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Test drive the future with eTV

WELCOME TO eTV's green WHEELS

Testing ... Evaluation ... Results.

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

We are excited to present this edition of *eTV's Green Wheels*, because it highlights some of the program's latest test results.

In this edition, you can read more about how new anti-idle technologies perform in Canada (see smart fortwo mhd), which clean diesel technologies are on the horizon (see VW Polo Bluemotion TDI), and how plug-in hybrids stand up against Canadian standards (see Hymotion-Prius).

We hope you enjoy learning more about the vehicles and technologies that eTV has been testing over the past year. As always, to learn more about eTV and its many activities, please visit our website at www.tc.gc.ca/eTV.

eTV's Test Results – Helping Test Driving the Future

Advances in automotive technologies are occurring at a fast pace. Every day, manufacturers are developing new technologies to meet stringent greenhouse gas (GHG) emissions regulations and to address concerns about fuel prices and the environment.

The following articles provide an overview of eTV's in-depth evaluations of three different advanced technologies from around the globe, including anti-idle, clean diesel and plug-in hybrid electric technologies.

Each article provides background information on eTV's objectives in evaluating the technology, potential barriers identified, the partnership and the vehicle, and then outlines what was tested and what results were obtained.

Finally, there is a discussion of what these results mean for Canadians and what the next steps are for the eTV program.

smart fortwo mhd

The Technology

The eTV program selected the smart fortwo micro hybrid drive (mhd) for testing and evaluation because, in addition to its attributes as a fuel-efficient vehicle, this European variant of the smart fortwo contains an advanced idle start-stop system.

Anti-idling or start-stop technology is designed to reduce fuel consumption and exhaust emissions during periods of stop-and-go driving that is typical of urban environments. These systems are relatively rare within the Canadian market, and are generally limited to passenger vehicles that are full hybrids. The idle start-stop technology, combined with the base smart's existing fuel efficient performance, made the smart fortwo mhd an ideal vehicle for inclusion in the eTV program.

The Vehicle

The smart fortwo mhd is classified as a two-seater sub-compact vehicle. It is equipped with a 999 cc (~1 litre), naturally aspirated, 3-cylinder engine. It is also equipped with other technologies, such as low rolling resistance tires, which help to limit fuel consumption and GHG emissions. Additionally, the moon roof is constructed of lightweight polycarbonate rather than glass, offering a 40% reduction in weight. In available documentation, the smart fortwo mhd is described as being capable of achieving 767 kilometres on a 33-litre tank of gasoline, based on a European combined fuel consumption rating of 4.3 L/100 km and producing only 103 g/km of CO_2.

Testing – Why and What

The eTV program acquired the *smart fortwo mhd* to help verify the fuel savings that could be obtained by using an idle start-stop system in Canada. In addition, eTV wanted to test the system under a variety of Canadian conditions, particularly in city driving and in cold weather. No Canadian data was available regarding the system's real-world performance, prior to eTV's testing and evaluation.

What We Found

Fuel Consumption	• In eTV 2-cycle testing, with the idle start-stop (eco-mode) turned ON, the fuel consumption values are 6.2 L/100 km for the city, 5.12 L/100 km for the highway and 5.71 L/100 km for combined city/highway. • In all eTV testing cycles, the use of idle start-stop offers considerable savings in fuel consumption in city driving.
Emissions	• In combined eTV city and highway testing, with the idle start-stop (eco-mode) turned ON, the smart fortwo mhd obtained an adjusted value of 137 g/km, which is 10% less than the current best performers in the sub-compact class and a 40% improvement over all comparable models. • With regard to non-CO_2 exhaust emissions, the 2009 smart fortwo mhd meets the Euro V emissions standards for which it was designed and is well below the Tier 2, Bin 5 standards in effect in Canada.
Handling and Performance	• Overall, handling and performance were good, pass or acceptable relative to the sub-compact class. • The smart fortwo mhd is able to operate between -7°C and 40°C, using various combinations of the auxiliary systems. However, below -7°C, the vehicle did not allow the eco-mode to engage and turn off the engine when idling, despite acceptable battery voltage levels.
Driver Feedback	The majority of the evaluators reported that they were comfortable with the idle start-stop system, even in heavy traffic. In a comparison test with a smart fortwo not equipped with anti-idling technology, the smart fortwo mhd obtained significant fuel savings.

What Do These Results Mean for Canadians?

At public outreach events where eTV demonstrated the smart fortwo mhd, most Canadians reported that, prior to seeing the vehicle, they were unfamiliar with anti-idle technologies. However, after speaking with program staff and seeing the technology 'first-hand,' many people expressed considerable interest. Feedback from eTV's test drivers indicated that the technology was unobtrusive, and operated well in a variety of real-world conditions. eTV's laboratory and track results show that the technology has the potential to offer significant performance benefits in terms of reduced fuel consumption and emissions. Based on these test results, eTV will work with industry and within government to help accelerate the introduction of anti-idle technologies in Canada.

