# PUBLIC ACCEPTANCE OF ELECTRIC VEHICLES IN TORONTO

**Adam Ing**
Adam.ing@utoronto.ca, 151 Booth Ave, Toronto, ON, Canada

## ABSTRACT

Habitants of the Greater Toronto Area (GTA) currently suffer from extreme commutes due to urban sprawl, lack of major roadways, and insufficient public transit. As gas prices continue to increase, people are constantly looking for ways to reduce their fuel costs and reduce carbon emissions, and battery electric vehicles can reduce both of these needs. The lack of charging infrastructure is causing "range anxiety" – fear of being stranded without power. As public charging stations become more common, range anxiety should be alleviated and allow for wider public acceptance.

Currently there are three main categories of electric vehicles: gasoline/diesel hybrid electric vehicle, plug-in electric hybrid, and battery electric vehicles. All of these vehicles have the common parts: electric motor, inverter, and battery.

There are 3 levels of battery charging: Level 1 charging is from a common electrical 110V outlet, and may take up to 20h to fully charge a depleted pack; Level 2 charging uses a 220V (washing machine) outlet, and will require 4-6 hours; Level 3 charging will complete in less than 30 minutes, and will be similar to a gas station.

Based on the acceptance of hybrid electric vehicles, early adopters aged 40 to 50 with at least a bachelors degree should adopt the technology first. Car sharing programs, taxis, and delivery trucks will also quickly adopt electric vehicles into their fleets because it is more economical than gasoline cars. Each of the 44 wards in Toronto were scored on population, age, household income, level of education, and number of daily auto trips. According to the normalized score, the first wards to adopt electric vehicle technology are wards 23, 22, 25, 27, and 16. Infrastructure should be built in these wards to accelerate public acceptance.

In the near future, automakers should: retrain their staff to service electric vehicles, focus on reducing car weight and size to maximize vehicle range, continue battery research and development, and determine how to properly dispose of batteries.

The Toronto government should follow lead of other governments and regulate gasoline prices, and provide tax incentives and subsidies to electric vehicles and infrastructure to promote adoption.

## 1. Why Consider Electric Vehicles? What's wrong with my gasoline car?

Habitants of the Greater Toronto Area (GTA) currently suffer from extreme commutes due to urban sprawl and lack of major roadways. Of the 5.5 million inhabitants, 2.4 million or 30% of the population uses a car to commute to work. The GTA has one of the longest commutes in the world, averaging approximately 80 minutes daily (Valdes-Dapena, 2010, Toronto Board of Trade, 2010, page 43). This commute time is forecasted to grow as Toronto is marketed as an attractive place to live; the population increasing at a steady 1% per year, marking 25% of Canada's overall population growth. The lack of effective transportation routes will become even more pronounced as the population increases.

As gas prices continue to rise, people are constantly looking for ways to reduce their fuel costs and reduce carbon emissions. Diesel engines, small vehicles, and hybrid gas-electric are examples of the movement towards a less fossil fuel dependant transportation system. Continuing this trend, battery electric vehicles are the next in line to become the main system of transportation.

### 1.1. Why even drive? Isn't there public transit?

There are 4 forms of public transportation in the commissioned in the GTA: buses, subways, streetcars (light rail), and heavy rail (GO). These forms of transportation help alleviate the congestion, but many routes are seen as a waste of resources as they are only fully utilized during rush hour. Furthermore, light rail cars share the same traffic lanes as many major city streets, thus contributing to congestion.

At 5.5 million, the GTA does not have a sufficient population to fund expensive transportation infrastructure projects such as subways or light rail. Furthermore, the TTC is consistently underutilized, making the profitability small and unattractive to private investors. In the past, the government has had problems financing the construction of additional subway stops, and have left routes unfinished due to lack of funds and poor budgeting.

## 2. What electric vehicle technology is available today?

Electric vehicles include hybrid electric vehicles, plug-in electric vehicles, and battery electric vehicles. These vehicles share an electric motor, inverter, and battery.

