EVALUATION OF ENERGY REDUCTION IN TRANSPORTATION: IMPACT OF ECO-DRIVING AND HYBRID-ELECTRIC VEHICLE TECHNOLOGIES IN URBAN QUÉBEC

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1. INTRODUCTION

Transportation makes up a great share of the total greenhouse gas emissions (GHG) around the world and reducing emissions from this sector has been a global challenge. Therefore, factors affecting fuel consumption (and eventually GHG emissions) are the focus of many studies done from this perspective. Different factors affect fuel consumption rate of motor vehicles such as: driving behavior, vehicle type (make, model and year), operating speed, ambient temperature, weather condition, type of road (local and highway), level of hybridization and etc.

This report is part of the project that was developed to evaluate impact of eco-driving training and hybrid-electric vehicle technologies on vehicular fuel consumption using real-world conditions. Eco-driving and hybrid-electric vehicle (HEV) technologies are two common initiatives to reduce fossil fuel energy consumption and greenhouse gas emissions.

These project has two objectives: i) Evaluating the impact of eco-driving strategies on vehicle fuel consumption and ii) Identifying the factors affecting fuel economy of hybrid-electric vehicles with particular focus on the winter season, low temperatures and cold-starts controlling for the effect of other factors such as, operating speed and type of road (highway or local). In this study, segment-level data is used from a sample of instrumented vehicles in urban Quebec.

According to these two objectives, this document is divided in two sections.

2. EVALUATING IMPACT OF ECO-DRIVING TRAINING (By Sabreena Anowar)

Eco-driving is an emerging soft technology which is referred to as the alteration of driving style from aggressive to more refined style. In the extant literature, the policy is labeled as a win–win proposition for both individuals (through cost savings and greater personal safety) and society (through reduced CO_2 emissions, reduced petroleum imports, reduced emissions of conventional pollutants, and fewer fatalities). For the current research project, nearly 100 participants from five different companies were monitored to observe changes in their driving habits and energy performance (fuel consumption). Trip level data was collected and a regression model for fuel consumption rate (FCR) for both Montreal and Quebec City was developed to identify if the training had a statistically significant impact on the trip level FCR while controlling for other confounding factors. From the preliminary analysis results it was found that eco-driving training had a negative impact on trip level FCR although it was not statistically significant. Further disaggregated analysis of the FCR at the city and highway level or season wise analysis might produce more insight into the impact of the technology.

The Context

Eco-driving is a new approach to driving style developed since the mid-nineties. There is no formal definition, *per se,* of the term eco-driving. In general terms, eco-driving is frequently referred to as the alteration of driving style from aggressive to more refined style (Berkenbus, 2010). Actually, there are several aspects associated with the concept and in the standard literature, the features and characteristics of this driving technique is generally well-defined and easily characterized (Anable and Bristow, 2007; Berkenbus, 2010). The eco-driving rules can be categorized into two major concepts: (1) adoption of anticipatory driving style and (2) use of engine as efficiently as possible. More elaborately, the different aspects of the strategy are: accelerating and decelerating moderately and gradually; shifting gears optimally; maintaining steady driving pace (driving at or below the posted speed limit); eliminating excessive vehicle idling; anticipating traffic flow while driving in order to avoid abrupt stops or braking; and keeping the vehicle in good maintenance (e.g. maintaining proper tyre pressure, and regularly changing air filter etc.) (Santos et al., 2010; Berkenbus, 2010; Barth and Boriboonsomsin, 2009; af Wahlberg, 2007). Its implementation can be achieved either by advertising campaigns or by direct education and training of drivers, the training being either compulsory or voluntary.

To put our research project into perspective, we decided to explore the existing literature and glean knowledge about the reported benefits, if any, of the eco-driving strategy worldwide. The following review is based on research studies dealing with eco-driving and its impacts (short-term and long-term) available in the standard literature. **Table 1** and **2** provides summary of such studies (within each table, the studies are organized chronologically). In **Table 1**, the literature on static eco-drive applications is provided, while the dynamic eco-drive application studies are presented in **Table 2**.

