
Yamaha	Japan	EAB	4	July 10
Honda	Japan	EAB	5	July 10
Renault	France	EAB	2	July 17
Peugeot	France	EAB	1	July 17
Procycle	Canada	EAB	4	July 18
Dubé Motors	Canada	EAB	1	July 11
Ford	U.S.	EAB	10	August 1
EV Global	U.S.	EPB	1	mid-August
Honda	Japan	EPB	9	August 25
TOTAL			55	

Table 3
 Characteristics of Electric Bicycles on the Market

Company	Brand	Country of origin	Characteristics									Number of Bicycles Provided
			Motor	Power Output Ratio	Speed Limit (km/h)	Propulsion Method	Battery	Range (km)	Number of Speeds	Time to Recharge (hours)	Weight (kg)	
AeroVironment	Charger	U.S.	375 W	½:1 1:1 2:1 3:1	32	EAB	Pb 24V	32	7	4	29	2
EPS	Amigo	Canada	400 W	½:1 1:1 2:1	32	Bi-modal	Ni-Cd 24V	30	21	3	24	1
EV Global Motors	E-Bike (24V)	U.S.	400 W		24	EPB	Pb 24V	32	7	4	32	10
	E-Bike (36V)	U.S.	400 W		32	EPB	Pb 24V	32	7	4		1
Honda	Racoon Compo	Japan	200 W	1:1	18	EAB	Ni-Cd 24V	20	3	2	22	5
	Grand Racoon	Japan	220 W	1:1	24	EAB	Ni-Cd 24V	30	3	3	25	9
Peugeot	Velectron	France	200 W	1:1	24	EAB	Ni-Cd 24V	35	4	3½	28	1



Charger



Amigo



E-Bike



Racoon Compo



Velectron

Table 3 (cont.)
 Characteristics of Electric Bicycles on the Market

Company	Brand	Country of Origin	Characteristics									Number of Bicycles Provided
			Motor	Power Output Ratio	Speed Limit (km/h)	Propulsion Method	Battery	Range (km)	Number of Speeds	Time to Recharge (hours)	Weight (kg)	
Procycle	Elektron II	Canada	250 W	1:1 2:1 3:1	24	EAB	Ni-Cd 24V	50	3	4	24	4
Renault	Equation	France	250 W	1:1	24	EAB with accelerator	Ni-Cd 24V	35	4	4	33	2
Th!nk Mobility	Th!nk Bike Fun	U.S.	400 W	1:1	32	EAB with accelerator	Pb 24V	40	7	2-4	33	5
	Th!nk Traveller	U.S.	250 W	1:1	29			30	4	1-4	24	5
Yamaha	PAS XPC26	Japan	235 W	1:1	24	EAB	Ni-MH 24V	50	4	3½	28	4
ZAP	Bianchi	U.S.	400 W		29	EPB	Pb 12V	13	7	3	24	2
	Diamondback	U.S.	200 W		21.5	EPB	Pb 12V	25	21	10	24	2
	Smith & Wesson	U.S.	400 W		29	EPB	Pb 12V	20	21	3	24	2



Elektron



Equation



Th!nk Traveller



PAS XP



Diamondback

Table 4
Distribution of E-Bikes by Identification Number and Partner Organization

Partner	Bicycle										
	AERO	EPS	EV Global	HONDA	PEUGEOT	PROCYCLE	RENAULT	THINK	YAMAHA	ZAP	TOTAL
MONTREAL											
Transport Canada			1	1					1		3
AMT		1	1								2
AQTR										1/#203	1
City of Montreal	1		1	2			1			1/#204	6
City of Lachine (GRAME)						3					3
QUEBEC CITY											
AEE			1	1		1			1	1/#206	5
City of Quebec			1			1		1		1/#205	4
Environment Quebec									1		1
Transport Canada								1			1
SAAQ			1	2				1		1/#201	5
Transport Quebec			1	2				1		1/#202	5
ST. JEROME											
Hydro Quebec			1	2	1	1					5
City of St. Jerome	1		1	1				1			4
TORONTO											
City of Toronto			1	1		4		2		1	9
TOTAL	2	1	10	12	1	10	1	7	3	7	54

5. EVALUATION RESULTS

5.1 General

5.1.1 Distance travelled by cyclists

As indicated in Table 5, 369 people travelled a total of 25,205 km on e-bikes in four months. In the three Quebec cities – Montreal, St. Jerome and Quebec City – 211 people travelled a total of 24,343 km to commute to work, an average of 115 km per cyclist during the two weeks of evaluation. In Ontario, 158 people travelled 862 km, an average of 5.4 km per cyclist.

Most of the volunteers normally used cars for their transportation purposes. Of the total number of participants, 49 percent had never used a bicycle to commute to work, 18 percent cycled to work a few times per month, 15 percent commuted to work by bike one to four times per week and 16 percent cycled to work every day.

Table 5 shows the breakdown of the cyclists who participated in the evaluation and completed questionnaires, and the number of kilometres they travelled.

Table 5
Distances Travelled and Number of Cyclists

Province	EPBs	EABs	Total
QUEBEC			
Number of cyclists	106	105	211
Number of km travelled	12,823	11,520	24,343
ONTARIO			
Number of cyclists	31	127	158
Number of km travelled	150	712	862
Total number of cyclists	137	232	369
Total number of km travelled	12,973	12,232	25,205

Although there were more electrically assisted bicycles than electrically propelled bicycles available for the project, the number of returned questionnaires was identical in both cases because the EPBs began to be used in the project starting in June, whereas the delivery of the EABs was delayed and some brands, such as Honda, were introduced into the project fairly late.

It is interesting to note that a similar number of kilometres was travelled in both cases, which allowed more relevant and consistent comparisons to be made between the characteristics of EABs and EPBs.

Because e-bikes could only be ridden on bicycle paths and in parks in Ontario, the resulting insufficient data gathered in Ontario could not be compared with the Quebec

data. Although the number of Ontario cyclists was fairly similar to that of Quebec, the analysed results could not be viewed in the same way. For example, the 158 Ontario cyclists who answered the questionnaire only travelled 3 percent – a statistically insignificant 862 km – of the total number of kilometres and only rode the e-bikes for very short periods. Some Ontario e-bike users said they were unable to properly judge elements of the answers they were asked to provide.