### 2.1. Introduction to Types of Electric Vehicles

Currently there are three main categories of electric vehicles: gasoline/diesel hybrid electric vehicle (HEV), plug-in electric hybrid (PHEV), and battery electric vehicles (BEV). In this document, BEVs and PHEVs will be referred to as electric vehicles (EVs).

HEV use gasoline as fuel, and has a battery and electric motor to assist in acceleration and can recover kinetic energy when braking and store it in the battery. A typical HEV has a small battery, and can be driven for 2-3km on battery alone. Examples of a HEV include the Toyota Prius, and the Honda Insight.

PHEVs use gasoline as fuel, but can also be charged at an electric outlet. Most PHEVs can be driven on battery power for up to 60km; afterwards the gasoline engine or turbine will start powering the vehicle. Most trips will only use battery power, and gasoline is only used as an auxiliary; for this reason, PHEVs are also know as electric vehicles with range extenders. Examples of PHEVs include the Chevrolet Volt, and the (Chinese) BYD F3DM.

BEVs never touch fossil fuels; they do not have a gas tank, nor an exhaust pipe. BEVs are charged via charging stations, wall outlets, or (in extreme cases) dragging it by tow truck. As charging infrastructure is scarce, most people are afraid of being stranded without power; this is called “range anxiety”. Although studies have proven that most daily trips are less than 100km, and can be done on a single battery charge, range anxiety is extremely common concern. Battery technology is also sensitive to ambient changes in temperature, and can affect range up to 60%. An example of a BEV is the Tesla Roadster, or the Nissan Leaf. Electric bikes and scooters are also considered BEVs.

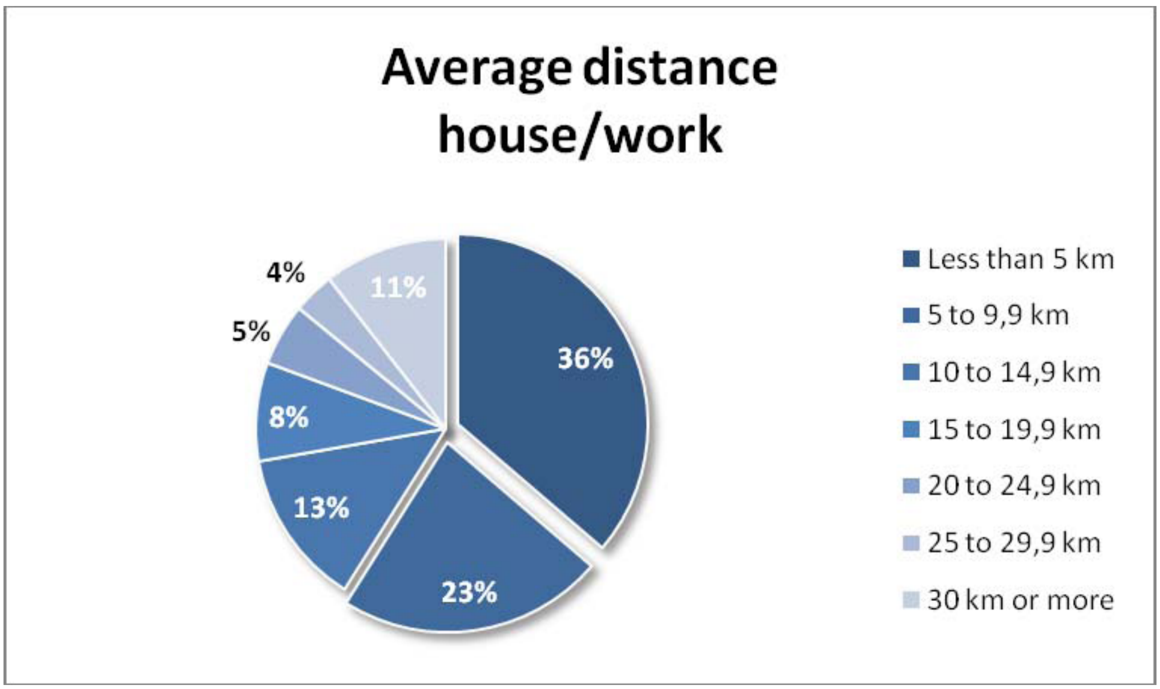


Figure 1: Average commute distance for a resident of Toronto (Electric Mobility Canada, 2010, page 10).