In dynamic eco-driving applications, real-time driving advice is provided to drivers so that they are able to modify their driving behaviour or take certain driving actions in order to reduce energy consumption and emissions (Xia et al., 2011). The advice can be given in various forms, such as: recommended driving speeds, optimal acceleration and deceleration profiles, and alerts. Broadly, the dynamic eco-driving technology can be categorized into two major groups: (1) freeway applications and (2) non-freeway applications. In the freeway application, which is similar to the concept of intelligent speed adaptation (ISA) and variable speed limit (VSL), a speed is suggested to the driver to follow on each segment of the roadway based on roadway characteristics and traffic conditions. On the other hand, the non-freeway applications, which are mostly focused on roads with traffic signals, provide alerts to individual vehicles regarding the possibility of passing the intersection prior to the signal turning red.

The following observations were made from the review of the literature. First, studies regarding the impact of eco-driving arrive at optimistic conclusions on its effectiveness without proper statistical testing. Second, the techniques used in these studies for synthesising trends of the empirical evidence rely on narrative techniques, such as verbal comparison and discussion, rather than statistical methods. Nevertheless, there is a general consensus among researchers that eco-driving scheme indeed has the potential to reduce carbon emissions from cars and transit buses significantly. However, it can apply to any vehicle (old or new, big or small) and be implemented quite easily in short term. To say the least, eco-driving, can be a win–win proposition for both individuals (through cost savings and greater personal safety) and society (through reduced CO_2 emissions, reduced petroleum imports, reduced emissions of conventional pollutants, and fewer fatalities).

Data Collection and Analysis

Nearly 100 participants from five different companies were monitored to observe changes in their driving habits and energy performance (fuel consumption). The monitoring was done over a period spanning from July 2009 to July 2010. For each of the companies that involved in this project, approximately 80% of participants were trained to conduct efficient (Test group) while the remaining 20% did not attend any training activity (Control group). Trained participants were divided into two distinct groups based approach employee training: simulator training or training of conventional style.

A linear regression model was developed in order to identify if eco-driving training has any statistically significant impact on the on-road fuel consumption while controlling for other potential factors. The typical mathematical formulation of the standard linear regression is as follows:

$$y_i = X_i\beta + \varepsilon_i \tag{1}$$

where, i $(i = 1,2, \dots\dots\dots, N)$ represents the observations, X_i is a vector of regressors, β is a vector of estimable parameters (including a constant), ε_i is the normally distributed error term. Please note that ordinary least square (OLS) estimation technique was used for estimating the regression model parameters.

The first regression model developed was for Montreal. We decided to develop separate models for Montreal and Quebec City instead of a combined one because the two regions offer reasonable contrast in terms of urban region size, public transportation system and culture, thus providing an ideal setting to compare the impact of eco-driving on fuel consumption. The results for Montreal are presented in **Table 3** while the results for Quebec are presented in **Table 4**.

For both cities, we found average speed has significant negative impact on FCR, meaning with increase in average speed, fuel consumption decreased. However, the negative impact was more pronounced for Montreal than Quebec City. Similar result was found by Redsell et al. (1992).

Both summer and winter positively impacted FCR. As expected, winter has greater impact than summer. The result is intuitively understandable. In winter, additional work is required to move a vehicle through snow covered road surface. As a result, fuel economy gets severely diminished. In addition, in cold climates many people bring the interiors to a comfortable temperature before driving and keep their engines idling during prolonged waiting periods to maintain that temperature. However, seasonal impact not found significant for Quebec City.

For both Montreal and Quebec City, engine type was another important factor for FCR. Vehicles with conventional engine set up increased the fuel consumption per 100 km of trip length. For Montreal, Van and hatchbacks was negatively associated with FCR. On the other hand, for

Quebec City, station wagon and hatchback significantly reduced FCR while SUV resulted in an increased in fuel consumption. Again, if the driven vehicle was personally owned, it resulted in reduced fuel consumption. This was only found significant for Montreal.

Young drivers had a higher FCR and drivers within 45 to 60 years had a lower FCR in Montreal model. Elderly drivers in Quebec City had lower fuel consumption rate. If the trip was made by a male driver, it had a higher probability of resulting in increased fuel consumption, although gender effect was only found significant in Quebec City model.