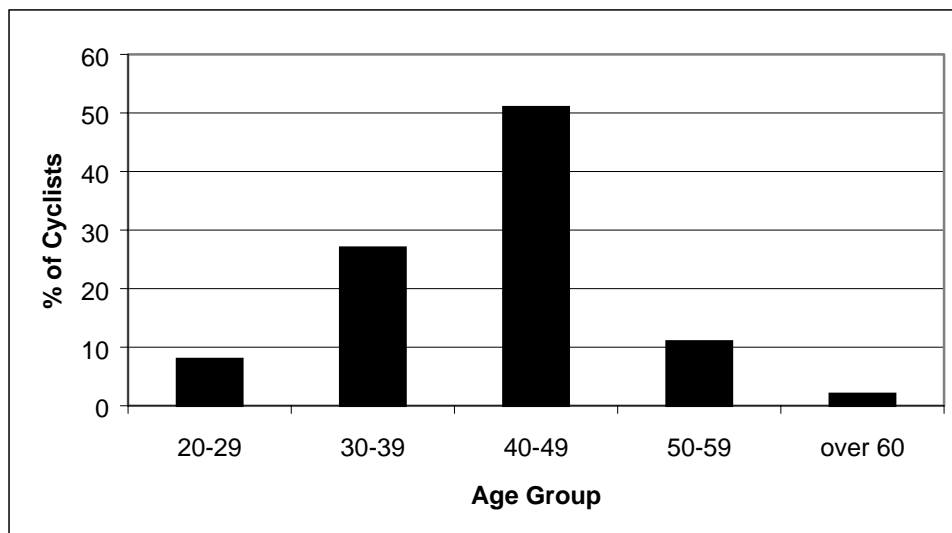
5.1.2 Cyclist profile

While Table 5 provides a summary of the distances travelled and number of cyclists in the provinces of Quebec and Ontario, the following section provides an analysis of Quebec cyclists.

Quebec cyclists

Of the 211 questionnaires collected in the Quebec tests, 74 percent were provided by male respondents and 26 percent by female respondents.

Figure 1
Breakdown of Cyclists by Age Group



All of the e-bike users participated on a voluntary basis. Figure 1 shows that interest in e-bikes was greater in the 40-49 age group than in any other age group. It also shows that 8 percent of cyclists were between the ages of 20 and 29, 27 percent were between 30 and 39, 51 percent between 40 and 49, 11 percent between 50 and 59 and 2 percent over the age of 60. Most of the cyclists (55 percent) were university educated and earned more than \$46,000 per year.

As mentioned in section 3.4.4, it is interesting to note that all of the Quebec cyclists rode their e-bikes to work, which was usually between 5 and 25 km from home.

Ontario cyclists

Overall, the Ontario cyclists were fairly well-educated (56 percent had university education); most were over 40 years old (63 percent); and 46 percent earned more than \$46,000 per year. They considered physical exercise important (94 percent) and felt they had a moderate level of fitness (80 percent).

5.2 E-bike safety

5.2.1 General

One of the evaluation's objectives was to assess the feelings of safety of e-bike users. To date, e-bikes do not have a specific classification in federal regulations. Throughout this study, it was interesting to determine whether the cyclists felt as safe riding on e-bikes as on conventional bicycles, whether they felt in full control on e-bikes and whether the power assist of the motors enhanced their feeling of safety.

Assuming that the cyclist's feeling of safety is related to the speed of the bicycle and given that the two types of e-bikes accelerate in different ways, it was worth determining whether the EPB, which is activated by a lever, should be classified in the same category as the EAB, which only propels itself when pedalled.

Sections 5.2.2 to 5.2.7 provide a comparison of these two types of e-bikes to determine whether they have a different impact on cyclists' feelings of safety. The safety aspect is discussed under the following headings:

- E-bike control/handling capability
- Effect of maximum power assist speed
- Ergonomic features
- Feelings of safety related to wearing a protective helmet
- Minimum age for riding an e-bike
- Safety of e-bikes on bicycle paths

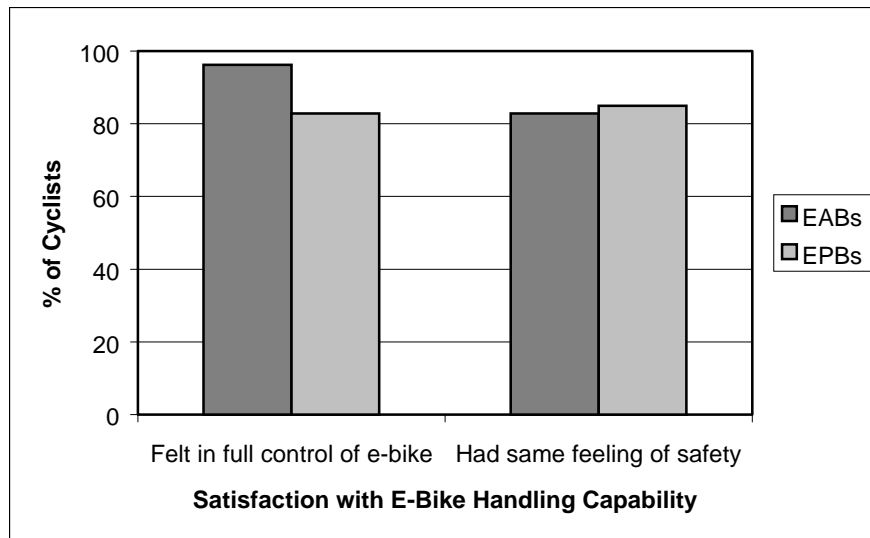
5.2.2 Comparison of EPB and EAB handling capabilities

Quebec cyclists

Figure 2 shows that of the 106 people who rode EPBs, 95 percent felt very satisfied and in full control of their bicycles when the motor was on. Of the 105 people who rode EABs, 96 percent felt they also had full control of their bicycles. Cyclists in both cases, therefore, felt they had firm control of their bicycles and did not feel any particular concern for their safety.

The questionnaire answers were also used to determine how safe the cyclists felt on e-bikes as compared to conventional bicycles. It was found that 85 percent of the cyclists who had ridden EPBs and 83 percent of those who had ridden EABs felt as safe as they did on conventional bicycles.

Figure 2
Satisfaction with E-Bike Handling Capability



The cyclists who did not feel safe (16 percent) were asked to describe the characteristics causing this perception and were given the opportunity to indicate more than one reason. Table 6 provides a breakdown by method of propulsion and by total percentages of cyclists who reported specific reasons for reduced safety in relation to all cyclists who did not have feelings of insecurity.

Table 6
Percentage Breakdown of Cyclists
With Reasons for Feelings of Insecurity

Reported reason for feeling of insecurity	EPB	EAB	All E-Bikes
Lack of control	16%	41%	28%
Too heavy	89%	65%	78%
Too fast	5%	6%	6%
Insufficient braking	5%	41%	22%
Difficult to handle in traffic	21%	35%	28%

Table 6 shows that e-bike weight was the main reason for feelings of insecurity. It appears that the weight of the e-bikes made them difficult to handle.

Only a small percentage of people who rode EPBs wanted the bikes to have gentler, more gradual acceleration. They represented 10 percent of the group of e-bike users who reported one or more reasons for feelings of insecurity.

It is necessary, of course, to have quick reflexes when riding an e-bike in traffic, as it is with a conventional bicycle, to avoid accidents and potential harm. Cyclists were

asked whether they had had to take special measures or precautions when riding an e-bike. It was found that 31 percent had had to avoid potential harm when riding an e-bike with the motor on. Without exception, all of the cyclists had had quick enough reflexes to avoid potential harm. Speed was at issue in 18 percent of cases.

