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Test drive the future with eTV



## WELCOME TO eTV's *green* WHEELS

Welcome to the Spring 2011 edition of eTV's Green Wheels, the ecoTECHNOLOGY for Vehicles (eTV) program's quarterly e-newsletter.

The last few months have been busy ones for the eTV team. We have been busy testing electric vehicles, studying new tire technologies and building partnerships with industry. You can read about these activities, and more, in this edition of *Green Wheels*.



### In this edition you will:

- Find out how the Honourable Chuck Strahl, former Minister of Transport, Infrastructure and Communities, and Mr. Koji Soga, President and Chief Executive Officer of Mitsubishi Motor Sales of Canada, marked the official start of testing on the Mitsubishi i-MiEV;
- Learn more about the first Canadian public on-road multi-driver evaluation of a battery electric vehicle, conducted by eTV in the National Capital Region;
- Discover what happens to EV batteries at the end of the vehicle's life;
- Learn all about eTV's partnership with the Canada Museum of Science and Technology;
- Discover how tires and their rolling resistance characteristics can have an effect on vehicle fuel consumption;
- Find out what happened at the eTV forum;
- Discover out what lies ahead for eTV.

We hope that you will find the eTV program updates in this newsletter as exciting as we do. Visit the website at [www.tc.gc.ca/eTV](http://www.tc.gc.ca/eTV) to find out more about eTV.

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## What are Battery Electric Vehicles?

Battery electric vehicles (BEVs) do not have an internal combustion engine. They are powered by an electric motor and batteries (usually lithium-ion). Compared to conventional vehicles, EVs have a performance advantage in city driving conditions. They can be charged on a 110 V or 220 V outlet. As well, they have zero tail pipe emissions and low 'lifecycle emissions' because of Canada's clean energy supply.



## eTV Signs an Agreement with Mitsubishi Motor Sales of Canada to Test BEVs in Canada

As previously reported, Transport Canada (TC) signed a Memorandum of Understanding with Mitsubishi Motor Sales of Canada to test the i-MiEV battery electric vehicle in Canada.

The Honourable Chuck Strahl, former Minister of Transport, Infrastructure and Communities, and Mr. Koji Soga, President and Chief Executive Officer of Mitsubishi Motor Sales of Canada, officially celebrated the signing of a Memorandum of Understanding between the Department and the automaker, and marked the start of testing in early September 2010.



Since July 2010, over 10,000 kilometres of laboratory and on-road testing have been completed on two i-MiEVs. The vehicles have been equipped with state-of-the-art sensors and data acquisition equipment that have allowed eTV to gather information on how electric vehicles behave in a variety of Canadian road and climate conditions.



In addition to testing the vehicles at various temperatures in laboratories, eTV used test facilities in Vancouver to evaluate the i-MiEV's performance in temperatures as low as -20 degrees Celsius.

Test results will also help to measure the energy consumption of these vehicles.

In this way, eTV is helping Canadians to better understand BEVs and their potential environmental benefits in Canada. eTV plans to publish results on its testing and evaluation of various electric vehicles in an aggregated report in Summer 2011.

## What did the evaluators tell us?

Prior to participating in the driver evaluation, participants had little or no experience with battery electric vehicles. After driving the i-MiEV, they were impressed by the vehicle's performance, ease of handling, power and acceleration. Most reported that the i-MiEV's performance in these areas was comparable to the performance of their gasoline-powered vehicle.

Evaluators further reported that vehicle instrumentation and layout was intuitive, which facilitated their transition from a conventional vehicle. eTV is currently compiling the results of the driver evaluation study. Results will help eTV understand how average Canadian drivers will experience a transition to an electric vehicle, and better understand how the technology will perform on Canadian roads.

## Driver Profiles

- Total of 45 drivers/evaluators;
- Average evaluator travels between 10-15 km during 1.5-hour evaluation and 30-80 km during 24/72-hour evaluation;
- Driver training and orientation provided prior to evaluation;
- Operated down to -20°C.

## eTV Takes the Mitsubishi i-MiEV on the Road

In 2010-2011, during a typical winter season in Ottawa, eTV conducted one of the first Canadian public on-road multi-driver evaluations of a battery electric vehicle, the Mitsubishi i-MiEV. The purpose of the evaluation project was to study how average Canadians who have little or no prior knowledge and ideas about BEVs experience the technology in the real-world.

From January 6 to February 15, 2011, eTV coordinated three driver evaluation programs:

- a 72-hour (weekend) evaluation, designed to simulate a primary family vehicle;
- a 24-hour (overnight) evaluation, designed to simulate a primary commuter vehicle;
- a 1.5 hour test drive (guided evaluation) with a technology expert, to introduce Canadian drivers to a battery electric vehicle.

eTV used different tools to gather information. Each driver, regardless of the type of evaluation involved, was asked to complete an evaluation questionnaire. As well, drivers who volunteered for the 24-hour or 72-hour evaluations were interviewed one-on-one when they returned the vehicle. And finally, some drivers participated in a focus group session, during which they could exchange views with other drivers/evaluators about their experience.