### 2.2. Parts of an Electric Vehicle

Electric vehicles all have the following common parts: electric drivetrain, battery, charger, and controller.

#### 2.2.1. Electric Motor

In hybrids and electric vehicles, an electric motor converts electrical energy into kinetic energy. Electric motors are about 3 times more efficient compared to internal combustion engines; electric motors convert 95% of electricity into movement. Electric motors can also be used as electric generators. When braking, the kinetic energy from movement is converted into electric current and the battery is recharged; this is called regenerative braking.

Most EVs use synchronous electric motors, which use permanent magnets and require alternating current. Batteries will only output direct current, so an inverter is always coupled with a electric motor to convert the current.

#### 2.2.2. Inverter

Small inverters (also known as battery chargers) are located onboard electric vehicles and will convert electricity from an outlet into the correct voltage to charge the battery. The battery and inverter size determines the rate in which it can charge; larger inverter can charge faster, bigger batteries take longer to charge. Fast charging is handled by larger inverters that are kept off board the vehicle.

#### 2.2.3. Battery

The battery is the most challenging part of an electric vehicle. Depending on the size of the pack, these batteries can store up to 30kWhrs on a single charge, which is enough energy to heat an average Canadian home for over a year (Natural Resources Canada, 1997). Currently, battery cells are extremely sensitive to temperature; too cold and they won't deliver power, too hot and they will quickly degrade. As a battery ages, it stores less energy, and delivers power less readily. Therefore a cooling/heating system, and thermal insulation is usually installed in the battery to moderate the temperature and maximize their performance and life.

### 2.3. Charging Methods and Standards

Currently there are 3 charging standards for electric vehicle. Each charging standard draws a different amount of power, charging a vehicle in a different amount of time.

#### 2.3.1. Level 1 Charging

Level 1 charging is the slowest, and is sometimes referred to as trickle charging. This charge mode is performed by plugging into a conventional 110V wall outlet at 15A (1650W), common to all North American homes. Using level 1 charging, it will generally take between 8-12 hours to charge from empty to full. This option is most likely only to be used in desperation or when doing battery repairs (U.S Department of Energy: EERE, 2011).

#### 2.3.2. Level 2 Charging

Level 2 charging is faster, and is forecast to be used in public lots and installed in homes. Using 220V at 60A (13.2kW), this circuit is also used for washing machines and dryers. Typically it will require 4-6 hours to charge from empty to full (EV Town, 2011).

##### 2.3.2.1. Home charging station

Home charging station should be the most widespread and easily accepted form of charging infrastructure. The home charging station would be a level 2 chargers, and is currently available on market for ~$2500. EV owners will install these in garages or driveways and charge their cars using cables. Some home charging stations will communicate with the vehicle and allow for data collection. By charging at home, the amount of trips to the "electric gas station" will be greatly decreased (Loveday, 2010).

**2.3.2.2. Parking meter design (Level 2 Charging):**

Currently this is the most popular type of public charging station. As 220V circuits are common to both commercial and residential buildings, it requires little change to the infrastructure. It is envisioned that people will park their car next to the charger, plug their vehicle into it using a power cable (provided by driver), and swipe their credit card. Like parking meters, the payment system could be centralized per street, and only the charging nodes would need to be repeated.

### 2.3.3. Level 3 Charging

Level 3 charging is referred to as fast charge or rapid charge. Level 3 chargers are expensive, ranging from $25,000 to $500,000, and thus will be akin to a gas station (Motavalli, 2011). Level 1 and Level 2 charging is achieved by accepting alternating current and converting it to direct current using the vehicle onboard inverter. The inverter to supply a fast charge is much larger than level 1 or 2, typically being the size of a gas pump. Level 3 charges will be completed in less than 30 minutes, thus investors may be interested in building coffee shops or rest areas around their charge stations to give drivers a place to wait.