Driver education significantly influenced FCR in both Montreal and Quebec City model. Higher education of drivers resulted in reduced FCR in Montreal. In Quebec City, drivers with high school degree had higher FCR while those with CEGEP degree had lower FCR. Interestingly, if the driver has low income, it resulted in increased fuel consumption while high come affected FCR in the opposite way. Similar impact of high income level was found in the Quebec City model as well. Unfortunately, we did not find any significant impact of eco-driving training on trip level fuel consumption rate (FCR).

Table 1: Studies on Static Eco-driving Applications

References	Study Area	Data Collection Instrument	Sample	Study Type	Technology	Parameters Investigated
Ando & Nishihori, 2011	Toyota City, Japan	▪ GPS ▪ Video camera	--	On-road social experiment	Eco-driving car following	Driver behaviour of the following car
	Results: ▪ The behaviour of the following car depended on the eco-driving behaviour of the leading car as well as the sticker used at the back of the car					
Liimatainen,2011	Tampere, Finland	▪ On-board logging device ▪ Driver survey	Bus drivers	--	Eco-driving incentive system	Driver performance
	Results: ▪ Driver independent factors were found to have significant effect on fuel consumption of buses ▪ Drivers opined that incentive system based on monitoring the fuel consumption affect their driving behaviour					
Lee et al., 2010	The Republic of Korea	▪ Internet survey ▪ User test	KIA Soul car drivers	Short-term impact	Eco-driving system on dashboard	▪ System use ▪ Why used ▪ Frequency of use ▪ System awareness while driving ▪ Gas savings ▪ Satisfaction ▪ Improvement options ▪ Task load
	Results: ▪ The increased cognitive demand placed on drivers while using Eco-Driving System negatively impacted gas mileage ▪ Drivers who are younger and have less driving experience more easily adapted to the system					
Beusen et al., 2009	Belgium	On-board logging device	Passenger car drivers	Before-after study	Eco-driving course	▪ Fuel consumption ▪ Different driving behaviours
	Results: ▪ Post-educational effects varied from one driver to another ▪ Overall, the average fuel consumption four months after the course fell by 5.8%					
Zarkadoula et al., 2007	Athens, Greece	--	Bus drivers	Pilot study	Driver training	▪ Change in driver behaviour ▪ Fuel consumption

					course on eco-driving	▪ Distance traveled ▪ Travel time
	Results: ▪ There was an overall 4.35% reduction in fuel saving per km					
Wahlberg, 2007	Uppsala, Sweden	--	Bus drivers	Evaluation study (Control group)	Driver training	▪ Fuel consumption ▪ Accident rates ▪ Acceleration behaviour
	Results: ▪ It was found that, the training did not have much of a long-term effect or a clear-cut short-term effect either ▪ There was no significant difference in accident rates as well					

Table 2: Studies on Dynamic Eco-driving Applications

References	Study Area	Data	Sample	Study Type	Technology Type	Impact Evaluated
Xia et al., 2011	-	-	-	Traffic Micro-simulation	Dynamic Eco-driving on Signalized Corridor	Indirect network-wide emissions
	Results: ▪ There were indirect network wide energy and emissions reductions ▪ The maximum fuel saving and emission reduction occurred during medium congestion (corresponding to traffic volume of 300 vehicles/lane/hour) and with low penetration rates (5%, 10% and 20%)					
Barth & Boriboonsomsin, 2009	-	Real-time traffic speed, density, flow	-	▪ Traffic Micro-simulation ▪ Real-world experiment	Freeway-based Dynamic Eco-driving	Energy and emissions
	Results: ▪ Fuel consumption and CO_2 emissions could be reduced by 10–20% without drastically affecting overall travel time ▪ The percentage savings depended on the congestion level: under free-flow conditions there was little benefit. However for severe congestion, the savings were considerable					

Table 3: Regression Analysis Results for Montreal

Variables	Coefficients	Std. Error	t-stat
Constant	220.126	33.424	6.586
Average Speed	-2.135	.222	-9.612
Season			
Winter	13.251	8.758	1.513
Summer	11.630	9.212	1.262
Engine type	17.685	14.633	1.209
Vehicle Type			
Van	-17.626	13.469	-1.309
Hatchback	-24.052	19.391	-1.240
Driver Education			
University Degree	-16.290	15.778	-1.032
Possession type	-16.348	15.147	-1.079
Driver Age			
< 30 years	43.102	18.920	2.278
45 to 59 years	-13.905	10.506	-1.324
Driver Income			
Low	43.533	17.834	2.441
High	-15.988	13.179	-1.213

