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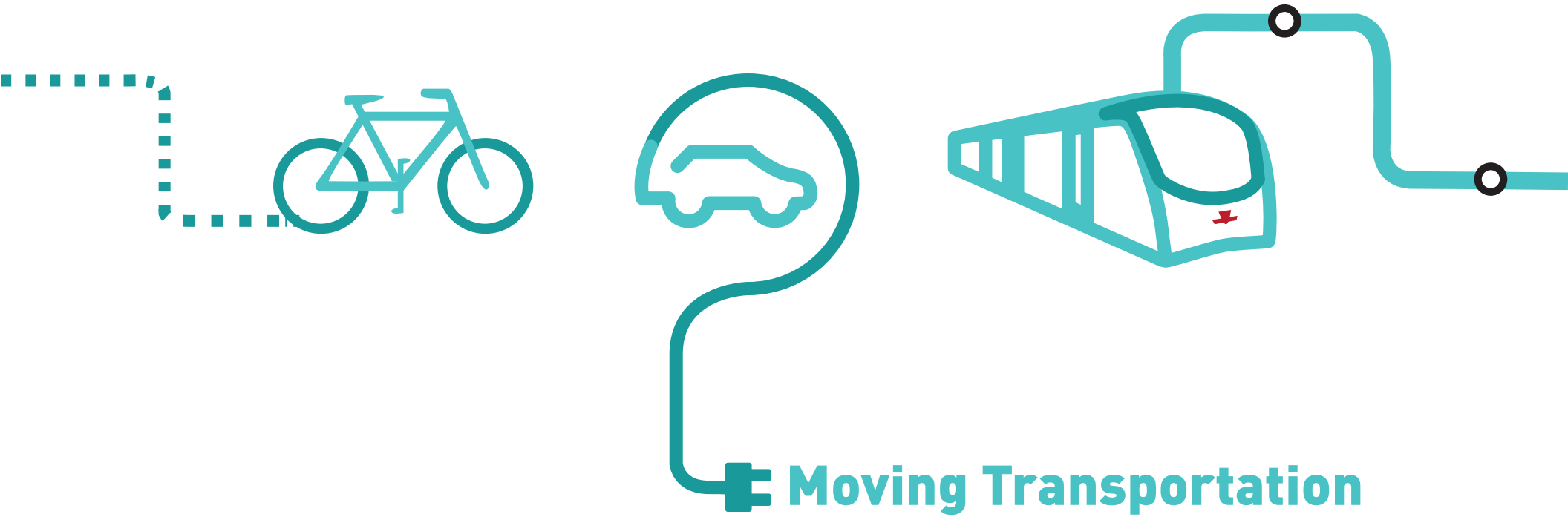

# Moving Transportation Into the 21st Century

2013 Campus Sustainability Survey Results

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The authors are grateful to the following individuals for their significant feedback and input to the drafting of questions in "Moving Transportation into the 21st Century": Brad Cochrane and Helen Psathas of Campus Services & Business Operations (CSBO); Mustafa Nazari, MES student and GA with CSBO; and Katrusia Balan of Smart Commute - North Toronto, Vaughan (Smart Commute NTV). The Institute for Social Research (ISR) was especially helpful in reviewing the survey and offering critical suggestions for its design relevant to its analytical outcomes. The Office of Institutional Research and Analysis (OIRA) provided university-wide demographics, which allowed the researchers to gain insight into representativeness of the survey sampling. As IRIS volunteers, Yeon-Ju Heo and Michelle Smith gave their time generously in researching background information that helped develop the substantive content of the survey.

Outreach marketing for the present survey was made possible largely by IRIS work study students: Enrique Miranda, Mitra Alizadeh, Bushra Noureen, Hao Yang, Jennifer Evola, and Sanaz Hojati, whose efforts were greatly facilitated by volunteers at IRIS' tabling events on both Keele and Glendon campuses.

IRIS thanks all contributors and appologizes to those who have been missed.

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# Executive Summary

In 2012, the Ontario government budgeted $11.8 million to support the uptake of electric vehicles and charging infrastructure. In 2017 the TTC will open the Yonge-University-Spadina subway with two stations at the Keele campus. Campus Services and Business Operations requested that the Institute for Research and Innovation in Sustainability (IRIS) examine community interest in electric vehicles and methods to further improve sustainable transportation options for York University for this year's Annual Campus Sustainability Survey.

In March 2013, IRIS staff and volunteers surveyed 1,006 York University community members about their interest in electric vehicles and other related transportation issues. This report highlights the survey results, and provides specific recommendations that address the transportation issues raised by community members about transportation at York University.

The survey results indicate that there is still limited interest in electric vehicles—both plug-in hybrids and battery electric vehicles—among York University community members. As a result, we recommend that York University proceeds slowly and carefully with the business of providing charging stations. A demonstration project in one of York University's parking garages using an indoor charging station is recommended.

There continues to be a mix of modes for commuting to the University. While some respondents plan to switch to using public transit with the arrival of the new subway, the majority do not. This may indicate a lack of understanding of the infrastructure changes that the subway extension will bring, and the University will need to more active communication to community members.

Interest in carpooling and cycling on campus do not match current behaviours. Carpooling initiatives and programs are known about by just under half the population, with more than half being motivated by cost of parking permits to carpool, yet only 27.4% of respondents regularly or occasionally carpool. Increased communication about the suite of carpooling initiatives available at York University could increase uptake. For cycling, interested community members cite lack of a safe network as the main reason for not cycling more. Changes in surrounding communities will likely be the main driver of increased cycling to campus, while improving cycle facilities at the university may motivate some of those interested in cycling to campus. Working to create a bike repair shop and a bike share network on campus are recommended, as well as better communicating the existing bike cages, shower facilities and lockers that are available.

# Introduction

The mandate of the Institute for Research and Innovation in Sustainability (IRIS) is to pursue inter-disciplinary research focused on sustainability. One of our ongoing projects is an annual campus sustainability survey on a sustainability theme. The topic of the sixth IRIS survey stemmed from the need to explore interest in electric vehicles as part of overall planning for transportation at the university, which includes the Yonge-University-Spadina subway expansion to York, parking, carpooling and cycling infrastructure.

York University is one of the greenest universities in Canada; we were one of four universities named Canada's Greenest Employers in 2013. In a continuing effort to promote more sustainable transportation and a cleaner environment, the University is investigating the interest in electric vehicle (EV) ownership. This will assist York University in planning for providing electric vehicle charging stations on campus. Currently, the Ontario government is supporting electric car uptake and vehicle charging infrastructure by budgeting $11.8 million in the current fiscal year to encourage said initiatives (ECO, 2012).

The survey, developed November 2012 through February 2013, and conducted in March 2013, also collected information to assess the various other modes of transportation used to commute to and from York University (all campus locations) by all members of the York University community, including cycling and carpooling. In particular, this information will help plan for transportation changes on the Keele campus with the arrival of the Yonge-University-Spadina subway at the end of 2016. This work builds on previous surveys (e.g. by Smart Commute - North Toronto, Vaughan (Smart Commute NTV) on the level of engagement in active and smarter transportation, e.g. cycling and carpooling.

This report highlights research on electric vehicles, carpooling and active transportation, provides the survey results and makes specific recommendations for further improving transportation at York University, including assessing the technical and economic feasibility of the installation, operation and management of electric vehicle charging stations at York University.

# Definitions

## Electric Vehicles

There are three different types of EV's, which are referred to interchangeably in various sources. **In this report**, the three classifications used will follow the typology used by Transport Canada (2010)'s "Electric Vehicle Primer." A quick fuel-based classification is provided below. For more information, please see the tables in Appendix A. **Unless otherwise specified in this report**, EV's shall refer to Battery Electric Vehicles (BEV's)

- **Hybrid Electric Vehicle (HEV)**: runs mostly on gas; electricity usage is assistive and secondary to gas;
- **Plug-in Hybrid Vehicle (PHEV)**: can run on both gas and electricity for regular driving; gas takes over when electricity is low
- **Battery Electric Vehicle (BEV)**: runs only on electricity for regular driving

## EV charging and chargers

An electric vehicle charging station, also known as an electric recharging point or simply a charging point, is a machine that supplies electricity for the recharging of plug-in hybrid electric vehicles and battery electric vehicles. The electricity is delivered at different voltages, depending on the level of the charging station; higher voltages mean a faster charge. See Appendix B to learn more.

## Active transportation

Active transportation refers to any form of human-powered transportation – walking, cycling, in-line skating, skateboarding, non-mechanized wheelchairing, etc. There are a range of recognized benefits from engaging in active transportation. They range from improved personal health to financial savings. Active transportation provides opportunities for physical activity, increase the likelihood of social interactions with people in the same area, reduces vehicular traffic, can contribute to greenhouse gas reductions, and can save money on transit fares, or gas and parking.