Although safe when seldom used, fast charging will quickly age the battery. For this reason, Nissan has decided to void its 7 year battery warranty if fast charging has been used. Fast charging requires thick heavy wires, and is not available on all electric vehicles (CHAdeMO, 2011).

Currently the most popular level 3 charging standard is CHAdeMO, which allows up for a 200A current and up to 65kW. The CHAdeMO standard requires the battery and the charger to communicate in order to optimize the charge rate; this is necessary because the charge rate varies between EVs.

### 2.3.4. Inductive charging technology

Currently there is technology to wirelessly transfer electric power through magnetically coupled inductive charging coils. As Level 1 charging is slow, and level 3 charging would require a large onboard inverter, inductive charging technology is best suited for level 2 charging. This technology requires two magnetic coils: one in your battery, and one from the charging station. These copper coils are identical in shape and size. As current is passed through one of the coils it will generate an electric field. If another coil is nearby, this electric field will resonate and create a current in the other coil. This allows electric power to be transferred through the air at up to 95% efficiency. This will reduce theft or damage to cables when using public charging stations.

If taken a step further, the inductive charging technology could be used to create road which could wirelessly charge a vehicle while driving. This would be an extremely large undertaking, but it would remove range anxiety, and promote the use of electric vehicles in a similar fashion to carpool lanes (Blanco, 2009).

## 3. Who will use EVs?

Currently there are very few commercial EVs on the road in Canada. Canada's electric vehicle market is harder to penetrate because cold winters limit vehicle range and decrease battery life. Based on a HEV model (namely the Prius), the adoption of PHEV and BEV should follow the same trend. These are the target markets that will first adopt the technology.

### 3.1. Early adopters

Early adopters always want the newest technology, and are willing to pay for it. Early adopters are more concerned with the image than the economics; 27% of people who purchased a Prius claimed they were an early adopter (Halbright, Dunn, 2011). These early adopters are 85% more likely to have at least a bachelor degree, and are generally 40 to 50 years old. They are also 27% more likely to be concerned about preserving the environment when compared to the average consumer (MediaMark Research & Intelligence, 2008).

#### 3.1.1. Car sharing programs

Car sharing programs will be one of the major early adopters of electric vehicles due to the economics of electric vehicles; they are cheaper to fuel, and have lower maintenance costs due to fewer mechanical parts; BEVs do not require oil changes, and regenerative braking decreases wear on brake pads (LaMonica, 2010).

ZipCar is a car sharing program with an ideal platform for electric vehicles. ZipCar rentals include the price of gas, but limit range. EVs have limited range per charge, and have cheaper fuel, thus larger profit margins for ZipCar. Most trips are short city trips and therefore range anxiety is not a problem, and chargers can be installed in their rental lots. ZipCar also offers a business rental plan which is attractive to small companies that cannot afford a fleet. It is cheaper and less time consuming than maintaining company cars and tracking expenses (ZipCar, 2011).

#### 3.1.2. Company fleets, taxis, and delivery trucks

Electric vehicles are ideal for taxi use due to their mostly city traffic driving and lowered fuel costs. A Nissan Volt takes less than $3 to fully charge the vehicle, which significantly cuts operating costs. Unfortunately, a taxi wants to be on the road all the time, but electric vehicles take up to 30 minutes to charge, even with rapid charging. PHEV is a more attractive alternative, as they are not restricted by range, but still charge their battery when taking breaks.

A pilot study has been performed for Toronto on the effect of changing a gas efficient gasoline taxi (Camry) to a hybrid (Prius). It was found that on average, the engine idles

25% of the time, wasting fuel and wearing down parts (brakes, alternator, starter, belts). It was shown that maintenance and fuel savings equalized with the more expensive price of the hybrid over 7 years (CrossChasm, 2009).