Table 4: Regression Analysis Results for Quebec City

Variables	Coefficients	Std. Error	t-stat
Constant	23.612	1.474	16.017
Average Speed	-.207	.015	-13.755
Engine type	3.356	.802	4.184
Vehicle Type			
Station-wagon	-1.132	.929	-1.218
Hatchback	-2.445	.724	-3.380
SUV	2.799	.920	3.041
Driver Age			
> 60 years	-1.459	1.047	-1.393
Driver Gender	2.990	.763	3.917
Driver Income			
High	-1.327	.728	-1.822
Driver Education			
High-school	1.934	.820	2.357
CEGEP	-1.589	.675	-2.354

3. EVALUATING THE PERFORMANCE OF HEV TECHNOLOGIES (By Amir Zahabi)

Again, the aim here is to identify the factors affecting fuel economy of hybrid vehicles and compared their performance with conventional vehicles. Particular attention is paid to winter season, low temperatures and cold-starts controlling for the effect of other factors such as, operating speed and type of road (highway or local). In this study, segment-level data is used from instrumented vehicles.

Despite the important contribution of this literature, very few studies have included a large population of drivers and vehicles operating in different environments and weather conditions, in particular the low temperatures during the winter time. Few studies have been done in cold North American cities that look at how the efficiency of HEV's batteries can be affected by very low temperatures (under -20 °C during the winter months of February and March). In particular in Canadian cities such as, Montreal and Quebec City, the temperatures can drop as low as -35°C. Cold-start is another important factor affecting fuel consumption which has not been studied for it merits. Based on the literature, the simultaneous effect of speed, temperature, link type, season, type of vehicle, cold-start and etc. on FCR have not been studied. Hybrid-electric vehicles are gaining popularity while their energy and environmental benefits are still in the process of being studied. The total benefits in fuel economy can be offset by the effect of winter and low temperatures.

Methodology

Different steps were executed to accomplish this study, including:

Data preparation: This study makes use of a rich database collected from studying driving behavior factors, specifically, eco-driving training as well as factors affecting fuel consumption of passenger vehicles in real driving conditions. For this purpose, a large sample of vehicles was instrumented with the participation of the drivers from different cities in the Province of Quebec, Canada. This project was financed by the Quebec Ministry of Natural Resources (MNR). The data was collected by a third party service provider (FPInnovations), using on board recording devices from the ISAAC Instruments company. These devices provide access to engine operation data using an OBD-II connector (on-board diagnostics used to request data from the vehicle), enabling the recording of several parameters simultaneously at a rate of 5 samples per second.

Exploratory analysis: The relationships between FCR and different factors were then explored including speed, driving environment (city vs. highway), vehicle type (sedan, SUV and hatchback) and propulsion technologies (regular fuel engine vs. hybrid vehicles). For the exploratory analysis, simple descriptive techniques and graphics were generated such as, box plots, FCR-speed curves, correlation matrix, etc.

***Regression analysis**:* In order to estimate the relationship between the factors of interest (speed, temperature, type of road, vehicle type/technology and cold starts) and fuel consumption, a driver random-effect linear regression model (RELRM) was used considering that observations coming from the same driver are nested (observations from the same driver are correlated). Based on a mathematical perspective, the random-effect model is of the following form:

$$Ln(FCR_{it}) = X_{it}\beta + (u_i + v_{it}) \quad (2)$$

Where:
$Ln(FCR_{it})$ - natural logarithm of fuel consumption by vehicle i in segment t.
β= vector of model parameters ($\beta_0, \ldots \beta_k$)
X_{it}= vector of factors affecting FCR such as speed, temperature, link type and etc.
u_i= Normally distributed random effect for each driver i.
v_{it}= Random independent error term, normally (Gaussian) distributed for driver i and segment t.
Note that the covariance of the two model errors is not zero, $\mathrm{cov}(u_i, v_{it}) \neq 0$. Random effect models were estimated for all data and controlling for different factors.

Data and Results

The data used in this analysis is also the sample of 95 vehicles and drivers (workers) from four corporations in four cities in the Quebec Province participated in this study. The cities were Montreal, Quebec City, Trois-Rivières and Sherbrooke, which represent the typical urban areas in the provinces with different population sizes. A data logger was installed in each of the 95 vehicles, in order to record the driving parameters such as, instantaneous speed, fuel consumption, driving regime, and idling time.