## Cycling infrastructure

Cycling infrastructure includes the network of roads (excepts those on which bikes are not allowed e.g., highways), bike paths and multi-purpose paths (like greenways), plus bike racks, specialized traffic signs and signals, lockers, changing rooms and shower facilities.

# Methodology

Survey methodology for "Moving Transportation into the 21st Century"

The survey was developed by IRIS staff, graduate students and volunteers, in close collaboration with various units of York's Campus Services and Business Operations (CSBO). Smart Commute NTV also contributed to the design of questions, in particular related to active transportation at York. The survey was submitted to and approved by York University's Office of Research Ethics. For ease of data collection and interpretation, the survey was administered online using SurveyMonkey.net. For interpretive simplicity, the survey was comprised largely of closed-ended questions, which required respondents to select from the provided answers. These questions allowed for either single or multiple selections. To accommodate for cases where the preset responses would not fully reflect a respondent's opinion, the option "other" was presented so that respondents could indicate any views or positions not otherwise present. Additionally, the option of selecting "n/a" (not applicable) was provided where it was possible that the question may not pertain to all respondents.

The survey was promoted and made available to the York University community through several means:

- **Tabling on Campus (**March 5-7): Laptops were set-up in Vari Hall and IRIS staff and student volunteers promoted and administered the survey. Tabling also took place at Glendon Campus on March 22.
- **Listservs:** The online survey link was sent to the CPM listserve on March 6, as well as several faculty and department listservs for transfer to their members.
- **Y-File Newsletter**: The online survey link was included in the Y-File e-newsletter, which is sent to all York staff.
- **IRIS Website**: The survey was promoted on a homepage banner. The banner could be selected to take users directly to the online survey.
- **Social Media:** Facebook and Twitter dissemination was used.
- **Posters**

The various survey distribution methods and promotions made the survey available to a wide York audience. Respondents could complete the survey in person (during tabling at Keele and Glendon campuses) or online. Prizes were used to entice otherwise uninterested individuals to visit the survey tables, and the online link.

The survey attracted the participation of 1,099 respondents, 1,006 of whom completed the survey (the completion rate was 91.5%), and whose responses are detailed in the following report.

# Caveats, Acknowledged Biases & Survey Limitations

All surveys have limitations and biases embedded within the questions that influence the survey results. Our assessment of these limitations and biases are discussed below.

IRIS has a mandate to carry out research related to sustainability, and thus the survey includes an admitted environmental bias. To ensure that all respondents could be confident that their opinion mattered, the survey preamble included the following note: "York University is one of the greenest universities in Canada. In a continuous effort to promote more sustainable transportation and a cleaner environment, the University is investigating the interest in electric vehicle (EV) ownership. This will assist in planning for providing electrical vehicles charging stations. This survey also seeks your critical input in planning for other transportation initiatives, including the Yonge-University-Spadina subway expansion to York, parking, as well as assist in building a carpooling culture and improving cycling infrastructure."

To counter this bias, we sought to make the survey easily acceptable to as many members of the York University community as possible. Through offering Metropass prizes we also sought to appeal to members of the community who would normally be less inclined to participate in such a study, though, understandably, individuals who are interested in transportation issues are likely to be over-represented in the data as they would be more likely to complete the voluntary survey.

Despite our aiming to design the survey for ease of completion, some respondents were not able to complete the survey. Only completed surveys were included in the final analysis. Consequently, this report does not reflect the partial input of the respondents who did not complete the survey.

The terms "survey participants" and "respondents" are used interchangeably. The usage of these terms in different questions does not always refer to the same group of individuals responding to a particular question. This is because the survey employed "skip logic" at various points to direct individuals past questions that did not pertain to them. An example to consider is a question which asks individuals whether they have access to a vehicle to drive to York. The question is relevant to all individuals who commute to York. For individuals who answered "no," campus parking questions will not be relevant to them and are thus bypassed. For individuals who answered positively, they will form a subpopulation that sees and responds to the campus parking questions. This point is an important one for those reviewing this report, which takes care to emphasize places in the analysis where the term "respondents" begins to represent different groups (or subpopulations) of individuals. Keeping this in mind will help reviewers gain a nuanced understanding of which and how different parts of the York University community are being engaged by campus initiatives.

Finally, through crosstabulation, some survey variables were found to be correlated with statistical significance. These findings are highlighted in the "Survey results" section of the report.

# Electric Vehicles

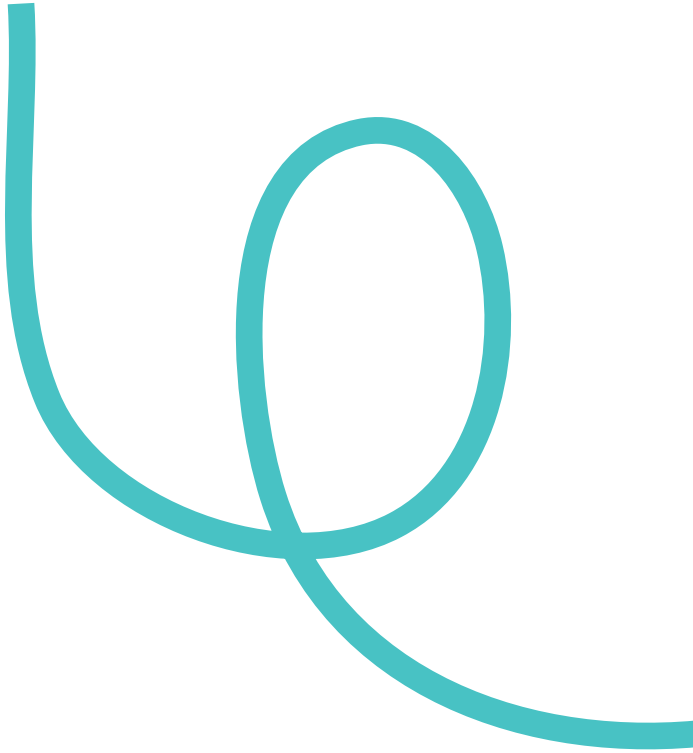
Electric vehicles are a generic term referring to vehicles that run partially or fully on electricity for power. These are contrasted with conventional vehicles, which run entirely on fossil fuels: that is, gasoline, diesel, natural gas and propane. Electric vehicles include hybrids, plug-in hybrids and battery electric vehicles (BEV). Only plug-in hybrids and battery only vehicles utilize charging stations to replenish their batteries, while hybrids use energy from deceleration and braking. See Appendix A – Electric Vehicles for more information.

Fossil fuel burning by conventional vehicles emits greenhouse gases which contribute to climate change and unpredictable weather events. BEV's however, do not emit greenhouse gases. In Ontario, it is estimated that 37 million tonnes of carbon dioxide (CO2) are emitted annually by light duty vehicles (Plug n Drive, 2013, using NRCAN data). Although charging EV batteries in some cases mean using electricity generated from carbon-emitting processes – such as at coal firing generators – switching to an EV from a conventional vehicle helps to lower CO2 consumed by as much as 90% (ibid).

There are a number of charging equipments providing three levels of charging. Level 1 charging stations are "plug and play" and can be used with residential outlets. Level 2 charging stations, with twice the level of voltage, require a licensed electrician for installation. Finally, Level 3 charging stations provide direct current (DC) versus alternate current (AC), and as such do not require AC-to-DC conversion and charge much faster. See Appendix B – Technical Aspects of EV's and Charging, to learn more.

An EV charging market is currently in test phases all over the world, with local governments leading most initiatives. Due in part to the lack of charging infrastructure, hybrid vehicles remain the most popular, however growth in plug-in hybrid and battery electric vehicles is expected to surpass traditional hybrids over the next decade. See Appendix C – Electric Car Market for more information.

Case studies for charging infrastructure which have moved beyond pilot testing are rare. However, a number of case studies are very useful as York University conducts detailed feasibility analysis of providing EV charging infrastructure in the future. The case studies by UCLA, University of British Columbia, and an overview of initiatives in the GTA are outlined in Appendix D – EV Case Studies.



# Electric Vehicles

## Ontario Government initiatives

Currently, the Ontario government offers the following incentives for purchasing an electric vehicle, installing electric charging equipment and driving the vehicle (Ministry of Transportation Ontario, 2013):

- If purchasing or leasing a new PHEV or BEV, the consumer can apply for a rebate ranging from $5,000 to $8,500. The rebate is provided through the Electric Vehicle Incentive Program
- If the above rebate is received, the consumer is further eligible for up to $1,000 or 50% (whichever is lower) in rebate towards the cost of purchasing and installing a charging station
- Vehicles from the Electric Vehicle Incentive Program incentive are eligible for an Ontario Green Plate, a licence plate permitting the vehicle to access high occupancy vehicle (HOV) lanes until June 30, 2015, regardless of the number of occupants in the vehicle

# Transportation at York

## Transit Options

Public transit and York University's shuttle system are key elements of the York University community's public transportation mix. York is serviced by four transit systems – Brampton Transit, York Region Transit, Go Transit, and the Toronto Transit Commission.