### 3.2. Six Figures Club

The pricetag of any new technology is high, and electric vehicles are no exception. With a starting price tag of $30k+, few households can afford to buy a brand new EV. 71% of Prius owners have a household income over $100k, which is significantly higher than the average auto buyer salary of $85k (HybridCars, 2006). To most consumers, a small fuel efficient car is much more economical than buying an electric vehicle (Mick, 2011). While many households express interest in buying an environmentally friendly vehicle, only 12% were willing to pay extra for it. Of these affluent people, 40% bought a Prius because it was cheaper than buying a luxury BMW or Mercedes, but the car appearance was still distinct and recognisable (Halbright, Dunn, 2010).

## 4. How to determine where to put charging infrastructure?

In order to increase market penetration of electric vehicles in Toronto, charging infrastructure must be created to alleviate EV owners range anxiety.

Information was taken from Statistics Canada. Every ward was given a score based the following metrics: ward population, age, education level, household income level, and trips by auto. These are measured relative to the maximum metric in each ward. These statistics were modelled against the demographic of Prius buyers to pinpoint a target market. The target age was 25-44, because the average auto buyer will be 40-50 in the next 10 years. The target household education level was bachelors or higher degree. The target household income was $100k+. The amount of daily auto trips was also taken into account.

WARD SCORE =
(#Population aged 25-44 in ward/Greatest population of 25-44 of all wards)*
(#Bachelors degrees in ward/Greatest number of bachelors degrees of all wards)*
( #Household incomes over 100K/Greatest number of household incomes 100k+ of all wards)*
(#Daily auto trips in ward/#Greatest daily auto trips of all wards)

Example: Ward 22
WARD SCORE = (27380/28580 [POP25-44])*(35940/36180 [BACH+])*(7810/9830 [100K+])*(78131/78131 [Avg daily auto trips]) = 0.618

Using this scoring formula, it was determined that the top 5 wards to develop in next 10 years are: 23, 22, 25, 27, 16 (see figure below).