To explore the association of FCR with key factors such as, speed, a set of box plots were built for each vehicle category. **Figure 1** shows the fuel consumption box plots for various vehicle categories: non-HEV which included the sedan, hatchback and Sport Utility Vehicle (SUV). From this, it is clear that the effect of speed is greatly associated with FCR, and as expected, the rates decrease in a non-linear way as speeds increase. In the non-HEVs plot (not reported here due to the word limitation), a more smooth curve can be observed, where as for the HEVs, the curve has a bump between speeds of 40 to 60 km/hr. This could be explained by the fact that HEVs start using their gasoline engine at speeds around this range which results in more fuel consumption.

Figure 2 shows the average variations in temperature and FCR across seasons. Optimal fuel consumption was observed in spring when temperatures are typically relatively high and the air conditioning (AC) is mildly used. The benefit from increased ambient temperature was negated by a more intense use of AC which resulted in a 2% consumption penalty. In winter and fall, reduced ambient temperatures resulted in increased fuel consumption which leads to a fuel economy deterioration of approximately 26% and 8%, respectively. This again highlights the need of taking into account temperature when calculating CO_2 emissions and evaluating policies related to emerging technologies.

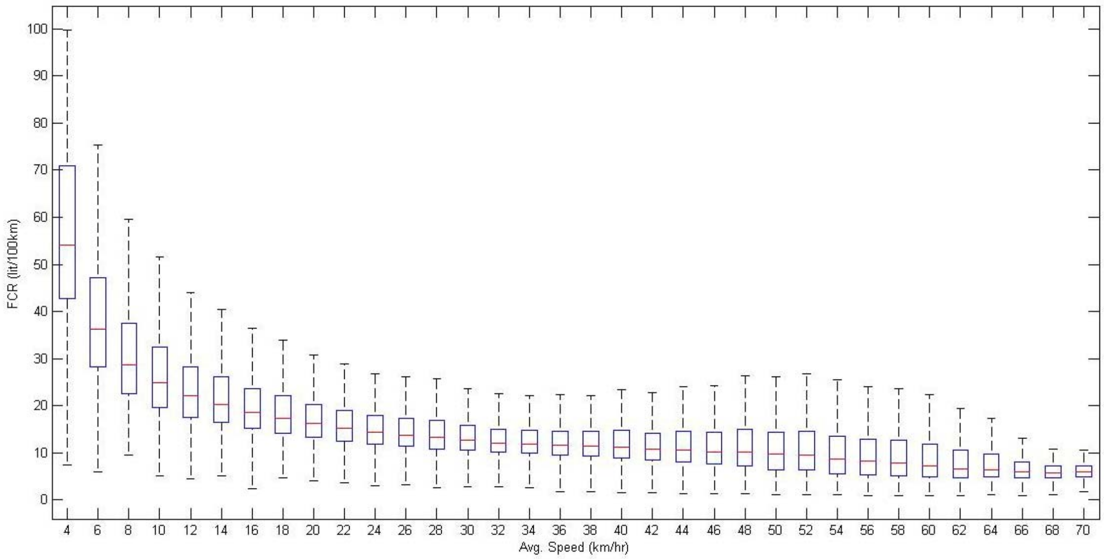

Figure 1: Fuel consumption vs. speed box plot for non-HEVs

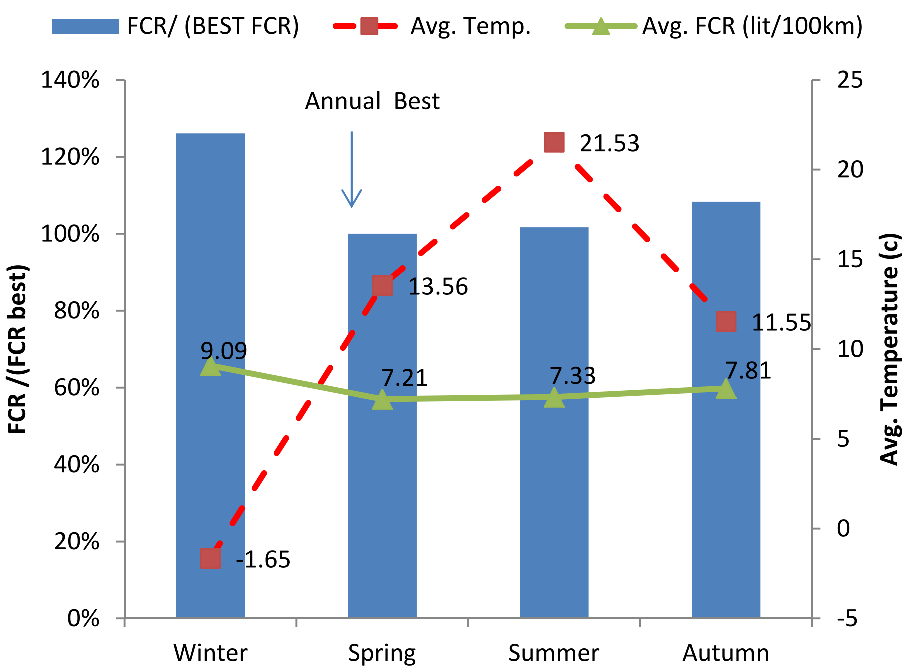

Figure 2: Annual fluctuation of FCR for HEVs in the data set and average ambient temperature

Conclusions

As one of the strategies to reduce energy and greenhouse gases, hybrid-electric passenger vehicles are considered as a promising technology. This paper's goal was to study the fuel efficiency levels of popular hybrid electric vehicles already in use and compare their performance with respect to standard gasoline vehicles. The impact of different factors on fuel efficiency was also investigated using segment data such as, speed, road driving conditions (city vs. highway), temperature, cold-starts, etc. For this purpose, fuel consumption data in real-world driving conditions from a sample of 74 instrumented vehicles was used.