All of the e-bike users agreed that a good way to reduce feelings of insecurity on e-bikes or conventional bicycles was to provide good reliable brakes. However, except for two specific EPB models included in the evaluation, most cyclists (95 percent) considered the braking capability of the bicycles appropriate and satisfactory, 92 percent felt they had full control of the bike and 93 percent considered the brakes sufficiently powerful given the weight of the bicycle.

All of these data indicate that the EPBs have interesting features that may encourage people to make greater use of them.

Although very optimistic, the figures for EABs are nonetheless slightly less positive, with 72 percent of the cyclists saying they felt the braking was satisfactory, 77 percent saying they felt in full control of the bike and 70 percent saying they thought the bike had sufficient braking power in relation to its weight and sturdiness. Although it could not be confirmed that brake adjustments were made, 3.8 percent of the cyclists actually reported poor brake reliability on some e-bike models.

The study also revealed that a total of 77 percent of the cyclists felt comfortable riding the bicycles in automobile traffic.

At the meeting mentioned in section 3.4.3, a small group of five cyclists said they attributed this feeling of additional safety to the availability of increased start-up power on the EPBs, which helped riders to react more quickly and satisfactorily in traffic. The group also thought that this slight advantage of the EPBs increased riders' tendency to obey Highway Safety Code regulations, for example, by making mandatory stops, because they knew that the motor would help with standing starts and therefore they would expend less energy throughout the trip.

Ontario cyclists

The data analysis indicated that 93 percent of the 158 Ontario cyclists felt as safe on an e-bike as on a conventional bicycle.

Table 7
Evaluation of E-Bike Versus Conventional Bike Safety Ontario Cyclists

Safer	17%
Just as safe	76%
Not as safe	3%

The very small number of cyclists (5) who did not feel safe gave the following reasons:

- Lack of control;
- Bike too heavy;
- Bike too fast;
- Insufficient braking.

Each reason was cited by only one or two cyclists.

In addition, a high percentage of cyclists (88 percent) specified that speed was not a factor in feelings of insecurity. Most of them wanted the motor power assist to enable them to achieve a speed above 25 km/h, as shown in Table 8.

Table 8
Preferred Maximum Power Assist Speed Ontario Cyclists

15 km/h	9%
20 km/h	22%
25 km/h	25%
30 km/h	33%

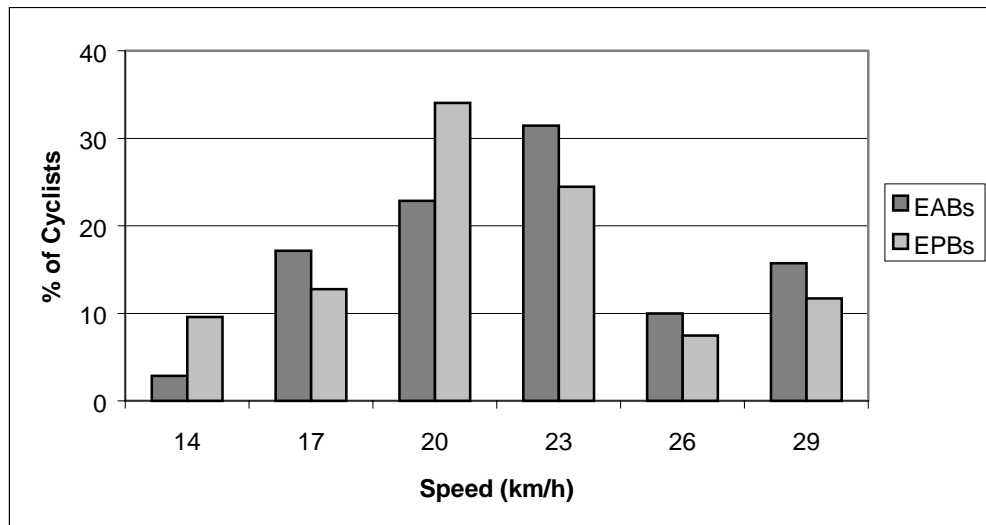
5.2.3 Impact of speed on e-bike safety

Since motorized vehicles are generally associated with “a faster mode of travel,” it should be emphasized that, although e-bikes are propelled by two complementary power sources – human power and electric power – these power sources are not considered a way to break speed records, but rather a way to stabilize the e-bike and help the cyclist reach a steady average speed. Cyclists feel the power assist of the motor when they cannot pedal efficiently, particularly during start-ups, on hills and in windy or adverse weather conditions.

Cyclists' answers indicated that instead of exhausting their own physical resources and quickly tiring, they felt “assisted” and were able to climb hills easily at a speed of 20 km/h. Cyclists were therefore able to maintain an average speed without inordinate effort over the entire distance.

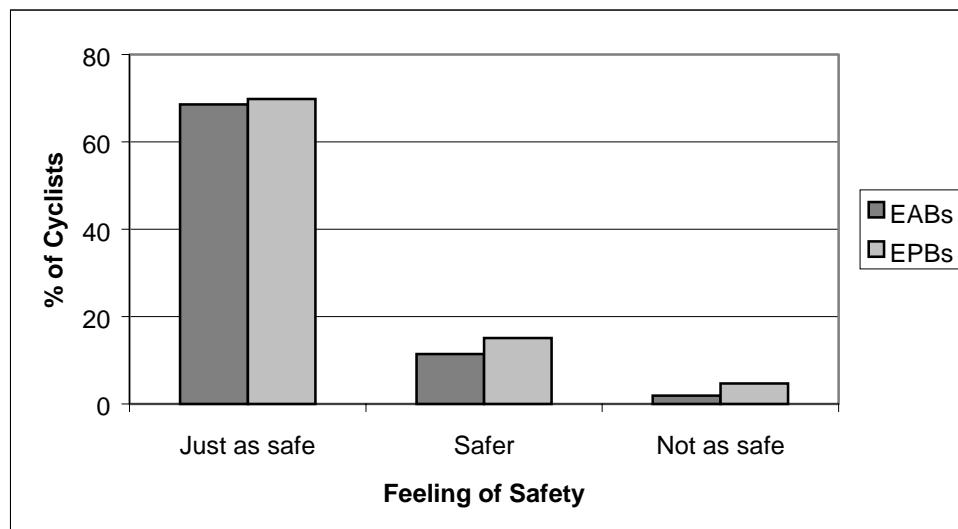
Figure 4 shows that most (more than 70 percent) of the cyclists felt they were no longer assisted by the motor at speeds higher than 23 km/h, the reason being that most of the tested e-bikes did not achieve maximum speeds above 24 km/h. Some of these bicycles – both EABs and EPBs – had power assist up to 30 km/h.

Figure 3
Perceptions of Maximum Power Assist Speed



On the basis of these observations, a correlation was established between the maximum speed to be adopted and the cyclists' feelings of safety on electric bicycles.