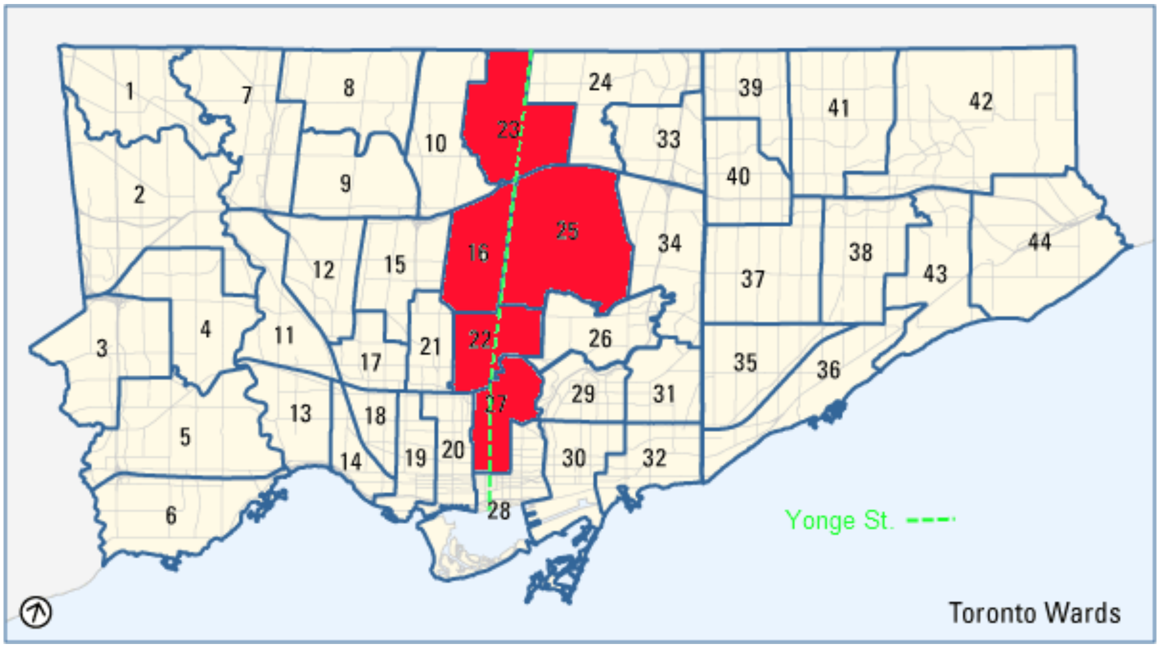


Figure 2: Selected wards for EV infrastructure, (Original picture from: Official website for the City of Toronto)

### 4.1. Analysis of suggested charger placement

Highlighted on the figure above, is one of Toronto's oldest and most developed streets; Yonge St. It is unsurprising that using the scoring formula determined that the chargers be placed around this street, as there are many businesses and land value is relatively high. Furthermore, Yonge St. is the route to a major subway line in Toronto. The selected wards are away from downtown core (southernmost part of Yonge St.), as there are few people actually living in downtown core that require a car to commute.

## 5. Private investments to promote EV acceptance

Private investors still doubt how quickly their investment will be returned, as not many important automotive groups may need to be retrained to support and maintain EVs. The limited range of an EV can be improved though redesigning smaller, lighter vehicles. Battery technology is forecast to become cheaper in the future, and will decrease the price of EVs. After a battery is no longer acceptable in an automotive application, it can be repurposed for a stationary application to recover costs and lower battery price.

### 5.1. Retrain Automotive Staff for EV

Most early adopters have range anxiety, but rarely do they worry about serviceability. Electric cars have much simpler architecture than gasoline or hybrid cars, but as they are mostly electronic, technicians will need to be retrained. As of now, many automotive companies have retrained their technicians to service hybrid vehicles, but there are components such as battery thermal systems that do not exist in hybrid vehicles. Over the next 6 months, GM is planning to retrain 22,000 technical and non technical staff at GM dealerships, to prepare for both selling and servicing Volts (Cobb, 2011). Similar training should be given to technicians and non technical staff in Toronto to promote EV adoption.

### 5.2. Shift towards Smaller, Lighter Vehicles.

The drivetrain of Electric Vehicles is much more efficient than gasoline vehicles, but EVs tend to be much heavier due to the low energy density of batteries. Therefore it is very important to minimize the mass of the vehicle to maximize range. By integrating the battery into the chassis, you can reduce the overall weight of the vehicle, and maintain a low centre of balance which is good for stability. Lighter alternatives to steel such as aluminium, magnesium, and composite materials should be evaluated for the construction of the car body. Also, reducing the overall size of the vehicle will increase the battery to vehicle weight ratio and improve range.

### 5.3. Cheaper Batteries can Decrease the price of EVs

An expensive product will hinder public acceptance, thus a decrease in battery costs be required for EVs to become competitive with gasoline cars (Green Car Congress, 2011). Currently, batteries are the most expensive component in the vehicle, accounting for up to half of the overall vehicle cost. Toyota predicts battery prices will fall by 50% in the next 20 years, but most battery manufacturers already have optimized processes, and battery materials such as nickel, manganese and cobalt have relatively stable prices (Ramsey, 2010). As the demand for batteries increase, the demand for these materials may rise; this may raise the price of batteries.

### 5.4. What about dead Batteries?

As batteries manufacturing will become much more popular in the near future, careful planning must be made to assure proper handling of battery waste. Most electric vehicles use lithium batteries, which do not contain large amounts of toxic materials, and are relatively harmless to the environment. Most parts of Lithium batteries can be recycled into materials for new batteries.

Batteries in automotive applications require high energy density to achieve a practical driving range. As a battery ages, its maximum energy density diminishes. GM will be retiring the batteries when their maximum capacity reaches 50% of a new battery. During the retired stage, the batteries will be repurposed in static applications such as solar and wind power (Valdes-Dapena, 2010).