Among other results, and as expected, HEVs performed better than gasoline vehicles particularly in city driving environments and at low speeds. On highways, their performance was very similar to that of regular gasoline vehicles. As documented in the literature, the low speeds of vehicles in city driving conditions seldom require the use of the gasoline engine due to the re-generation of electricity through breaking – these conditions significantly (or immensely or consequently) improve the efficiency of a HEV(Fontaras et al 2008.; Rutty et al. 2013).

Another important parameter affecting fuel efficiency was ambient temperature which had a higher effect on HEVs than non-HEVs. The results show that a HEV tends to consume less gasoline in spring due to the better performance of its batteries at higher ambient temperatures. Although the temperature is higher in summer, due to the use of air conditioning, the performance of the batteries is less apparent (7.33 lit/100km vs. 7.21 lit/100km). More importantly, the winter season and in particular low temperatures show to have a significant negative impact of HEV technology. In this study, Cold months or low temperatures tended to have a deteriorating effect on the economic fuel consumption of hybrid vehicles. This is a critical factor in cool cities like those involved in this analysis. The effect of cold starts was also explored and found to be more dominant for HEVs. In other words, cold starts affect more HEVs than non-HEVs. In addition, while eco-driving training did improve fuel consumption, its impact was marginal. The city effect also played an important role in fuel economy. After controlling for other factors, fuel economy was lower in Montreal than in the other three cities under analysis. This is perhaps due to a reflection of the congestion problem in this city.

In summary, the fuel economy of HEVs is indisputable as demonstrated by many other studies (Alvarez et al.2010; Fontaras et al. 2008; Reynolds et al. 2007) However, some factors improve or offset the benefits of hybrid technologies with respect to regular gasoline technologies such as, temperature or season, speed and driving road conditions. Eco-driving can play a role, but this seems to be marginal. The variation of fuel efficiency across cities may be a good reflection of a congestion problem.

As more work continues on the matter, more disaggregate fuel consumption measures will be used to validate the results. Data and analysis will be regenerated to measure the sensitivity of the results with respect to the level of data aggregation.