Volkswagen Polo Bluemotion TDI

The Technology

The 2008 Polo Bluemotion TDI from Volkswagen is a sub-compact, clean diesel vehicle available in several European markets. The eTV program selected the Polo Bluemotion for testing because it is equipped with several technologies to reduce fuel consumption, including advanced clean diesel technologies and advanced aerodynamics, among other features.

The Vehicle

The VW Polo Bluemotion TDI, classified as a sub-compact vehicle, is equipped with a 1.4-litre inline 3-cylinder turbocharged engine. The vehicle's engine power train is equipped with several environmentally friendly technologies such as exhaust gas recirculation, which help to reduce nitrogen oxides, a by-product of diesel combustion. As well, the 5-speed manual transmission, with longer gear ratios in gears 3 through 5, provides fuel savings during periods of high-speed cruising. The variable turbine geometry turbocharger helps to provide additional power over a longer range of engine speeds.

Testing – Why and What

The eTV program was particularly interested in gathering information to answer two questions.

- How well do the Volkswagen Polo Bluemotion's advanced diesel technologies reduce fuel consumption, GHG emissions and other pollutants?
- How well does the Volkswagen Polo Bluemotion operate on Canadian roads and under Canadian driving conditions?

What We Found

Fuel Consumption	The Polo's fuel consumption in eTV testing is 5.9 L/100 km in the city, 4.2 L/100 km on the highway and 5.1 L/100 km combined. These fuel consumption rates are in keeping with the actual fuel consumption achieved over the first 5,000 kilometres of real-world operation.
Emissions	In combined eTV city and highway tests, the Polo's emissions value is 109 g/km. This is 29% lower than the two most fuel-efficient sub-compacts currently available in Canada. However, the 2008 VW Polo was designed to meet the Euro IV emissions standards. It would need to improve its particulate matter (PM) and nitrogen oxide (NO_x) emissions values in order to meet both the Euro V and the average North American emissions standards for a light-duty vehicle (Tier 2, Bin 5).
Handling and Performance	Overall, handling and performance were either good, pass or acceptable relative to the sub-compact class.
Driver Feedback	With respect to consumer feedback, eTV was able to validate acceptance of several unique technologies, including a transmission optimized to maximize fuel economy and a variable geometry turbocharger (VGT). Both of these innovations have limited penetration in Canada. Common driver evaluation comments included good low-end torque (allowing for quick acceleration from a stopped start), good interior space, including headroom, and reasonable cargo space for a sub-compact vehicle. Drivers also commented on the amount of vibration produced by the diesel engine and how it was significantly more noticeable than in a gasoline engine, especially when idling.

What Do These Results Mean for Canadians?

Diesel technologies have come a long way over the past few years. Diesel vehicles are quieter and cleaner than ever, and they continue to be inexpensive to operate. For example, based on an average of 20,000 km of driving per year and fuel costs of $1.00/L, fuel cost for the Polo would be approximately $1,020 per year. As well, the Polo leaves a low carbon footprint of 2,700 kg of CO_2 emissions per year emitted from the tailpipe (based on 20,000 km driven annually).

The Polo is equipped with several unique technologies, including a transmission optimized to maximize fuel economy and a VGT. While VGT technology has been used in larger displacement engines in heavy-duty vehicles for many years, the Polo is one of the first examples of its use in a small displacement diesel engine. On the road, drivers reported that the Polo performed well and was able to accelerate quickly from stops.

Driver evaluations, however, also indicated that Canadian drivers are still unaccustomed to the higher vibrations and noise of diesel engine technologies, particularly those like the Polo, that are not equipped with common rail direct injection. It is not clear to what degree this may be a barrier to consumer uptake.

Hymotion-Prius

The Technology

Hybrid electric vehicles (HEVs) have the potential to reduce overall fuel consumption and emissions because they use an electric motor that operates as a complement to an internal combustion engine. A plug-in hybrid electric vehicle (PHEV) is a particular kind of hybrid. It is equipped with batteries that can be recharged from an external power source, such as a standard 110 or 220-volt outlet. PHEVs can operate in a fully electric mode over a certain distance before the gas engine engages to provide power and/or charge the battery pack. PHEVs capable of operating in extended fully electric mode are of particular interest because they have the potential to significantly reduce the environmental impact of passenger vehicles in Canada.