Brampton Transit's Züm Bus Rapid Transit operates a service along Queen Street from downtown Brampton to York University. Züm's York University service runs between seven and fifteen minutes every day. GO Transit runs eight buses throughout the week. Route 46, Hwy. 407 West extends from the University of Guelph to York. Route 42, Hwy. 407 East extends from the Oshawa Bus Terminal to York. Route 65, Barrie GO Bus and Train extends from the Barrie South GO Station to Union Station, and stops at York University's GO Station. This GO Station is serviced by a York University Shuttle. The Toronto Transit Commission operates fifteen bus routes adjacent to the Harry. W. Arthurs Commons. When the York University and Black Creek Pioneer Village Stations open in the fall of 2016, the current bus loop will be relocated to the new 407 Transitway, part of the multi-modal transportation hub at the Highway 407 Station.

York University also operates its own shuttle services for the exclusive use of the York University Community. An all day Glendon shuttle allows for trips between York's two campuses in approximately 45 minutes. A Go Train shuttle runs during rush hour between York University and the York University Go Train station. York University Village shuttles – Village West, Village East and Village Express – run in the late evening and early morning, in order to facilitate safe travel for Village residents. Van Go, a mobility service for people with disabilities can be accessed through prior request.

# Transportation at York

## Carpooling

Carpooling is not a new concept, but has become increasingly popular as traffic congestion continues to worsen. Also known as ride-sharing, carpooling is the active sharing of a vehicle with others who typically choose to drive alone. Carpooling allows commuters to share their commute cost with others while at the same time reducing harmful emissions.

According to the York University 2012 Commuting Survey conducted by Smart Commute NTV, the top motivators that would encourage students, staff and faculty to carpool were: (1) help in finding suitable people to carpool with (2) flexibility to carpool occasionally (3) reserved parking for carpoolers close to the entrance.

Smart Commute's Carpool Zone website (www.carpoolzone.smartcommute.ca) offers users an easy-to-use and convenient network which functions as a database allowing commuters to connect based on their location and destination. During registration, users input their current location, destination and frequency of travel. Carpool Zone then produces a map of nearby users who may be contacted through the website, thus establishing a carpool match.

As well, Smart Commute NTV has implemented the Diamond Pool Parking Program which offers students, staff and faculty the option of sharing a parking permit amongst two or more people. Participants of the Diamond Pool Parking Program are eligible for the Priority Carpool Parking Program, which provides convenient spaces on the Keele campus that allow carpoolers closer access to building entrances and walkways.

There is also a car-sharing program available on the Keele Campus provided by Zipcar. This service offers users flexibility in terms of use and is designed to accommodate short distance travel. Vehicles can be reserved online and the rental cost includes gas, insurance and maintenance.

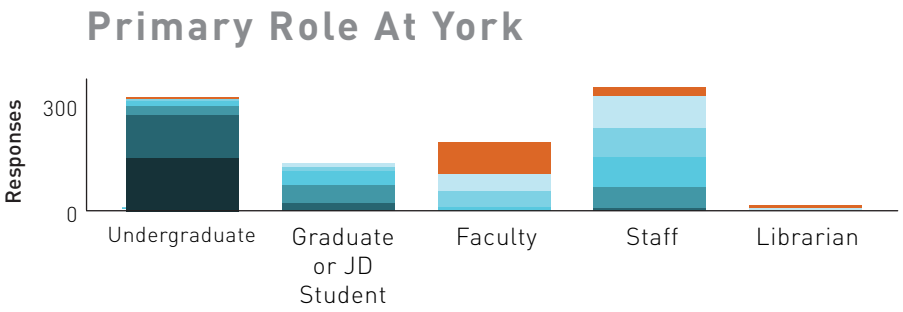
# Transportation at York

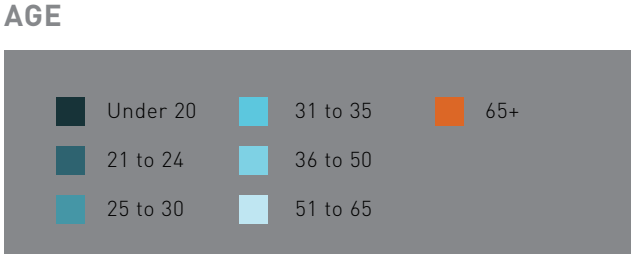
## Cycling

Although York University is not centrally located in the downtown core of Toronto, there is infrastructure that allows students, staff and faculty to choose cycling as their primary commuting mode. Infrastructure improvements are the main incentive that respondents of the York University 2012 Commuting Survey suggested would encourage them to try walking or cycling to campus. Currently, there is access to York University's Keele Campus via bike lanes on Sentinel Road, as well as from the Finch Hydro Corridor multi-use path; promotion of this infrastructure and information on safe cycling and walking could be provided, which was another motivator mentioned by 9% of respondents. Sheltered bike parking was reported as an encouragement to support cycling to campus. 26% of respondents indicated a need for secure or sheltered bicycle parking on campus.

Indoor bike cages can be used at the York University Student Services and Arboretum parking garages free of charge. Application forms are available at York University Parking and Transportation Services. Shower and locker facilities are available at York University's Tait Mackenzie Fitness Centre located on Thompson Road. Route advice and maps encourage cycling and walking, and are provided at both Seneca Student Services on-site, as well as at the Smart Commute NTV storefront office located on the Keele campus.

# Survey Results




Of the 1,099 respondents attracted to the survey, 1,006 (91.5%) completed it. The subsequent analyses are based on the completed survey responses.

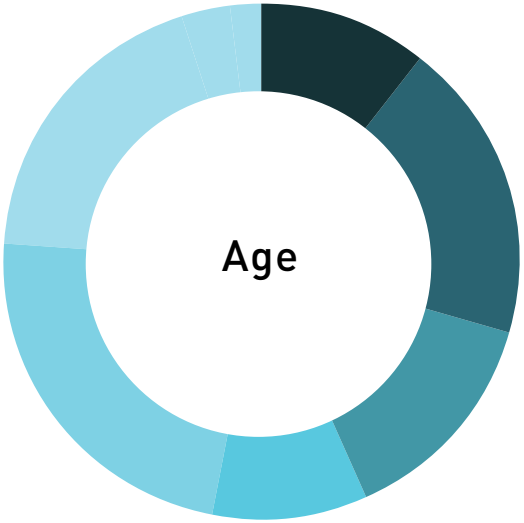
The bulk of respondents to this year's survey are undergraduates and staff members. However, according to university -wide data (York University Factbook, 2013), staff and faculty number roughly 3,000, as compared to an (a) undergraduate population of just under 50,000 and (b) a graduate population of just under 6,000. There is a significant over-representation of staff and faculty and an under-representation of undergraduate students. The higher representation of faculty and staff is likely due to easier access to campus listserves to reach these groups versus students. The authors do acknowledge this demographic discrepancy.

Using undergraduate and graduate student demographics from the Office of Institutional Research and Analysis (OIRA), the researchers of this study conclude that the survey performed reasonably well in recruiting participants based on gender and age. Some large discrepancies can be seen with over- or under-representation of certain undergraduate colleges, which may have been related to relative success (or lack thereof) of promotional efforts at some departments. By extension, faculty members recruited to the study may have also been over- or under-represented in some departments. Further analysis would be needed to uncover issues with representing the university community along certain demographic lines, in order to inform future promotional efforts by IRIS.

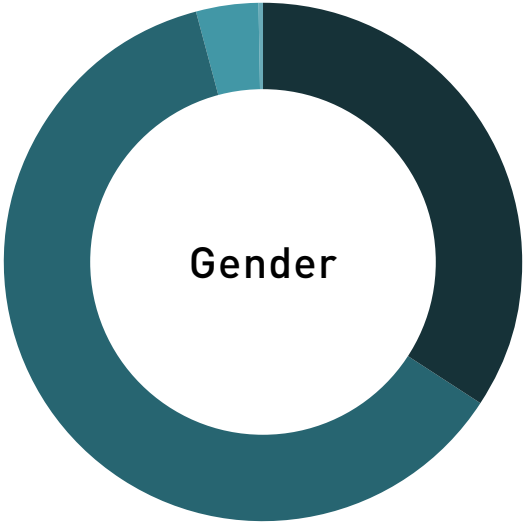
Predictably the vast majority (84.7%) of undergraduate respondents are under 25 years old, and a further 8.5% are aged between 25 and 30. Over one-third (37.4%) of graduate respondents are between 25 and 30, with smaller but similar percentages in age categories 21-24, 25-30 and 31-35. The vast majority (82.1%) of the faculty members who responded are between 36 and 65 years old. Among staff, 64.7% are between 36 and 65, and age categories of 25-30 and 31-35 are each represented at just under 15%. Librarian respondents are mostly 36 and older.

The demographics of the survey respondents follow on pages 16-19.