## Why Test BEVs?

After years of research and development, manufacturers are beginning to introduce BEVs in North America. To inform consumers about these technologies, and to accurately measure their energy consumption and performance, governments need new BEV test procedures and protocols. Transport Canada also needs to understand how unique Canadian conditions, including harsh winter weather, will these technologies. This is why eTV has been working with industry to test several different BEVs in Canada.

# Reducing the Impact

## Decommissioning the Batteries in a Battery Electric Vehicle

Several electric vehicle enthusiasts have asked us what happens to EV batteries at the end of the vehicle's life. To answer this question, eTV recently researched a number of ways to decommission the batteries in one of its first test vehicles – a Hybrid Technologies EV Conversion.

This electric vehicle was retrofitted from a gasoline internal combustion engine vehicle in 2007. Several modifications were made to the vehicle to accommodate the batteries and power management systems. The vehicle's batteries consist of 10 battery packs, with a total capacity of 29 kilowatt-hours and a total weight in excess of 200 kilograms. Since the vehicle was imported into Canada under special conditions, it had to either be exported or destroyed once testing was complete.

The process of decommissioning batteries in an environmentally sensitive manner begins by depleting them to a near-zero state of charge. They are then removed by trained personnel using electrical safety gloves and insulated tools to protect individuals from electric shock.

The batteries are shipped to a battery recycling company capable of recycling large lithium-ion batteries. Metals such as lithium, manganese, nickel and cobalt are extracted from the battery for use in other applications, thus reducing the technology's carbon footprint. In the case of eTV's Hybrid Technologies EV Conversion, once the battery has been safely removed and disposed, the vehicle chassis will be recycled.



# Just Around the Corner

## Working with the Canada Science and Technology Museum (CSTM)

The eTV program is pleased to once again have had the opportunity to work with the CSTM on *Just Around the Corner*. This exhibition area is part of the broader *In Search of the Canadian Car* exhibit, which opened in June 2010. The larger exhibit looks at how our national identity can influence the manufacturing, creation and marketing of cars in Canada, as well as the choices that Canadian consumers make in terms of the cars they drive.

The *Just Around the Corner* exhibition area highlights technologies that could one day be found in the cars that populate Canadian roads. The primary objective is to explore some of the perceptions that Canadians have about electric vehicles. The Tesla Roadster, one of eTV's fleet vehicles and the first battery electric vehicle to be sold in Canada, was recently on display in the museum until April 2011. This fully electric car proves that you don't have to sacrifice innovative design and performance for the sake of the environment. It can travel nearly 400

kilometres on a single charge of its lithium-ion battery, and can go from 0 to 100 km/h in 3.9 seconds.



## Steady-State Rolling Resistance Co-efficient

A comparative parameter that defines how much force is used to deform a tire to maintain the contact patch of the tire on a surface at a constant speed. The steady-state rolling resistance coefficient can be measured at a standard reference condition (a function of the tire's maximum load and base inflation pressure) or at a special condition (a function of the vehicle's load and recommended tire inflation pressure).

## Rolling Out Preliminary Results on Rolling Resistance

The eTV program conducts in-depth testing of advanced emissions-reducing technologies for use in light-duty vehicles. Low rolling resistance (LRR) tires are one such technology tested by eTV. Tires and their rolling resistance characteristics can have an effect on vehicle fuel consumption. Increasingly, tire manufacturers are seeking to develop tires with low rolling resistance, while still maintaining very good uniform tire quality grading (UTQG) ratings.

The eTV program undertook a pilot study on LRR tires to:

- evaluate the extent to which rolling resistance can reduce fuel consumption;
- determine whether rolling resistance coefficients can be used to compare the environmental benefits of tires;
- quantify the time a vehicle is able to coastdown for a predetermined reduction in rolling resistance;
- assess whether rolling resistance has an impact on dry braking distances.

The tires selected for testing cover a variety of parameters, including different vehicle sizes (compact, mid-size, full size), tire widths, tire profiles, rim sizes, manufacturers, all-season and winter tires. Because this was a preliminary study, it was decided to limit the study to tires that can be fitted on 15-inch and 16-inch rims. These sizes are common in Canada, and represent a large percentage of light-duty tire sales.

A total of twenty-five different tires underwent laboratory and on-road testing to determine steady-state and dynamic rolling resistance coefficients.

The pilot study explored the impact of rolling resistance on the dry braking distance of the tires tested. Although the dry braking distance for the ten tires tested was well below the Canada Motor Vehicle Safety Standard of 70 metres at 100 km/h, given the limited sample size, further study is needed to be able to draw definitive conclusions.

Regarding the coastdown time, the initial premise was that lower rolling resistance would translate into a longer coastdown time. That was indeed the case for the 25 tires tested, with the lowest rolling resistance tire coasting 15% longer from 105 km/h to 15 km/h. In practical terms, this study demonstrated that a vehicle equipped with lower rolling resistance tires requires less energy to overcome rolling resistance. And the less energy needed to overcome rolling resistance, the less fuel is needed to power the vehicle and the greater the environmental benefits.