REFERENCES

1. af Wåhlberg, A. E. (2007). Long-term effects of training in economical driving: Fuel consumption, accidents, driver acceleration behavior and technical feedback. *International Journal of Industrial Ergonomics, 37*(4), 333-343.
2. Alvarez, R., Schlienger, P., & Weilenmann, M., (2010). Effect of hybrid system battery performance on determining CO2 emissions of hybrid electric vehicles in real-world conditions. *Energy Policy, 38* (11), 6919-6925.
3. Ando, R., & Nishihori, Y. (2011). How does driving behavior change when following an eco-driving car? *Procedia-Social and Behavioural Sciences, 20*, 577-587.
4. Barkenbus, J. N. (2010). Eco-driving: An overlooked climate change initiative. *Energy Policy, 38*(2), 762-769.
5. Barth, M., & Boriboonsomsin, K. (2009). Energy and emissions impacts of a freeway-based dynamic eco-driving system. *Transportation Research Part D: Transport and Environment, 14*(6), 400-410.
6. Beusen, B., Broekx, S., Denys, T., Beckx, C., Degraeuwe, B., Gijsbers, M., . . . Panis, L. I. (2009). Using on-board logging devices to study the longer-term impact of an eco-driving course. *Transportation Research Part D: Transport and Environment, 14*(7), 514-520.
7. Canada, E. (2007). National Inventory Report 1990-2005: Greenhouse Gas Sources and Sinks in Canada.
8. de Haan, P., Mueller, M. G., & Peters, A. (2006). Does the hybrid Toyota Prius lead to rebound effects? Analysis of size and number of cars previously owned by Swiss Prius buyers. *Ecological Economics, 58*(3), 592-605.
9. Fontaras, G., Pistikopoulos, P., & Samaras, Z. (2008). Experimental evaluation of hybrid vehicle fuel economy and pollutant emissions over real-world simulation driving cycles. *Atmospheric Environment, 42*(18), 4023-4035.
10. Kahn, J. R., & Gibson, R. C. (1999). Fuel economy rebound effect for U.S. household vehicles. *The Energy Journal, 20*(3), 1-31.
11. Haitao, X., Boriboonsomsin, K., & Barth, M. (2011). *Indirect network-wide energy/emissions benefits from dynamic eco-driving on signalized corridors.* Paper presented at the 14th International IEEE Conference on Intelligent Transportation Systems (ITSC).
12. Lee, H., Lee, W., & Lim, Y. K. (2010). *The effect of eco-driving system towards sustainable driving behavior.* Paper presented at the Conference on Human Factors in Computing Systems, Atlanta, GA, USA.
13. Liimatainen, H. (2011). Utilization of fuel consumption data in an ecodriving incentive system for heavy-duty vehicle drivers. *IEEE Transactions on Intelligent Transportation Systems, 12*(4), 1087-1095.
14. Möser, G., & Bamberg, S. (2008). The effectiveness of soft transport policy measures: A critical assessment and meta-analysis of empirical evidence. *Journal of Environmental Psychology, 28*(1), 10-26.
15. Reynolds, C. & Kandlikar, M. (2007). How hybrid-electric vehicles are different from conventional vehicles: the effect of weight and power on fuel consumption. *Environmental Research Letters, 2,* 1-8.
16. Rutty, M., Matthews, L., Andrey, J., & Del Matto, T. (2013). Eco-driver training within the City of Calgary's municipal fleet: Monitoring the impact. *Transportation Research Part D: Transport and Environment, 24,* 44-51
17. Santos, G., Behrendt, H., & Teytelboym, A. (2010). Part II: Policy instruments for sustainable road transport. *Research in Transportation Economics, 28*(1), 46-91.
18. Small, K. A., & Dender, K. V. (2007). Fuel efficiency and motor vehicle travel: the declining rebound effect. *The Energy Journal, 28*(1), 25-51.
19. Wu, G., Yamamoto, T., & Kitamura, R. (1999). Vehicle Ownership Model That Incorporates the Causal Structure Underlying Attitudes Toward Vehicle Ownership. *Transportation Research Record: Journal of the Transportation Research Board, 1676*, 61-67.
20. Yamamoto, T. (2009). Comparative analysis of household car, motorcycle and bicycle ownership between Osaka metropolitan area, Japan and Kuala Lumpur, Malaysia. *Transportation, 36*(3), 351-366.
21. Zarkadoula, M., Zoidis, G., & Tritopoulou, E. (2007). Training urban bus drivers to promote smart driving: A note on a Greek eco-driving pilot program. *Transportation Research Part D: Transport and Environment, 12*(6), 449-451.