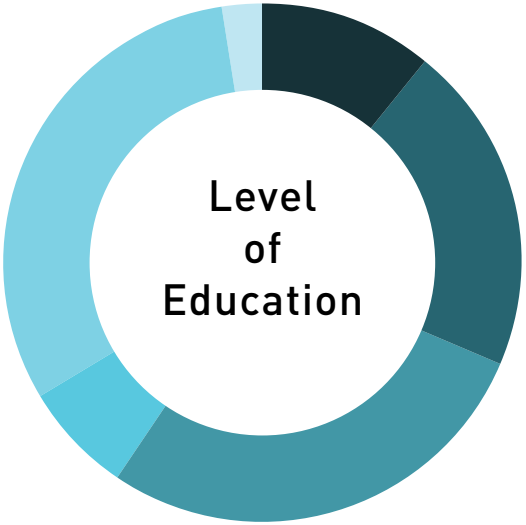
# Demographics




- Under 20
- 21 to 24
- 25 to 30
- 31 to 35
- 36 to 50
- 51 to 65
- 65+
- Undisclosed

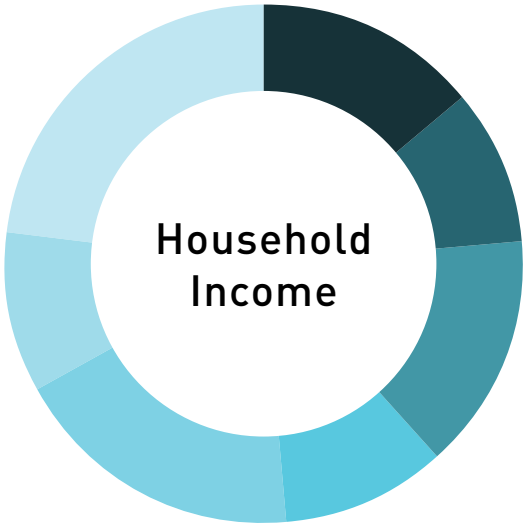



- Male
- Female
- Undisclosed
- Other

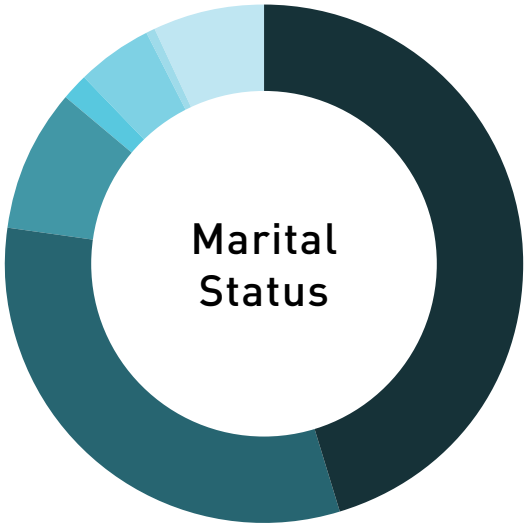



- High School
- University/College
- University/College Graduate
- Some Post Graduate
- Post Graduate Degree
- Undisclosed

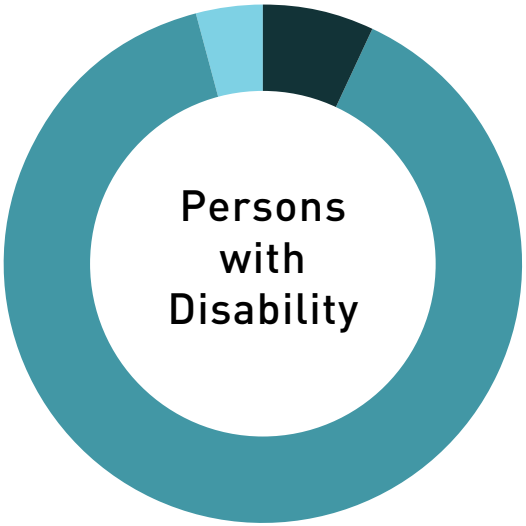
# Demographics




- Less than $25,000
- $25,000 to $49,999
- $50,000 to $74,999
- $75,000 to $99,999
- $100,000 to $149,999
- $150,000 +
- Undisclosed

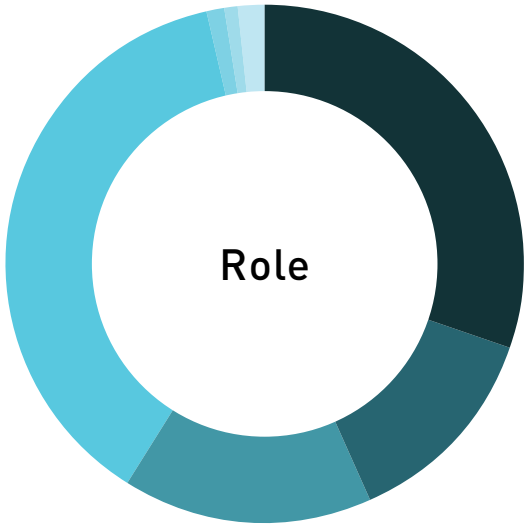



- Single
- Married
- Common-law
- Separated
- Divorced
- Widowed
- Undisclosed

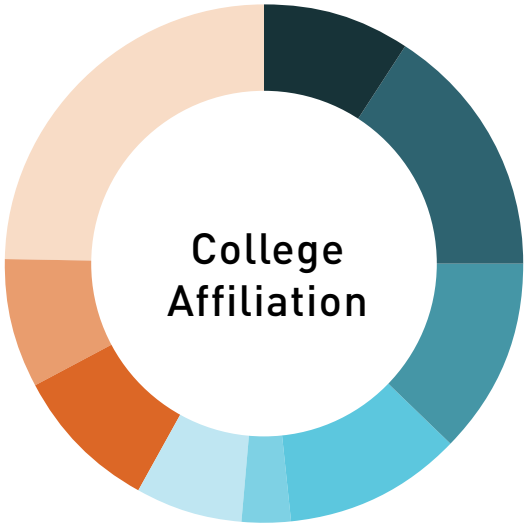



- Yes
- No
- Undisclosed

# Demographics



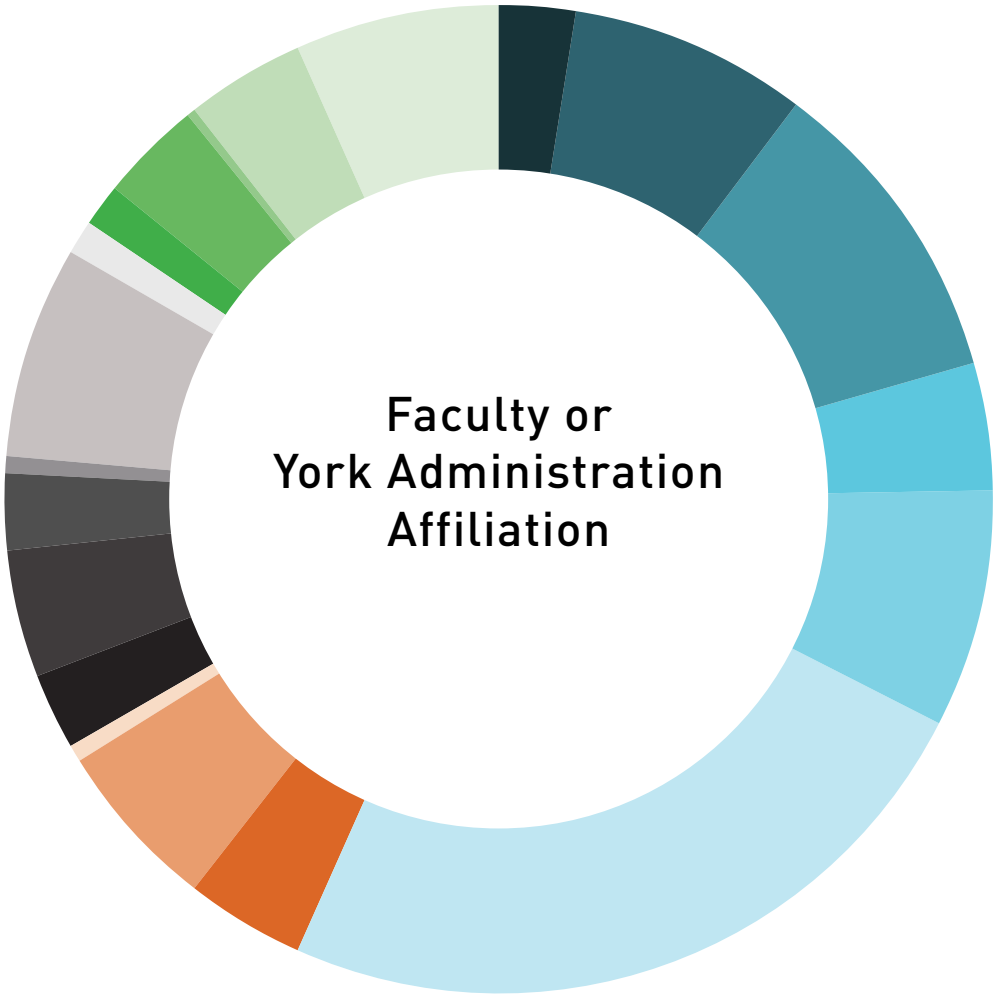

- Undergraduate
- Graduate or JD Student
- Faculty
- Staff
- Librarian
- Undisclosed
- Other