## 6. Public initiatives to promote EV acceptance.

Governments have regulated the price of gasoline in order to artificially promote non fossil fuel propulsion. Tax rebates and government funded initiates have also been used to promote EV acceptance. Various independent companies have performed pilot programs and submitted rapid adoption proposals to the government. Other governments around the world have introduced EV adoption programs by giving tax incentives, taxing gasoline, and changing policy.

### 6.1. Gas Prices May not Scare People into Buying EVs

Expensive gasoline and cheap electricity are great incentives to buy an EV over a gasoline car. It is difficult to determine the breakpoint where it is more economic to buy an EV rather than a gasoline car due to varying prices of energy and fuel. For example: electricity prices are dependent on time of day, location, and power generation source. Smart timers have been proposed as a way to charge your car during off peak hours when electricity is cheaper.

In Europe, the price of gas can be double that of the US (~$8/gallon) due to heavy government taxing. Yet despite the high gas prices, a study by Deloitte shows that only 16% of people are considering an electric car. Furthermore, as gasoline cars become more fuel efficient, EVs become more expensive by comparison (Deloitte, 2011).

### 6.2. Government Policy and Subsidy

Expensive vehicle prices can limit the adoption of EVs, but can be offset by government intervention. In order to meet their 100,000 EV target, the London government has offered an $8,000 subsidy on the purchase of any BEV or PHEV. Also, major tax breaks are offered to EVs in company fleets by removing congestion charges(~$4368), and company car taxes for the first five years. Furthermore, EVs in London have been classified as quadricycles, and therefore do not have to meet the same standards as ICE cars (SourceLondon, 2011).

More importantly, governments need to subsidize investors interested in placing charging stations. Currently in the US, the Department of Energy is funding an infrastructure project named “the EV project”. $230 million will be used to place EV chargers across the US in major cities, and provide subsidy on home chargers that collect driving and charging data for the Department of Energy (TheEVProject, 2009).

Electric Mobility Canada also has proposed an EV adoption program to the Canadian government, offering a $5,000-$8,000 subsidy on the purchase of a plug-in hybrid, and up to $2,000 towards a personal charging station. Green stickers have been offered to EVs, which grant them special passage in carpool lanes. Should this proposal be accepted, EV acceptance will be accelerated (Electric Mobility Canada, 2010).

A future concept that will increase the acceptance of EVs is the creation of an “EV corridor”. By placing rapid charging stations along major highways between cities, one would be able to drive from one city to another by charging along the way (Ecotality, 2010).

## 7. Conclusion

Toronto is and will always be a city run by private automotives. Fuel efficient cars and hybrid electric technology have become a vital part of reducing overall fuel consumption and pollution. Following the trend of reducing dependence on fossil fuels, electric vehicles will become a more dominant form of automobile in the near future. Private investment and public initiatives can expedite the acceptance of electric vehicle technology. As we move towards a greener, more sustainable future, the electric vehicle will eventually phase out the gasoline car. But, gasoline cars will not disappear forever; they will still be our iron racehorses.

## References

Blanco, Sebastian (2009), *Korean electric car gets a charge - an induction charge - from the road* Autoblog Green, <http://green.autoblog.com/2009/09/02/korean-electric-car-gets-a-charge-an-induction-charge-from-t/>

Cobb, Jeff (2011), *Evolving toward the age of the EV: Volt dealerships are being shown the way*, GM-Volt, <http://gm-volt.com/2011/04/08/grassroots-growth-volt-dealerships-are-learning-how-to-usher-in-the-age-of-the-ev/>

CrossChasm (2009), *Toronto Hybrid Taxi Pilot*, <http://www.toronto.ca/taf/pdf/hybrid-taxi-oct09.pdf>

CHAdeMO (2011), *CHAdeMO Chargers*, <http://chademo.com/pdf/CHAdeMOchargers.pdf>

Deloitte (2011), Despite rising fuel prices, mass adoption of electric vehicles still a distance away, <http://www.deloitte.com/view/en_BE/be/press/press-releases/897ec2ba3b99e210VgnVCM1000001a56f00aRCRD.htm>