Figure 4
Feeling of Safety at Higher Power Assist Speeds



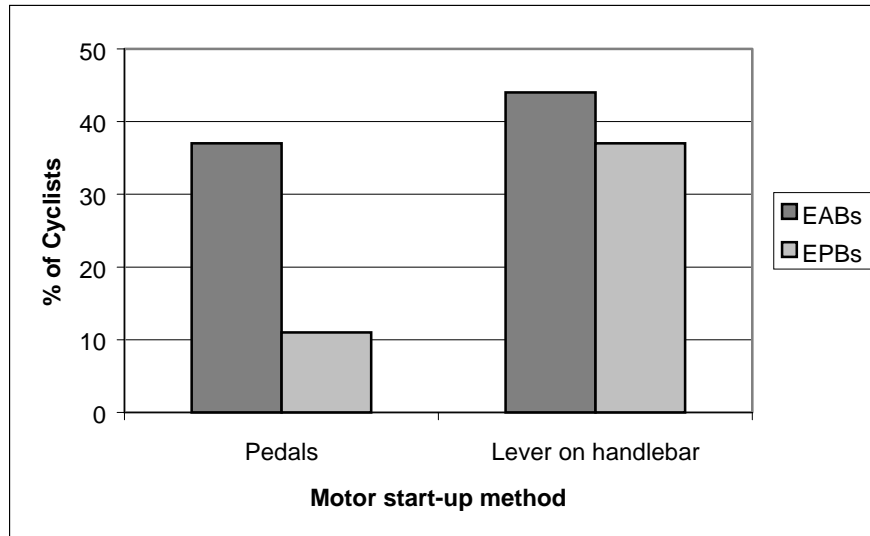
Most of the cyclists felt that e-bikes, whether assisted or self-propelled, were as safe and sometimes even safer than conventional bicycles. Only some 4 percent of the cyclists felt that increasing the speed would result in feelings of insecurity.

5.2.4 Impact of ergonomics on e-bike safety

Figure 5 shows that the cyclists thought it was safer to activate the motor using a lever attached to the handlebar. This view was shared by EAB users (37 percent approved).

The relevance of this suggestion is interesting because a large majority of the cyclists were not able to try both types of e-bike start-up methods.

Figure 5
Feelings of Greater Safety by Motor Start-Up Method



Many comments indicated that the cyclists' feelings of safety on an e-bike were often related to the design of the bicycle itself, particularly the motor control levers.

Although the EPBs seemed safer because of their start-up method, the following four comments about this type of bicycle suggest that improvements are necessary:

- "I have to let go of the lever to signal."
- "The motor lever on the handlebar is too hard to operate."
- "The lever for starting the motor is in a bad spot."
- "The motor control lever is in a bad spot; it should be placed on the right handlebar because the cyclist has to use the left hand to signal."

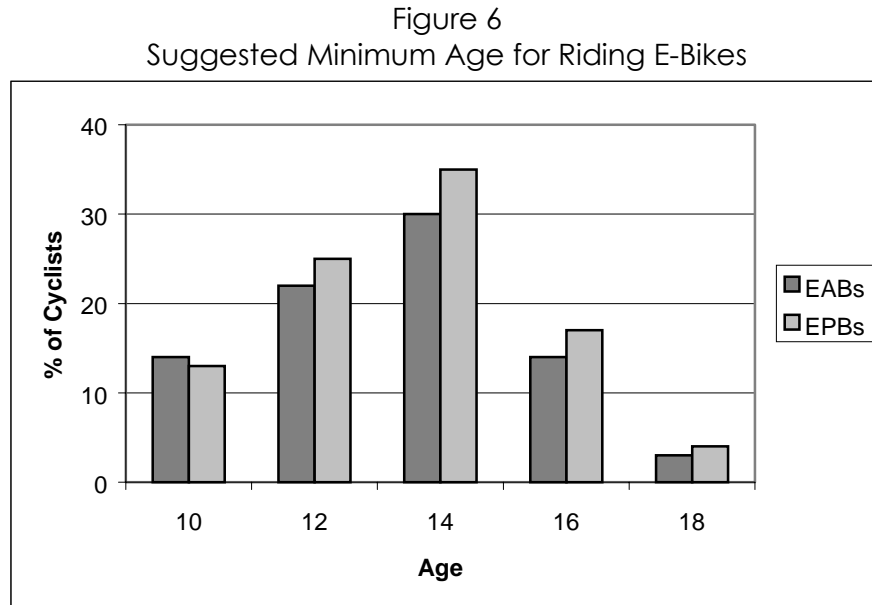
5.2.5 Protective helmets

Although current regulations state that cyclists are advised to wear protective helmets, they are still optional for riders of conventional bicycles. This study sought to determine volunteers' perceptions about wearing helmets when riding e-bikes. First, it should be explained that 78 percent of the cyclists wore helmets during the tests, even though CEVEQ formally advised everyone to wear a helmet! Of the total number of cyclists, 62 percent suggested that helmets be made mandatory for cyclists on e-bikes.

The data also revealed that 11 percent of the cyclists wanted to take special training in the use of e-bikes. This comment was difficult to assess because it was unclear whether they wanted to take a training course on how to operate an e-bike or simply be given more technical information on e-bikes.

5.2.6 Minimum age

Most of the cyclists (70 percent) felt that the required minimum age for riding an e-bike, either an EPB or EAB, should be at least 14 years. Figure 6 also shows that a large percentage (37 percent) felt that the minimum age could even be set at 12 years.

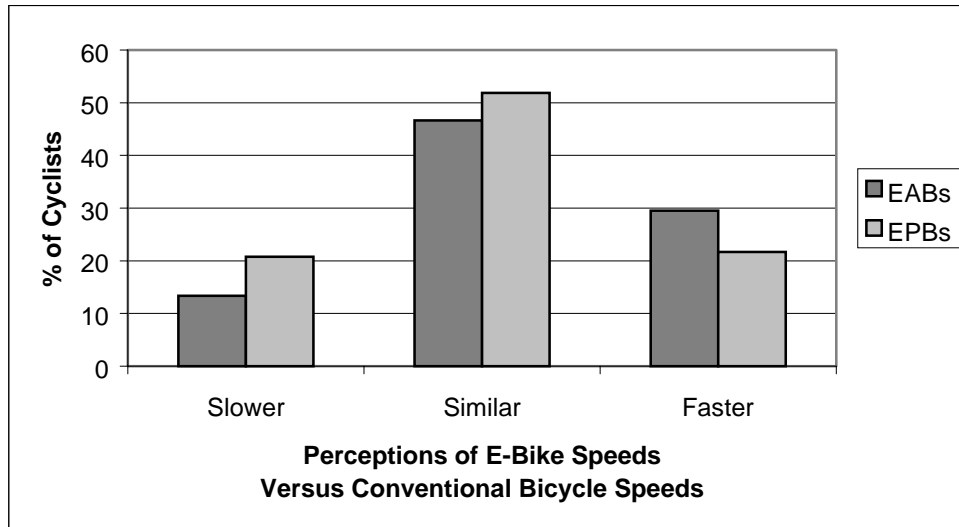


5.2.7 E-bikes versus conventional bicycles on bicycle paths

Cyclists who had opportunities to ride on bicycle paths, either to commute to work or for recreation, provided assessments of the handling capabilities of e-bikes, compared with those of conventional bicycles, on bicycle paths. In answer to the question “Do e-bikes belong on bicycle paths?”, 94 percent of respondents said yes and 3 percent said no. In all, 2 percent of cyclists felt that e-bikes were not suited because of their potential speed. After these answers were studied more closely, it was found that most of this 2 percent segment had ridden e-bikes with power assists that disengaged at 24 km/h. The notion of speed in this case remains questionable.