- Calumet
- Founder
- Glendon
- McLaughlin
- New
- Norman Bethune
- Stong
- Vanier
- Winters

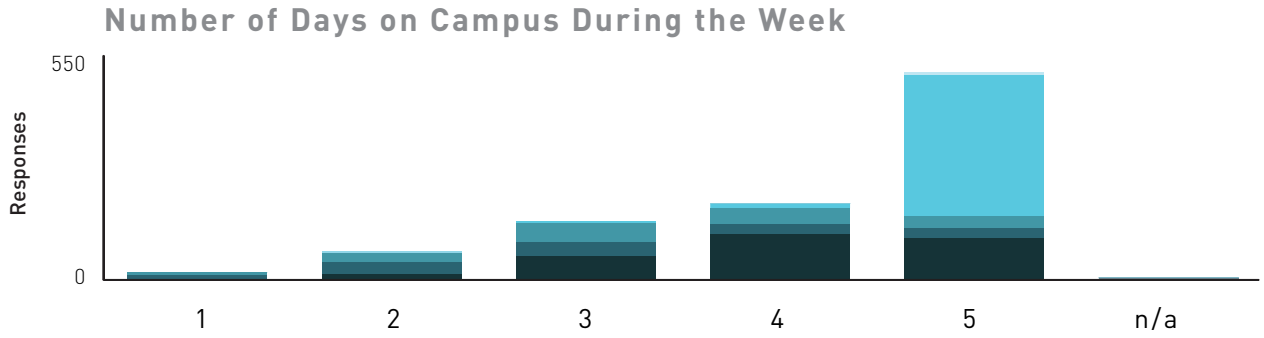

- 1 to 2 years
- 3 to 4 years
- 5 to 10 years
- 11 to 15 years
- 16 to 20 years
- 20 +
- Undisclosed

# Demographics




- Faculty of Education
- Faculty of Environmental Studies
- Faculty of Fine Arts
- Faculty of Graduate Studies
- Faculty of Health
- Faculty of Liberal Arts and Professional Studies
- Faculty of Science
- Glendon Campus
- Lassonde School of Engineering
- Osgoode Hall Law School
- Schulich School of Business
- Academic - Not a Specific Faculty
- Advancement
- Finance & Administration
- President
- Research & Innovation
- Vice - Provost Students
- Seneca@York
- Not Applicable
- Undisclosed

# Time on Campus




PRIMARY ROLE

Undergraduate
Graduate/JD
Faculty
Staff
Librarian

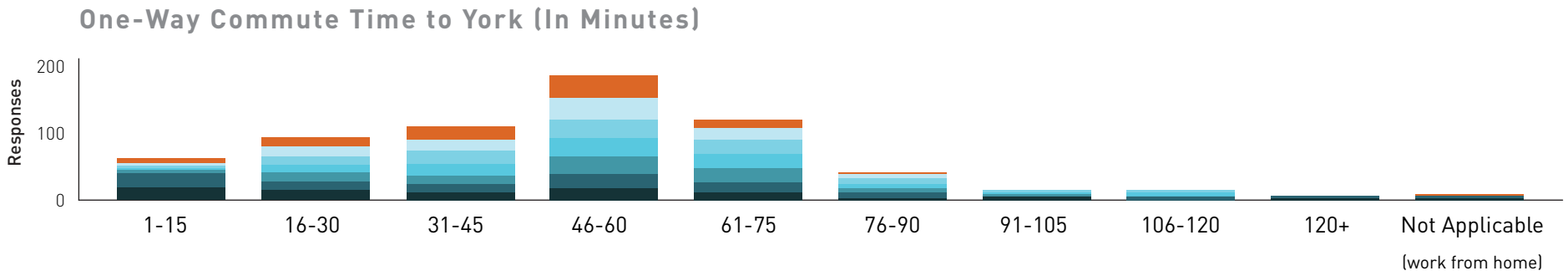
**Analysis**

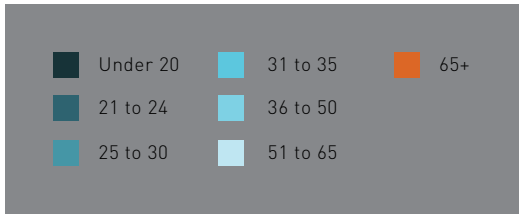
Over half of the respondents (53.6%) come to campus every weekday, 67.9% within these respondents were staff and librarians.

A large majority (79.0 % to 93.7%) of respondents who come to campus on weekdays are here between 8am and 6pm. 59.2% to 73.4% respondents who commute to campus on weekends are here between 10:30am and 6pm. Morning, evening and overnight hours are also common on weekends.

# Commuting to York

## Commute Time and Distance




### Analysis

**How long does your one-way commute from home to campus take?**

Commute times between 46 and 60 minutes were most common at 27.1%, followed by 61 to 75 minutes (18.5%) and 31 to 45 minutes (16.7%).

- Respondents under 25 years old are more likely to spend between 1-15 minutes in commute, because a sizeable proportion of this group lives on or near campus; respondents between 25 and 65 tend more to spend 46-60 minutes each way.

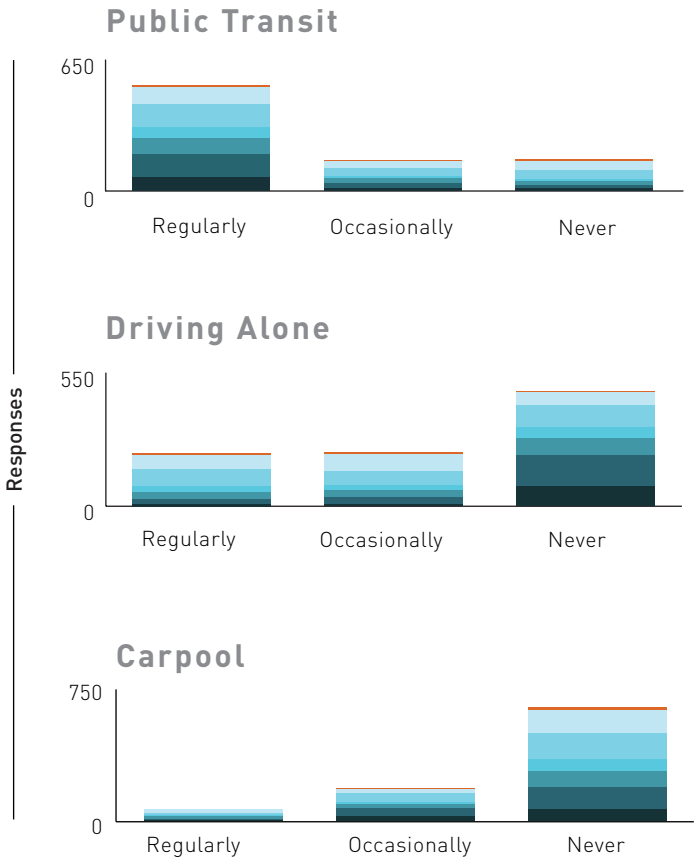
**What is the distance (one-way) of your commute from home to campus?**

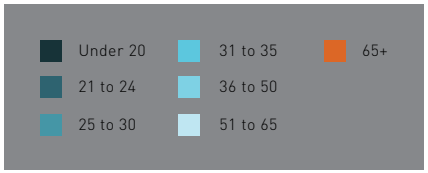
20% of respondents live between 16 to 20 kilometres from school, followed by 17.8% reporting 21-30 kilometres and 13.2% reporting a distance of 11 to 15 kilometres.

- Respondents between 25 and 50 years old are most likely to live between 16 and 20 kilometres away.

# Commuting to York

## Frequency of Modes of Transportation




### Analysis

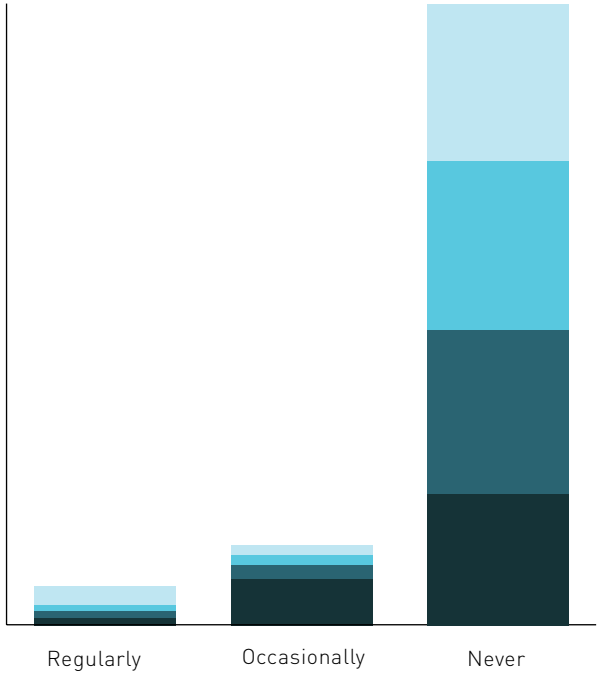
62.8% of survey takers identify public transit as the form of transportation they regularly rely on to get to campus. This is the highest percentage of regular usage reported compared to other modes of transportation. The second most frequently used mode is driving alone (24.3%) and walking (10.1%). For travelling in private vehicles, 51.8% report as never driving alone and 72.6% as never carpooling in order to get to York.