Ecotality North America (2010), *The EV Project FAQ*, <http://www.ecotality.com/pressreleases/FAQ_DOE_Ecotality_The_EV_Project.pdf>

Electric Mobility Canada (2010), *DRIVING THE RAPID ADOPTION OF ELECTRIC VEHICLES IN CANADA*, page 10, <http://www.emc-mec.ca/files/DrivingTheRapidAdoptionOfPEVsInCanada-v3a.pdf>

EV Town, *Levels of Charging*, <http://www.evtown.org/about-ev-town/ev-charging/charging-levels.html>

Green Car Congress (2010), Study Finds Coordinated Off-peak Charging Can Support Large Scale Plug-in Use Without Additional Generation Capacity; TCO and GHG Abatement Costs for BEVs Projected to Remain High, <http://www.greencarcongress.com/2010/10/vanvliet-20101018.html>

Halbright Rudi, Dunn Max (2010), *Case Study: The Toyota Prius: Lessons in marketing eco-friendly products*, <http://presidioedu.academia.edu/MaxDunn/Papers/177832/Prius_Marketing_Case_Study>

Hybrid Cars (2006), *Profile of Hybrid Drivers*, <http://www.hybridcars.com/hybrid-drivers/profile-of-hybrid-drivers.html>

LaMonica, Martin (2010*), How much does cost matter in the first wave of EVs?*, Cnet News, < http://news.cnet.com/8301-11128_3-20011950-54.html>

Loveday, Eric (2011*), Coulomb CT500 Level II home charging station now available, Autoblog Green* <http://green.autoblog.com/2010/07/29/coulomb-ct500-level-ii-home-charging-station-now-available/>

Mick, Jason (2011), *UPDATED: Study Claims Hybrids Are Bad Buy, But is it Flawed?,* DailyTech, <http://www.dailytech.com/article.aspx?newsid=21642>

Mediamark Research & Intelligence (2008), *HYBRID CAR OWNERS REMAIN A SMALL AND RARIFIED GROUP,* <http://www.gfkmri.com/PDF/MRIPR_112508_Hybrid%20Cars.pdf>

Motavalli, Jim (2011), *Texas E.V. Charging Plan Expands to Dallas-Fort Worth*, New York Times, <http://wheels.blogs.nytimes.com/2011/04/08/texas-e-v-charging-plan-expands-to-dallas-fort-worth/>

Natural Resources Canada (1997), *1997 Survey of Household Energy Use*, <http://oee.nrcan.gc.ca/publications/infosource/pub/energy_use/sheu_e/index.cfm>

Official website for the City of Toronto (2006), *Ward Profiles Summary*, <http://app.toronto.ca/wards/jsp/wards.jsp>

Ramsey, Mike (2010), *High Battery Cost Curbs Electric Cars*, Wall Street Journal, <http://online.wsj.com/article/SB10001424052748703735804575536242934528502.html>

SourceLondon (2011), *A Plan for London*, <https://www.sourcelondon.net/plan-london>

The EV Project (2009), *The largest deployment of EVs & charge infrastructure*, <http://www.theevproject.com/overview.php/>

Toronto Board of Trade (2010), *Toronto Scorecard on Prosperity – 2010*, page 43, <http://bot.com/Content/NavigationMenu/Policy/Scorecard/Scorecard_on_Prosperity_2010_FINAL.pdf>

United States Department of Energy – Energy Efficiency and Renewable Energy (EERE) (2011), *Battery Chargers for Electric Vehicles,* <http://www1.eere.energy.gov/vehiclesandfuels/avta/light_duty/fsev/fsev_battery_chargers.html>

Valdes-Dapena, Peter (2010), *Ultimate electric car challenge: Dead batteries* ,CNN Money, <http://money.cnn.com/2010/12/14/autos/electric_car_battery_recycling/index.htm>

ZipCar (2011), *Rates & Plans*, <http://www.zipcar.com/toronto/check-rates>