As shown in Figure 7, between 55 and 70 percent of volunteers felt that their travelling speed on a bicycle path was similar to or lower than that of ordinary cyclists (conventional bicycles), while 30 percent of EAB riders and 22 percent of EPB riders thought their speed was higher.

Figure 7
Perceptions of Electric versus Conventional Bicycle Speeds on Bicycle Paths



5.2.8 Highlights

In short, where e-bike safety is concerned, 90 percent of cyclists felt they were in control and more than 80 percent said they felt as safe on an e-bike as on a conventional bicycle. Weight, not the motor's maximum power assist speed, was the characteristic cited most often as a reason for feeling insecure. Most of the cyclists thought a maximum power assist speed higher than what they had experienced on the tested bicycles would be an additional safety factor. Moreover, a maximum power assist speed of 30 km/h was preferred.

The cyclists considered brake reliability and performance to be the most important safety components on both electric bicycles and conventional bicycles, although they wanted to see some improvement in these areas.

The cyclists also pointed out that e-bike ergonomics, particularly the location of levers, were important for operating safety. Close to two thirds of participants suggested that wearing protective helmets be made mandatory. Some 70 percent also thought that the required minimum age for riding an e-bike should be set at 14 years.

Lastly, with regard to whether e-bikes belonged on various thoroughfares to which they had access, more than two thirds of cyclists said they felt comfortable in city traffic, while close to 95 percent thought that e-bikes should be allowed on bicycle paths.

5.3 E-bike performance

5.3.1 Overall performance

Quebec cyclists

Participants were asked to evaluate the overall performance of the e-bikes and use their judgement to assign ratings from excellent to mediocre. To meet the objectives of this study, the performance of the EPBs was compared with that of EABs and no significant differences were found.

The following percentages in descending order represent the “excellent” or “good” ratings given by all of the cyclists:

This information confirmed the overall findings, namely, that weight was the least liked aspect. Speed was rated “excellent” by 15 percent of the participants and “good” by 30 percent. The other participants gave speed an “average” or “mediocre” rating.

Ontario cyclists

The results listed above can be compared with those of the Ontario cyclists who were asked the same questions:

Overall, there were many similarities between the perceptions of Quebec and Ontario cyclists. The major difference lay in their perceptions of e-bike weight, which the Ontario cyclists rated as “excellent” or “good”. The difference may be explained by the fact that the Quebec participants were allowed to keep their e-bikes for two weeks and were able to handle them much more (e.g., carry them up stairs, place them on bicycle racks, etc.). Battery recharging time was not mentioned because the cyclists could not test this characteristic.

5.3.2 Motor power

This study clearly established that cyclists felt the e-bikes were not fast enough. However, they liked the speed of acceleration, which made it easier for them to get back up to speed in difficult circumstances.

It is important to note that the key attraction of e-bikes was their ability to start up as quickly as possible and climb hills without difficulty. The collected data made it possible to compare the motor power of the two categories of e-bikes and assess user satisfaction rates.

Table 9 compares e-bikes equipped with motors with nominal power outputs between 100 and 250 W and those with motors with nominal power outputs between 250 and 400 W. The results show that motor power was not a determining factor in evaluating the power assist for hills and start-ups.

Table 9
Percentage Breakdown of Satisfied Cyclists by Motor Power Output

Motors with power output of 250 W or less	EABs (83 cyclists)	EPBs (28 cyclists)
Steep hills	24%	11%
Start-ups	80%	57%
Low or average hills	60%	68%
Motors with power output of more than 250 W	EABs (18 cyclists)	EPBs (77 cyclists)
Steep hills	17%	21%
Start-ups	44%	75%
Low or average hills	50%	62%

According to the Table 9 data, EAB riders had a higher satisfaction rate with less powerful bicycles. Although it is difficult to quickly draw conclusions, this surprising fact may be attributable to bicycle quality rather than motor power. It should also be noted here that the final numerical ratio between the chain-wheel and the gear ratio used at start-up has a direct impact on the bicycle's accelerating capacity because of the torque value applied to the rear wheel. This value directly affects the bicycle's capacity to start up quickly or climb steep hills easily.

In any case, these specific characteristics related to motor power certainly make it possible to dissociate motor power from e-bike performance. There may be other factors to take into account, such as motor location and gear-changing characteristics, before looking at motor power.

For the purposes of this project, the cyclists were also asked whether the motor should disengage according to the gear levels. In all, 44 percent of cyclists said yes and 36 percent said no. The other cyclists did not answer the question.

It was therefore very difficult to make firm observations about motor power for the following reasons: the EPBs were generally more powerful than the EABs; most cyclists did not test both types of e-bikes; and there was apparent confusion in the minds of some respondents between power and acceleration, and between speed and gear ratios or levels.

The cyclists were also not very satisfied with the performance of either type of e-bike on steep hills, regardless of motor power. It was, in fact, on steep hills that they made the greatest demands on the motor, which sometimes had difficulty providing enough assistance. In such cases, cyclists had to compensate by pedalling harder. However, on low or average hills, cyclists found the EPBs to be the most satisfactory vehicles.

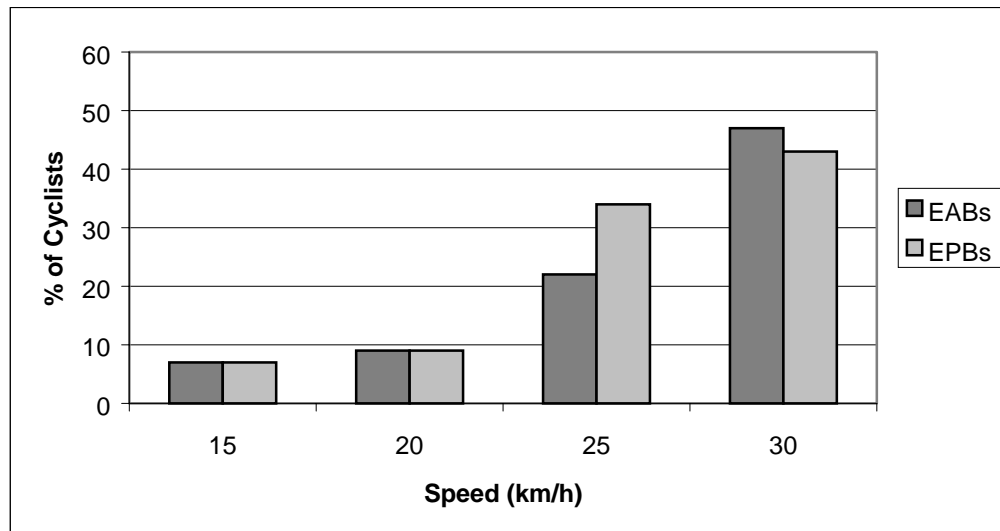
5.3.3 Maximum e-bike speed

It was found during the study that, depending on the cyclists' opinions of the e-bikes and their experience with conventional bicycles, there was considerable similarity in the speeds obtained with the bike in conventional mode and electric mode. According to the data collected on both EABs and EPBs, cyclists obtained average maximum speeds of about 30 km/h with or without power assist.