Age was found to be negatively correlated with public transit usage. By contrast, age appears to be positively correlated with driving.

# Commuting to York

## Frequency of Modes of Transportation

### Frequency of Use of Other Forms of Transit




FORM OF TRANSPORTATION

Dropped Off
Bicycle
Shuttle Bus
Walk

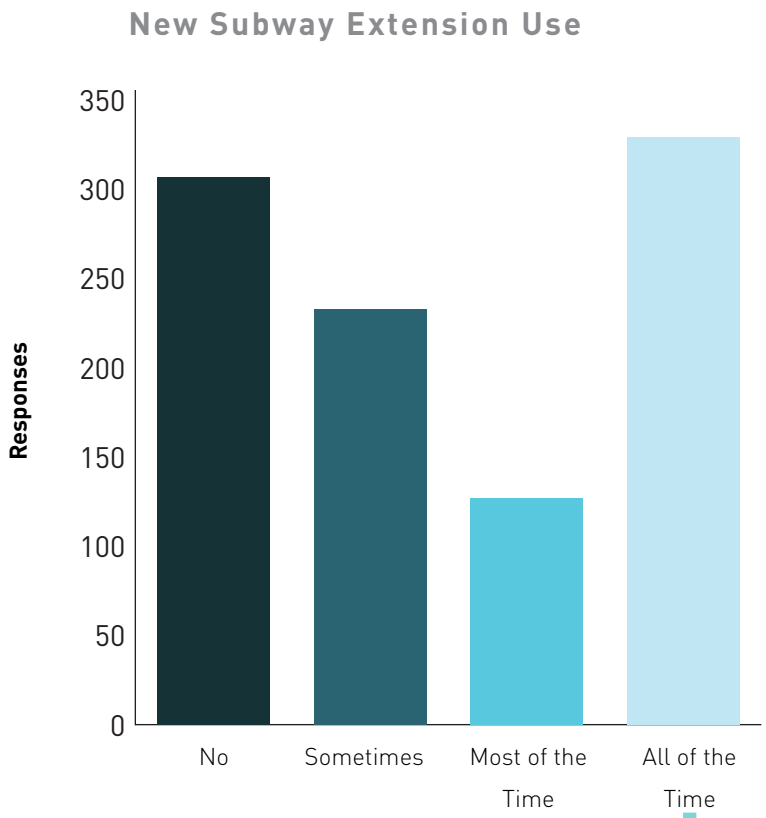
### Continued Analysis

Other commuting options entered in open-ended responses included:

- Using GO train or bus, sometimes in conjunction with other modes of transportation – in four (4) responses
- Taking a taxi regularly or occasionally – in three (3) responses

# Commuting to York

## New Subway Stations at Keele Campus

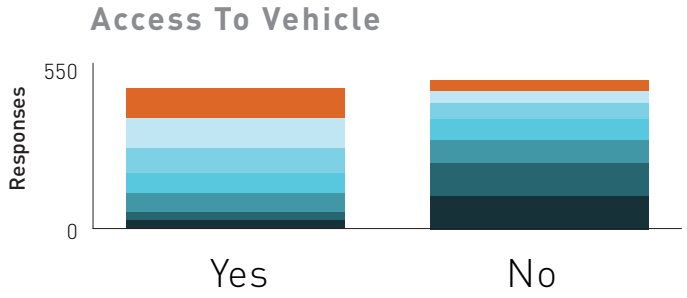


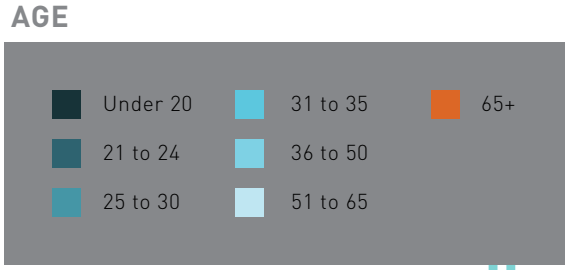

### Analysis

A combined 45.8% of respondents will take the new subway extension either most or all of the time. A further 23.4% will take the new subway occasionally. These numbers mark quite a significant demand for the new extension. These figures are similar to those found in the Smart Commute NTV's 2012 Commuting Survey which indicated that 62% take TTC bus or streetcar en route to campus, and 52% take a TTC subway line.

# Commuting to York

## Access to Vehicle Used to Drive to York



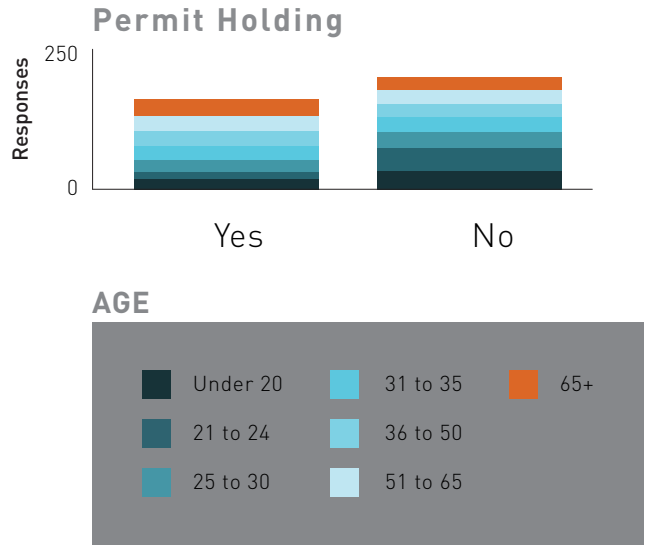

### Analysis

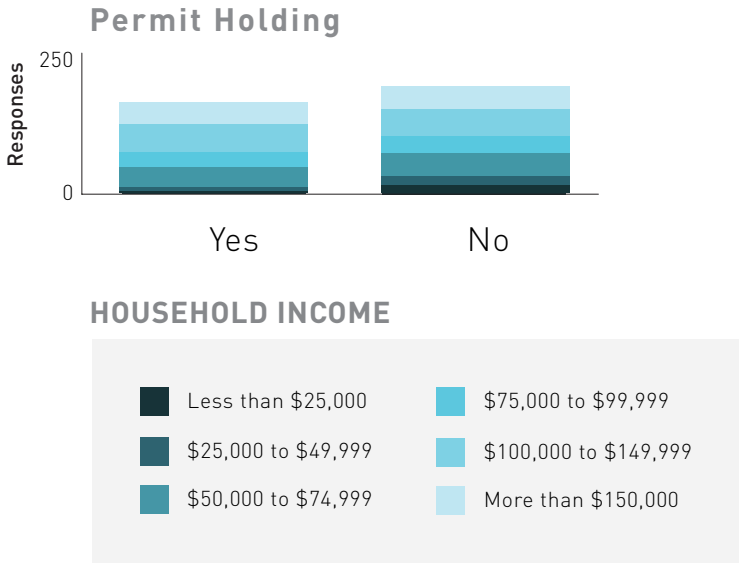
47.7% respondents answered "yes." As the graph shows, older respondents are progressively more likely to have vehicle access and drive to York.

For the 52.3% that answered "no," a skip logic in the survey was used to bypass subsequent questions about parking, electric vehicles (EV) and EV charging at York University. These latter respondents proceeded to answer questions about carpooling and active transportation, which will be covered in later sections.