Hymotion, working out of Concord, Ontario, first introduced their conversion kits in 2006. The Massachusetts-based A123 Systems, which manufactures the batteries for the conversion module, acquired Hymotion in February 2007. Although originally designed to convert Toyota Prius and Ford Escape and Mariner Hybrids, the L5 Plug-in Conversion Modules (PMC) are now designed specifically to convert Toyota Prius HEVs into PHEVs and can be installed as an after-market conversion.

The Conversion Module

The L5 PMC converts the Toyota Prius from an ordinary hybrid electric vehicle into a plug-in hybrid electric vehicle (PHEV). The 2008 Toyota Prius, the base vehicle into which the L5 PCM was installed, is classified as a mid-size vehicle. It is equipped with a gasoline-electric hybrid power train that uses a 1.5-litre inline 4-cylinder gasoline engine and an AC electric motor linked in parallel through a continuously variable transmission.

Testing – Why and What

eTV was particularly interested in finding the answers to the following questions, among others:

- How does the laboratory fuel consumption and emissions performance obtained by the Hymotion-Prius in full PHEV mode and in hybrid mode compare with real-world performance?
- What would the annual fuel consumption costs and emissions be when the vehicle is operated in different driving conditions and at different states of charge?
- What are the characteristics of the Hymotion-Prius emissions? Does it satisfy the Tier 2, Bin 5 standards prescribed by the U.S. EPA and Environment Canada?
- Does the small weight difference due to the add-on battery pack placed in the spare tire compartment have an impact on the vehicle's overall dynamic performance?
- What consumer barriers exist, if any, with respect to PHEV technologies, as identified through driver evaluation feedback and eTV outreach activities?

What We Found

Fuel Consumption	• When running in normal hybrid mode (using the car's engine and electric battery), the fuel consumption values during eTV testing are 4.0 L/100 km in the city, 4.2 L/100 km on the highway and 4.1 L/100 km combined city/ highway. • When running in PHEV mode (using the additional electric battery), fuel consumption during eTV testing is 1.6 L/100 km in the city, 2.2 L/100 km on the highway and 1.9 L/100 km combined city/highway.
Emissions	• In eTV's city and highway test cycles, the Hymotion-Prius produced a combined emissions value of 104 g/km CO_2 while in regular hybrid mode, and 44 g/km CO_2 while in PHEV mode, with a combined value for both modes of 84 g/km CO_2. The Hymotion-Prius offers a 20% to 50% reduction in CO_2 emissions when compared to all of the best performers across all classes, for the same model year. • The Hymotion-Prius meets the emissions standards for Tier 2, Bin 5 and all emissions are well below the applicable regulated standards. Specifically, the Hymotion-Prius exceeds the fleet average Tier 2, Bin 5 standards as prescribed by the U.S. Environmental Protection Agency and Environment Canada.
Handling and Performance	All aspects of handling and performance were good, pass or acceptable relative to the mid-size class.
Driver Feedback	Drivers and occupants commented that the Hymotion-Prius conversion operated seamlessly. For those evaluators who took the car home overnight, they commented on the ease with which the vehicle could be plugged in to charge the conversion pack. They also commented that the Hymotion-Prius was quiet and offered a similar driving experience to other mid-size cars with regard to acceleration, handling, parking and general visibility.

What Does This Mean For Canadians?

eTV is one of the first government programs to obtain and conduct in-depth emissions, energy consumption, dynamic and on-road performance testing of PHEV technologies in Canada. Because PHEVs are "plugged into" the electrical grid, they are considered to be an electrical appliance, and need to conform to a new set of standards that previously did not apply to vehicles. eTV is working with industry and other government departments, using the test results from the A123 Conversion, to develop the codes and standards necessary to ensure PHEVs are on Canadian roads as soon as possible.

Consumers still have questions with respect to how hybrids and PHEVs charge their batteries, how regenerative braking works, as well as concerns about battery lifespan, replacement cost and safety performance. Many still do not appreciate the environmental and financial benefits that fuel-efficient technologies can offer. The eTV program is helping to inform Canadians about PHEVs through its outreach events and through its website, which includes a wealth of information as well as videos.

Parting thoughts – What's Next for eTV

Over the next few months, eTV will focus on implementing its comprehensive electric vehicle (EV) testing and evaluation strategy. Linking with Government of Canada priorities for EVs, eTV will test a range of electric vehicles, including a Mitsubishi i-MiEV and a Tesla Roadster, among others. eTV will study how they perform in Canada, to identify potential barriers to their introduction, inform the development of new codes and standards, and where possible, determine strategies to overcome these barriers.

We hope that you share our excitement about these promising new green technologies and will visit our website to read more about how eTV is *test driving the future*!

If you have any questions, comments, or know of an event eTV should attend to showcase advanced technologies, please send an e-mail to eTV@tc.gc.ca.

Until next time,

The ecoTECHNOLOGY for Vehicles Team