Once it is taken into account that the cyclists did not rely on the power assist of the e-bike motors to obtain higher speeds, it follows that the speed of e-bikes should at least be equal to the average speed of conventional bicycles. This was one of the reasons the vast majority of cyclists said they preferred that the motor assist them up to 30 km/h, as indicated in Figure 8.

The questionnaire gave cyclists a choice of several maximum assisted speeds. The selection of 30 km/h as the maximum speed was based on various considerations, including the preferences of some government authorities, perceptions of community stakeholders of what constitutes a reasonable, practical maximum speed, and practices in Europe where speeds above this level are not permitted.

Figure 8
Preferred Maximum Power Assist Speed



Most of the cyclists were understandably dissatisfied with motors that did not provide power assist above 23 km/h and saw no advantage in riding e-bikes at speeds below what they usually obtained. In addition, because e-bikes are heavier, cyclists also had to exert more effort above that speed than on a conventional bicycle.

5.3.4 Highlights

In terms of overall performance, Quebec and Ontario cyclists had similar evaluations and high levels of satisfaction relative to the following characteristics (in descending order) of e-bikes, whether they were EABs or EPBs: user-friendliness, braking, reliability and acceleration.

By comparison, the bicycle's weight, especially, and lack of power assist at high speeds were the least liked characteristics. In addition, many cyclists would have preferred greater power assist, especially on steep hills. Given that the maximum average speed obtained was approximately 30 km/h for both types of bicycles, with or without power assist, most cyclists said they also preferred a maximum assisted speed of 30 km/h.

5.4 E-bikes as a mode of urban transportation

Nowadays, transportation in urban areas is a complex economic, social and environmental problem. Since e-bikes may provide an alternative to increased pollution and urban congestion, this evaluation has sought to determine whether e-bikes could be an alternative way to commute to work.

5.4.1 Cyclists' current modes of transportation

Quebec cyclists

The following is a breakdown of the usual modes of transportation used by the 211 Quebec participants to commute to work:

- 44% by car
- 25% by bicycle
- 20% by bus
- 7% by subway
- 4% on foot

Ontario cyclists

The following is a breakdown of modes of transportation currently used by Toronto participants to commute to work:

- 27% by car
- 25% by bicycle
- 18% by public transit
- 14% on foot

5.4.2 Reasons for commuting to work on e-bikes

Quebec cyclists

When asked what would encourage them to ride an e-bike to their place of work, 79 percent of cyclists said that physical exercise was the main reason. For 51 percent, environmental concerns and reducing pollution were an incentive, while for 41 percent, the low cost of e-bike use was a major reason.

Close to two thirds of the participants (64 percent) were prepared to use e-bikes to commute to work. Of those who usually travelled by car, the percentage climbed to 65 percent, while for bicycle users, the rate was 71 percent. Many people are clearly attracted by the new technology.

Cyclists felt that e-bikes were well suited for commuting to work. Forty-four percent expressed this opinion, as opposed to 9 percent who thought e-bikes should only be used for recreational purposes.

E-bikes cost between US\$1,000 and US\$3,000, which may seem expensive at first, but when the cost of electricity for recharging the battery (i.e., just a few pennies), and the lower expenditures incurred with this mode of transportation (less money spent on parking, gas, maintenance and purchasing or leasing a second vehicle, for example) are taken into account, it can be advantageous to buy an e-bike.

Ontario cyclists

As previously mentioned, volunteers in this part of the evaluation did not have sufficient time to form strong opinions on e-bikes. However, they were forthcoming in their opinions about the possible uses for e-bikes. When asked to give their straightforward, unreserved assessments, they said that e-bikes could be used instead of cars for commuting to work, occasional travel and recreation.

Other results were similar to the Quebec findings: 37 percent of respondents believed that e-bikes were suitable for commuting to work, while 23 percent said they were only suitable for recreation owing to the limited range of the battery (30 km on average).

Moreover, 68 percent of the participants who filled out the questionnaire were interested in using e-bikes to commute to work for environmental reasons, greater speed in traffic and the benefits of cycling (physical exercise in the fresh air) without having to worry about hills and adverse weather conditions (heat and wind).

However, they found it difficult to believe that the city would allow unrestricted use of e-bikes. A similar percentage as in Quebec – 34 percent – did not believe that the city would give cycling commuters priority by adopting supportive measures.

In reply to the question “In your situation, do you think that the e-bike can replace the car for: (1) commuting to work; (2) occasional travel; (3) recreation?”, the respondents, who were allowed to check off several answers, provided 251 data items. According to the data, more than half of the cyclists (83 out of 158) would commute to work on an e-bike instead of by car. This percentage shows that e-bikes are perceived as a mode of transportation for both commuting to work and recreation.

5.4.3 E-bike advantages

When asked about the advantages of e-bikes, respondents said that they made it easier to climb hills (59 percent), ride into the wind (58 percent) and travel in the open air (51 percent). Their liking for the e-bikes' hill-climbing ability was quite understandable given that 84 percent of cyclists could not avoid hills when commuting to work. Regardless of whether they had ridden EABs (42 percent) or EPBs (45 percent), 88 percent of respondents said the e-bike made their rides easier.

Similarly, 79 percent of volunteers said the e-bikes enabled them to expend less effort and sweat while riding, and 59 percent said this mode of transportation was now a significant option for them.

5.4.4 Influence of external factors

With regard to external factors influencing the use of e-bikes, 79 percent of cyclists said they were very influenced by the weather. Fear of adverse weather conditions, such as rain (71 percent), was the major drawback, with appropriate apparel following far behind (35 percent).

5.4.5 E-bike parking

Further to the topic of commuting to work by e-bike, the study confirmed that 74 percent of cyclists were able to find safe parking for their e-bikes at work. The cyclists believed (64 percent) that their employers would make arrangements to provide them with safe parking, if necessary. This was a significant finding because 56 percent of respondents felt that there were not enough parking spots for conventional bicycles. In addition, 89 percent said that during the test phase, they had places that were considered suitable for parking their e-bike.

Theft was a concern for many of the cyclists, who rightly thought these bicycles would be very attractive to thieves. Anti-theft devices need to be improved in most cases to prevent thefts of bicycles and batteries. Some bicycles were difficult to lock in the parking spots provided.

Companies could therefore provide safe parking places for their fitness-minded employees, which would naturally promote the use of e-bikes.

5.4.6 Use of bicycle paths

The e-bike users said they rode mostly on bicycle paths for recreational purposes (65 percent) because they did not think (34 percent) that the city in which they lived gave priority to cycling commuters.