# Parking

## Permit Holding




### Analysis

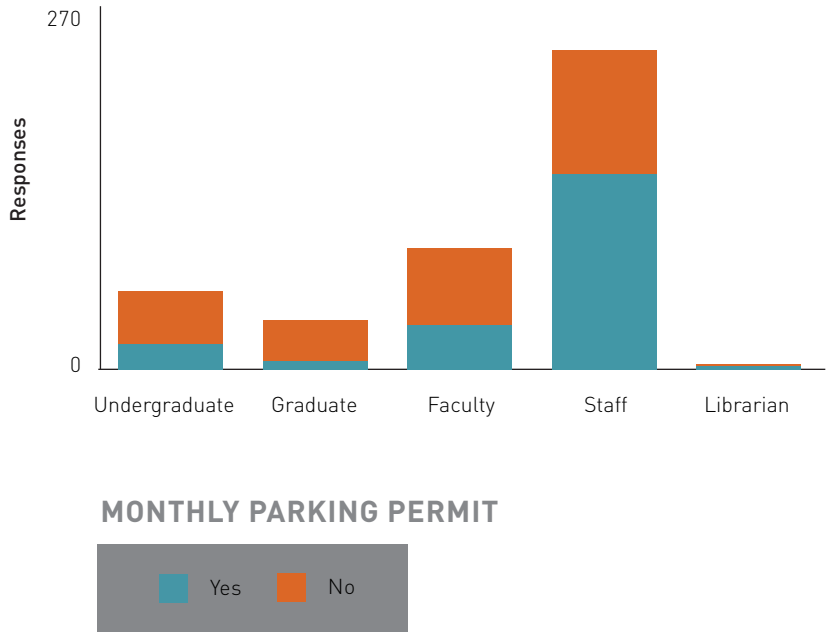
48.5% of respondents who have access to a vehicle to get to York are also permit holders.

Not surprisingly, respondents 25 years and older are more likely to be permit holders than younger respondents, which is closely related to higher income earned.

# Parking

## Permit Holding

### Permit Holding vs. Primary Role at York




### Analysis

As the graph demonstrates, staff represent the largest group possessing a parking permit at York University. Faculty and undergraduates are the next largest groups by count. These findings make sense considering each group's usage of different modes of commute, which are explored more fully on page 44.

# Parking

**Frequently used spots**

### Top 5 Parking Spaces

| | |
|---|---|
| Student Services Garage | 17.4% |
| Arboretum Garage | 14.9% |
| York Boulevard Lot | 8.1% |
| Sentinel Road Lot East | 7.7% |
| York Lanes | 7.1% |

## Analysis

With only one answer required, the two most frequently used parking spaces on Keele campus are the Student Services Parking Garage (at 17.4%), followed by the Arboretum Parking Garage (at 14.9%). A few respondents pointed out that the Central Utilities Building (CUB) was not included in the list, however no such lot exists; respondents likely meant the Chimney Stack which was on the list. More than a handful of responses also mention the Black Creek Pioneer Village lots, where parking is cheaper. At Glendon, Reserved/Visitor Lot A is the most used at 41.1%.

## Parking Comments

In this open-ended, optional section, a large number of respondents (97 or 42.5% of those who left a comment) expressed the view that parking at York is too expensive or inequitable for those with fewer or no other means of commuting. More than two dozen (27 or 11.8%) respondents desired free/reduced parking rates for staff or part-time/shift workers. 18 or 7.9% of respondents perceived snow removal as being inadequate, which could pose an issue of accessibility. A dozen (12) cited security concerns, particularly in terms of accessing the parking lots at night and where lighting is poor. A handful of respondents (5) expressed satisfaction with parking services. Two (2) participants express dissatisfaction with the lack of transportation and/or parking options at Glendon. These findings are not surprising as they are consistent with those elicited by IRIS' 2012 survey on campus accessibility.

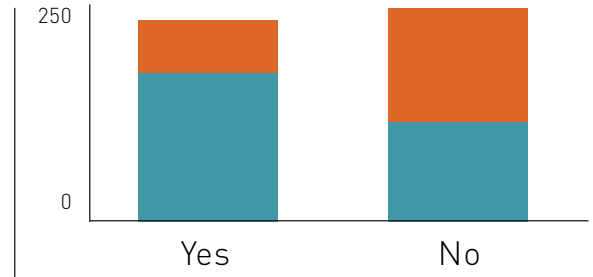
Other parking issues of note (whose respondents number between five and 10) include:

- The perception that Keele campus should charge equal or less than downtown Toronto because of its suburban location
- The perception that there is a lack of transparency or accessibility in the dissemination of parking-related information
- Payment schemes are not adequately pro-rated (are inflexible) for those who need to park for short durations
- Frustration with the lack of parking spaces where and when they are needed. Some respondents would like to see full-day parking to allow the driver to enter multiple lots and/or re-enter the same lot after making off-campus trips
- Experience with lack of assistance from Facilities and/or Parking staff
- Negotiating heavy pedestrian, buses and other vehicular traffic poses safety concerns, especially at busy intersections at Sentinel Road
- Broken parking equipment

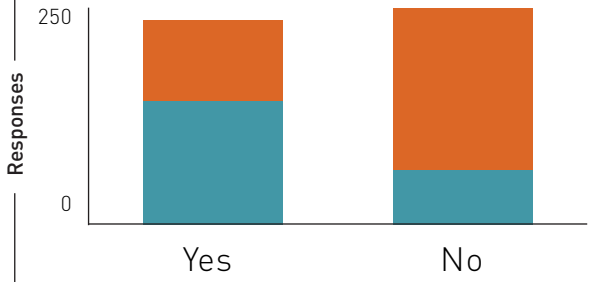
# Carpooling

## Awareness of:

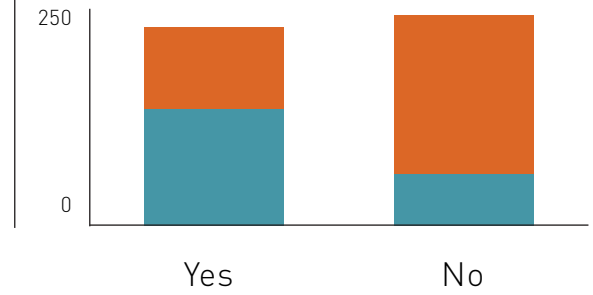
### Carpool Zone Website




### Diamond Pool Parking Permit




### Priority Carpool Parking Program




Responses

**Holds Permit**

**AWARENESS**


### Analysis

In general, parking permit holders are more aware of the following initiatives relative to those without permits: the (a) Carpool Zone website, the (b) Diamond Pool Parking Program and the (c) Priority Carpool Parking Program. However, some permit holders are unaware of the initiatives, especially the Diamond Pool Parking Permit and Priority Carpool Parking Program.

Exactly one quarter (25%) of the respondents have carpooled to York. These participants were then invited to select their top three (3) reasons for carpooling to the university in Q 24.

The top three reasons were:

- To reduce gas and parking costs (60.2%)
- To socialize (39.8%)
- To reduce ones environmental impact (38.6%)

Other reasons for carpooling provided in the open-ended responses include:

- Regular drop-off routine as a favour to oneself or others (in 28 responses)
- Preference for carpooling over transit for convenience or saving time (in 16 responses)
- Carpooling for occasional use only (in 8 responses)
- To reduce the wear and tear of carpooler's own vehicle

Exactly one-quarter (25%) of the respondents knew of the Diamond Pool Parking Program, where 2 or more registered vehicle owners (a) carpool to Keele Campus, (b) share a parking space and the cost of the parking permit.

Similarly, individuals who knew about the Diamond Pool Parking program almost all knew about the Priority Carpool Parking Program (at 24.9%), which provides 45 parking spaces reserved for carpooling vehicles.

# Carpooling

## Priority Carpool Parking Program

"The greatest challenge for me is finding someone to carpool with – I live quite far away and do not wish to alter my work hours to fit someone else's schedule."

"I do not drive and prefer the independence public transportation (TTC) gives me rather than hoping I can find someone willing to drive me for the sake of carpooling."

"I don't believe in using cars due to pollution and environmental factors."

### Analysis

**What encourages you or would encourage you to use the Priority Carpool Parking program? Please select all that apply.**

The ability to split the cost of a parking permit emerged as the top incentive (at 54.9% of the respondents). 43.6% of the respondents view this program as an environmental initiative they can support by participating in it. A little over one-third (36.5%) would carpool if parking spaces were provided in convenient locations.