The study found that, for the 25 tires tested:

- the difference between the tires having the highest and the lowest steady-state rolling resistance coefficient was 39% at standard reference conditions and 32% at special conditions;
- the difference between the tires having the highest and the lowest Standard Mean Equivalent Rolling Force (SMERF) was 46%;
- in real-world testing, a 30% difference was found between the stock tires and the low rolling resistance replacement tires.

A report from the National Research Council of the Academies suggests that “A 10 percent reduction in average rolling resistance would translate to a 1 to 2 percent reduction in passenger fuel consumption” (*Tires and Passenger Vehicle Fuel Economy*. National Research Council of the National Academies, 2006, p. 106). Using this study as a reference, the pilot study found a 3.0% to 4.6% improvement in fuel consumption over the standardized laboratory driving cycle and in real-world testing. Each 1% reduction in fuel use translates into a reduction of 40 kg of CO<sub>2</sub>. For the average vehicle travelling 20,000 km annually, the use of low rolling resistance tires could therefore result in a reduction of up to 120-180 kg of CO<sub>2</sub> per year.

The eTV pilot study also looked at how rolling resistance affects three variables: treadwear, traction and cost. Here’s what we found for the 25 tires tested:

- Low rolling resistance tires did not seem to wear out faster.
- Rolling resistance did not appear to affect wet traction. All tires tested displayed good to excellent wet traction capabilities, with an asphalt deceleration rate of higher than 0.47 g (4.61 m/s<sup>2</sup>).
- There was no direct relationship between rolling resistance and tire price. The tires with the lowest rolling resistance had an average price of \$143 per tire. The average cost of conventional replacement tires is about \$130 per tire. Based on eTV’s sample, buying a set of four tires with a low rolling resistance coefficient could cost up to \$52 more than a set of conventional tires. However, if we consider that the average Canadian spends about \$2,000 a year on fuel, each 1% reduction in fuel use equals approximately \$20 in savings per year. A 3.0% to 4.6% improvement in fuel consumption could therefore mean a savings of \$60 to \$92 per year.

The preliminary evidence in this pilot study suggests that rolling resistance coefficients can be a good indicator of the fuel efficiency savings that a tire can generate. A tire with a lower rolling resistance coefficient requires less energy to deform, resulting in lower fuel consumption and reduced emissions for light-duty vehicles. As such, rolling resistance coefficients can be used to compare the relative environmental benefits of different tires.

## Dynamic Rolling Resistance Co-efficient

A comparative parameter that defines how much force is used to deform a tire in order for it to maintain contact with a surface at different speeds. The dynamic rolling resistance coefficient can be measured at a standard reference condition (a function of the tire’s maximum load and base inflation pressure) or at a special condition (a function of the vehicle’s load and recommended tire inflation pressure).



## From Testing to Reporting Results eTV Forum Was a Great Success

Over the past four years, the eTV program has worked with government, industry and academics to test and evaluate the performance of more than 50 different advanced technologies for passenger vehicles. Through these activities, the program has gathered information about emerging vehicle technologies that we wanted to share with colleagues across government. Therefore, on March 24, 2011, eTV hosted an *Advanced Vehicle Technology Forum* and Vehicle Demonstration at the Canada Science and Technology Museum. This event was the first of its kind, and gathered participants from various government departments and agencies, notably Environment Canada, Canadian Space Agency, Industry Canada and Natural Resources Canada, among others.

The forum began with opening remarks by Mary Komarynsky, TC's Assistant Deputy Minister, Programs, and Denise Amyot, President and CEO of the Canada Science and Technology Museums Corporation. Throughout the day, participants had the opportunity to learn about and discuss advanced vehicle technologies with their colleagues from TC and other departments. eTV presented key test results on battery electric vehicles, anti-idle systems and low rolling resistance tires, among others. These test results are being used to help inform the development of new protocols and standards for the next generation of advanced vehicle technologies in Canada.

Representatives from other federal departments presented on a variety of topics, which included an update on the *Electric Vehicle Technology Roadmap* by Natural Resources Canada, an overview of Canada's *Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations for Model Years 2011-2016* by Environment Canada, and a presentation on the Canadian Science and Technology Museum's educational outreach activities.



## Intriguing and Informative

Those in attendance found the event to be both very intriguing and informative. One participant explained that it offered a “rich and diversified set of viewpoints from several departments.” Moreover, another participant shared that the event “made it possible to get the latest information in fields of work not usually accessible to us from our department.”

## Parting Thoughts

If you are interested in learning more about how certain technologies work, we invite you to visit the eTV website and browse through our new series of animations at [www.tc.gc.ca/eTV](http://www.tc.gc.ca/eTV).

Until next time,  
*The ecoTECHNOLOGY for Vehicles Team*

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