However, of those who used e-bikes to commute to work, 49 percent preferred to ride them on bicycle paths. Furthermore, 9 percent did not think that motorists were accommodating toward them.

An e-bike weighs between 27 and 35 kg, which makes it difficult to carry or set in motion from a stationary position. In their comments, many cyclists expressed disappointment about not being able to transport most e-bikes on the bicycle racks of their cars, because of their weight and shape.

5.4.7 Highlights

Nearly two thirds of respondents said that the primary reasons they were prepared to use e-bikes as a mode of transportation for commuting to work were exercise and environmental concerns. They also mentioned the ability to deal more easily with physically demanding situations as a key advantage.

Most respondents also said they were able to park their e-bikes in a safe place when they got to work. However, possible theft of their bicycle was a concern for many. Almost two thirds of the cyclists rode the e-bikes on bicycle paths.

5.5 Project impact

The project was given outstanding press coverage. Although it is difficult to provide the exact content of the coverage, many newspaper articles, television and radio interviews, and special televised features were produced after each press conference. See Appendix B for a list of newspaper articles and radio/television coverage particulars.

Overall, the Electric Bike 2000 Project generated considerable interest and excitement.

5.5.1 Impact on the public and cyclists

The public was unaware of this new type of bicycle because it has not been marketed in Canada.

The project significantly enhanced the visibility of e-bikes and helped raise public awareness of the importance of developing non-polluting modes of transportation. The project promptly received extensive media coverage; CEVEQ was inundated with interested visitors; and telephone calls were received from many potential e-bike users.

The cyclists were also keenly interested in the experiment in which they participated and in the e-bikes themselves. Very few withdrew from the project after their initial involvement. They were also conscientious and thorough in filling out their evaluation questionnaires.

5.5.2 Impact on government authorities

It should be remembered that this project was developed jointly with Transport Canada, Transport Quebec and the Société de l'Assurance Automobile du Québec, and that the results were intended to be a relevant source of information for drafting government regulations.

Various government departments and agencies provided encouragement for this environmental initiative by providing funding and involving their employees.

This evaluation gave the Ontario Ministry of Transportation, through the Moving the Economy (MTE) organization in Toronto, an opportunity to observe the tests and assess the relevance of amending its policy and regulations relative to e-bikes.

5.5.3 Impact on participating organizations

Participating firms were very pleased with this innovative project and encouraged their employees to commute to work on e-bikes. They also helped set up internal mechanisms to co-ordinate the bicycle testing.

Aside from its environmental character, participatory nature and overall scope, the project enhanced the corporate images of the participating organizations.

E-bike manufacturers benefited from the media coverage and through their participation obtained useful information on cyclists' perceptions of their various products as well as improvements they wished to see incorporated in the bicycles.

6. CONCLUSIONS

That the Electric Bike 2000 Project was a tremendous success can be seen in the level of interest it generated in cyclists and participating organizations. Moreover, the sustained media attention received throughout the evaluation project was an indication of the enthusiasm felt for this new mode of transportation.

Because the e-bikes were tested in actual-use situations by people of all ages in various cities, the study and its findings are widely applicable.

6.1 E-bike safety

The study showed that cyclists did not view the e-bikes as a safety risk, whether they were assisted (EABs) or propelled (EPBs) by a motor. The test findings also showed that both types of e-bikes were considered equally safe. It was suggested that no restrictions on motor start-up methods should be included in the new regulations.

6.2 E-bike performance

The survey findings clearly indicated a feeling of dissatisfaction among cyclists who tested e-bikes with a limited speed of 24 km/h, which was lower than the usual speed they obtained on conventional bicycles. Above this speed, the cyclists had to exert much more effort than on conventional bicycles to compensate for the weight of the bicycles. Top priority should therefore be given to reducing the weight of the bicycles. Based on cyclists' observations, an increase in the power assist speed to 30 km/h would provide greater latitude without compromising safety.

With respect to the variations in motor power of the e-bikes, it was noted in some cases that motors with low power output made more work for the cyclists who had to compensate by pedalling harder. The ideal e-bike for cyclists would be one on which they could pedal at the same pace up hills and along flat stretches. The motor should be able to compensate for the additional energy required to pedal up hills.

6.3 E-bikes as a mode of urban transportation

The study found that most of the cyclists were prepared to use e-bikes for commuting to work primarily because they provided good physical exercise within an ecological framework while providing power assistance in difficult parts of their journey.

The findings also revealed that improvements should be made in urban communities to make them more accommodating for e-bike users and thus enhance conditions for e-bike use in general.

Because e-bikes have good acceleration and can easily weave through traffic, cyclists can quickly react and avert situations that may compromise their safety. The tests demonstrated that e-bikes could become very popular and replace automobiles as a way to commute to work, particularly in warm weather.

6.4 Future of e-bikes

E-bikes admittedly have little appeal for competitive cyclists or mountain bike enthusiasts. However, they are a feasible mode of transportation for commuting to work or travelling short distances.

During these tests, many people were attracted to the e-bikes, which rekindled their interest to travel by different means than a car. Some of them had given up on conventional bicycles because it was difficult to climb the steep hills on their route. Others were hesitant about riding bicycles because of weather conditions.

The evaluation results and the excitement generated by this new vehicle suggest that a segment of the population would leave the car at home and commute to work by e-bike, at least in fine weather.

Seniors and people with respiratory conditions, cardiovascular problems or muscular disabilities can rediscover the pleasures of cycling without having to expend a lot of physical effort.

It appears that a new market niche will open up for e-bikes without compromising the traditional bicycle market. As with conventional bicycles, the more varied the choice of e-bikes, the greater the number of consumers who will find a product that meets their needs.

7. RECOMMENDATIONS

7.1 Cyclists' needs

Further to analysing the answers obtained from participating cyclists in the e-bike evaluation and the conclusions drawn, the study outlined the following needs of potential customers that must be met to promote the use of e-bikes:

- Maximum electric power assist speed up to 30 km/h;
- A high-performance, ergonomic product capable of assisting cyclists on steep hills and providing good acceleration;
- A lighter product;
- A product equipped with accessories that promote greater safety in urban environments (rearview mirror, lights, saddlebags and effective brakes);
- Improved anti-theft devices to prevent the theft of bicycles or batteries;
- Safe parking places provided by employers for fitness-minded employees.

7.2 Government regulations

For the purposes of government safety regulations, the study raised the following points:

- It was found that motors with the highest power outputs did not provide the e-bikes with the greatest amount of power assist. The regulations currently proposed by Transport Canada do not cover this aspect. However, it would be worthwhile to enact regulations on acceleration speeds rather than motor power so as not to restrict research and development in the e-bike industry;
- Because the test results demonstrated that both types of e-bikes (EABs and EPBs) were equally safe, it is recommended that no restrictions on the type of power assist provided by the motor be included in the new regulations.

APPENDIX A

SUMMARY OF QUALITATIVE ANALYSIS OF CYCLISTS' COMMENTS

Introduction

The approach used in the methodology, as described in section 3 of the report, gave respondents very little leeway in their answers, except for a space reserved for personal comments. These comments provided additional elements for the responses to the questionnaire and reflect the perceptions of a certain number of cyclists, keeping in mind that not all respondents provided opinions and that respondents were free to provide details according to their interest in the subject.

More specifically, the analysis was designed to identify a certain number of elements that would group respondents' comments having similar subject matter and put them in a more consistent form. This was done to extract potentially useful information that had not been provided in the answers to the questions.

Comments were classified according to the following categories: acceleration, minimum driving age, range, control, brakes, interest in this mode of transportation, weight, power, safety and speed. A short qualitative analysis of these comments was carried out.

Overall perceptions

There were 211 participants in these tests. On average, each participant commented on two of the ten characteristics described above and, altogether, there were 441 comments. However, interest in this mode of transportation, weight, speed, range and safety – in descending order – were the e-bike elements that generated more interest on the part of the respondents (all categories of electric bicycles combined).

Surprisingly, volunteers were less interested in elements such as acceleration, minimum driving age and motor power. Because of this low level of interest, these elements are not dealt with in the following paragraphs.

Interest in e-bikes as a mode of transportation

It was found that 87 percent of test participants expressed in their comments an interest in e-bikes as a mode of transportation. These comments represent 37 percent of the total number provided.

Among the overall observations, some interesting comments made about both types of e-bikes include the following:

- With an e-bike, I am much less short of breath and exert less effort in windy conditions and on hills;
- E-bikes give older people and those with heart conditions and other problems the chance to exercise and get back into cycling again;
- E-bikes are not very advisable for long trips in power-assist mode because of their limited range; they are better for short trips;
- E-bikes are too expensive in comparison with conventional bicycles;
- E-bikes can reduce pollution and congestion in urban centres;
- E-bikes make it easier to stop and start frequently in city traffic;
- Greater provision should be made for e-bikes in city traffic (lack of bicycle paths, pavement in poor repair and lack of services).

Many other comments were made about a broad range of accessories and equipment, most importantly the following:

- Need for a very reliable anti-theft system;
- E-bike frame is not suitable for conventional bicycle racks;
- Need for headlight, mirrors, horn, saddlebags and mudguards.

Speed

Nearly 34 percent of cyclists commented on this characteristic, which accounted for nearly 15 percent of all comments received. It was found that many cyclists seemed to confuse the concept of travelling speed with front and rear wheel gear ratios and levels.

Cyclists generally complained that their e-bikes performed poorly in terms of speeds achieved with power assistance from the motor. It was more difficult to reach or maintain normal cruising speed than with conventional bicycles.

Many cyclists also complained about an insufficient number of gear ratios, which did not help them reach the desired or appropriate cruising speed.

Weight

About 32 percent of cyclists commented on this aspect of the e-bikes, which accounted for about 14 percent of all comments made.

Regardless of the type of e-bike, EAB or EPB, cyclists preferred a lighter bike. The following are the comments most frequently made about this characteristic:

- The gains achieved on hills are lost on the flat stretches;
- It is difficult to lift the bike onto the sidewalk, place it on the roof of a car or position it on a bike rack;
- There is too much weight in relation to its maximum speed;
- The bicycle's weight should be distributed better;
- The weight noticeably increases acceleration when you go down hills.

Range

Some 25 percent of cyclists commented on the e-bikes' range, which accounted for about 10 percent of the total number of comments. The range in power-assist mode was generally rated as insufficient.

The following are some typical comments:

- Hills reduce the range of the bicycles significantly;
- The limited range of the battery causes stress because the charge runs out quickly;
- Two chargers are needed: one at work and one at home;
- The range is too limited to use the e-bike for recreation.

Safety

About 18 percent of participants commented on the safety of the e-bikes, which accounted for nearly 7 percent of all comments. E-bike safety was not an element identified by cyclists as a factor that would limit the use of this new mode of transportation. None of the cyclists said that this type of bicycle was potentially dangerous or unsafe for their physical well-being because of the power-assist feature.

Contrary to expectations, feelings of insecurity were associated more specifically with the bicycles' technical components, for example:

- A pedal touches the ground (crankset too close to the ground);
- The battery is unstable during travel;
- The location of the accelerator lever can be mistaken for that of the brake lever;
- The positioning of the motor is a cause for concern (possible burns) or start-up problems (rider must turn to start it);
- There is a risk of falling if going up on a sidewalk diagonally;
- The motor slides on the wheel when it rains.

The following comments indicate that the e-bikes are a fairly safe mode of transportation:

- The power assist is not a factor in reduced safety;
- The e-bike is safer than a conventional bicycle.

Overall findings

The comments provided by participants are reflected in the report's conclusions. They show that the cyclists were very pleased for the most part with this mode of transportation and in favour of its further development. They would like to see changes made to e-bikes, as with conventional bicycles, to make them more suitable for all types of users.

There was also nothing to indicate that this mode of transportation posed a risk for users, especially since it was viewed as a wise choice for seniors and people with disabilities, and because volunteers chose not to say anything in their answers to suggest that electric bicycles were in any way unsafe. This is significant in light of the study's specific objective to determine whether electric bicycles are potentially dangerous.

APPENDIX B

LIST OF NEWSPAPER ARTICLES AND RADIO/TELEVISION COVERAGE

The following is an incomplete list of newspaper articles and electronic media coverage following CEVEQ's implementation of the study's communication strategy.

Newspapers

<i>Le Soleil</i>	"Ça roule, ces vélos électriques," June 14, 2000
<i>Le Journal de Québec</i>	"Vélos électriques," June 14, 2000
<i>Le Devoir</i>	"Vélos branchés," July 1, 2000
<i>Le Nord</i>	"Des vélos électriques à Saint-Jérôme," July 5, 2000
<i>Le Devoir</i>	"À quand des rues réservées au vélo à Montréal?" July 12, 2000
<i>La Presse</i>	"Le vélo électrique pour vaincre la pollution," July 12, 2000
<i>The Montreal Gazette</i>	"Electric Bikes, A Threat to Sweat," July 12, 2000
<i>Le Messager Lachine Dorval</i>	"Je roule électrique au travail," July 16, 2000
<i>Le Soleil</i>	"Vélos électriques à l'essai," July 26, 2000
<i>Today</i>	"City to Study Electric Bikes as Solution to Traffic Pollution Woes," August 17, 2000
<i>The Globe and Mail</i>	"From Sweat to Svelte: Electric Bikes Promise Pep Without Perspiration," August 18, 2000
<i>The Toronto Star</i>	"Electric Bikes to Get Trial Run", August 18, 2000
<i>National Post</i>	"Pilot Project Promises to Empower Cyclists," August 18, 2000
<i>Accès Laurentides</i>	"400 cyclistes propulsés à l'électricité," September 29, 2000

Radio coverage

Radio-Canada	July 11 & 12, 2000
CKAC	July 13, 2000
CIME FM	July 17, 2000
CKOI	July 19, 2000
Radio Ville-Marie	July 15, 2000

Television coverage

TQS; Radio Canada; TVA; RDI; LCN; "Technofolies" show on Canal Z; Télé Québec; and various Toronto television stations.