Open-ended input to this question reveals:

- That for a large number of participants, nothing would encourage their use of carpooling, with reasons ranging from the desire to use transit, environmental considerations and the lack of car access (in 121 responses)
- A significant portion of the drivers have been frustrated in their efforts to find carpoolers while meeting all of the following criteria: convenience in location, cost of driving and parking vehicles and scheduling; those who are open to carpooling often cannot because erratic on-campus schedules is a major barrier in finding carpooling partners (in 82 responses)
- Parking discounts for carpooling participants as well as trustworthiness of carpoolers are also important for a handful of respondents

# Current Vehicle

Power of Car


Regular Gas **94.6%**


Diesel **2.3%**

Hybrid **2.1%**

Plug-in Electric **0%**

Electric Only **0%**


Don't Know **1%**

**How is the car you drive, or the car you are driven in, powered?**

**Analysis**

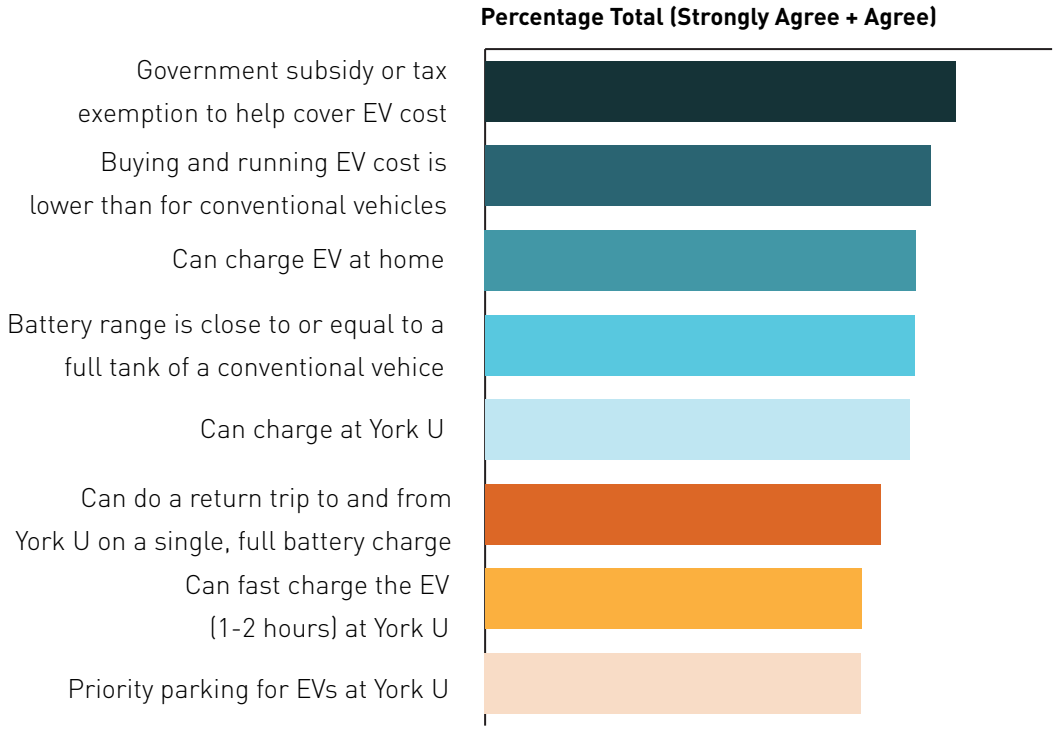
Regular gas is the predominant power source reported at 94.6%. Diesel and hybrid (mainly gas, supplemented by electricity charged during braking and used at low speeds) are the only other ones reported at 2.3% and 2.1%, respectively. Currently, it appears that there are extremely few if any users of plug-in or fully electric vehicles at York.

The vast majority (80%) of respondents who can drive to York plan to make their next vehicle purchase after a year from now. 39.6% within this group see themselves buying a car between the next 1-3 years.

# Electric Vehicles

## Understanding and Incentive

### Top EV Purchase Incentives




### Analysis

Individuals reporting sufficient understanding of EV's tend to be more willing to entertain the idea of moving their parking spot, if EV charging cannot be installed near to their current parking spot. (That is, a higher proportion of knowledgable EV respondents agree to potentially moving parking spots and a lower proportion of them disagree with moving parking – compared to respondents who do not consider themselves knowledgeable.)

95.8% of drivers are **aware** of hybrid EV's currently being on the market.

The plug-in EV market is a little less well-known, at 90.4%. Awareness of the market for fully electric vehicles is noticeably less well-known at 70.3%.

A little more than one-third (36.5%) of the respondents feel **knowledgeable** enough about EVs to make a purchasing decision. Many people feel somewhat (42.6%) or not knowledgeable enough (20.9%). This last group which indicated they don't know enough were directed past Q 16-21, which invited responses regarding different aspects of implementing EV charging on campus.

The responses to each of the individual EV buying incentive show that individuals require a mix of, or all of these incentives to invest in EV's. Looking only at the percentages of "strongly agree" responses, it seems that government subsidy or tax exemptions helping to cover the additional cost of buying an EV emerges as the most effective incentive. Offering EV users priority parking and fast-charging options (between 1-2 hours) are less salient concerns for respondents compared to other incentives in these questions.

# Adoption of Electric Cars and Electric Charging

## Next Car Purchase

Power of Next Car


Regular Gas **63%**


Diesel **19.1%**

Hybrid **50.3%**

Plug-in Electric **21.9%**

Electric Only **15.4%**

**Please consider the following statement: I plan on making my next car purchase a: Gas, Diesel, Hybrid, Plug-in Electric, or Electric Only.**

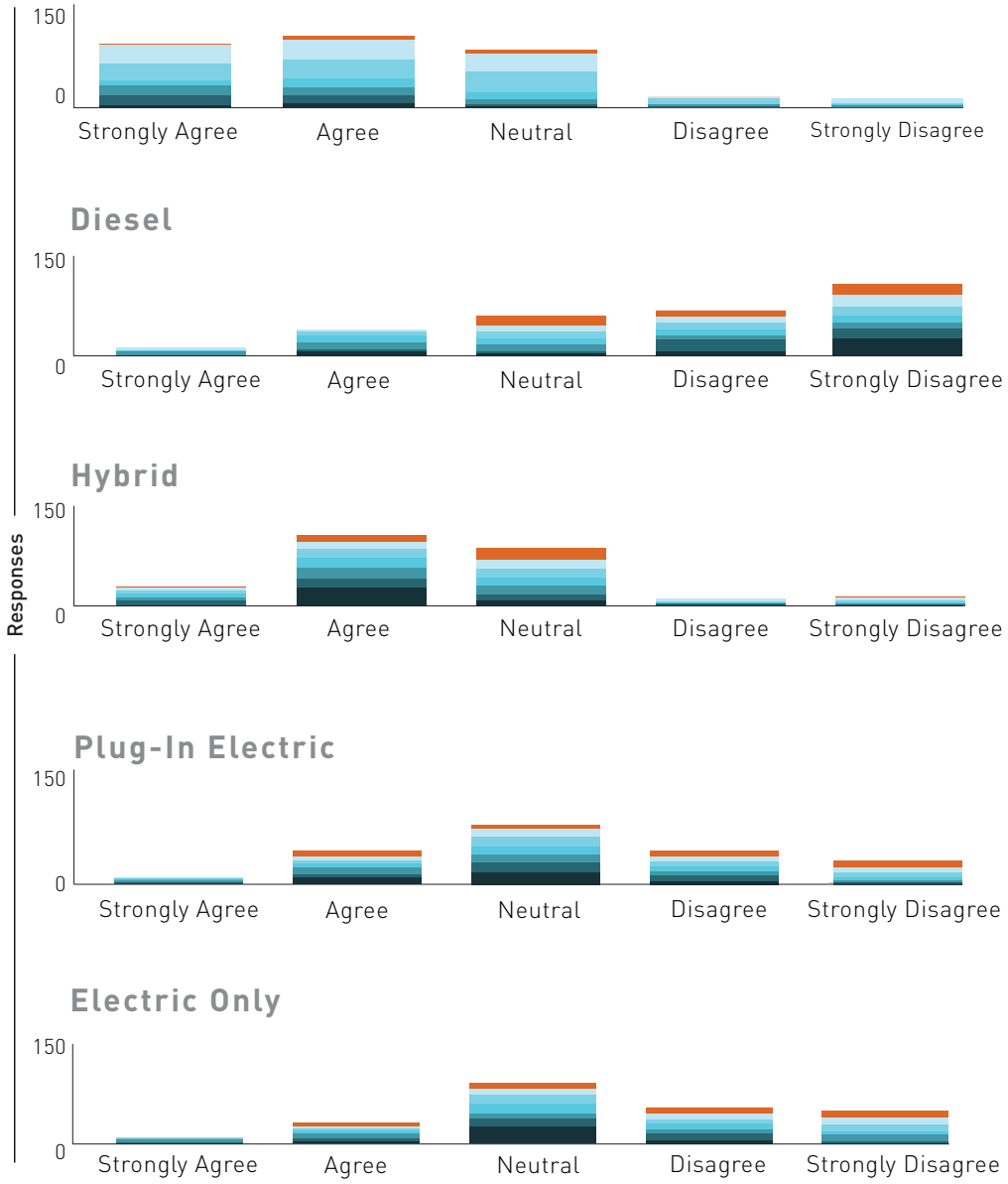
### Analysis

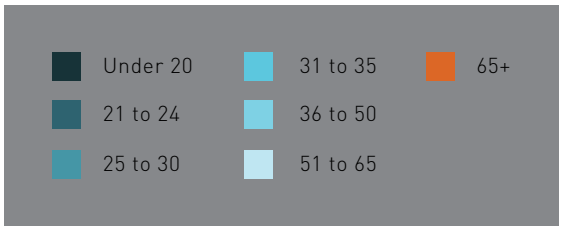
This question gauges attitudes or intentions of participants about vehicle purchasing, and not actual behaviours. Academic research on environmental behaviour suggests a weak link with attitudes or intentions expressed: a well-cited article by Kollmuss and Agyeman (2002) reviews prior research on this gap. Nevertheless, attitudes can be a precursor to behaviours, as well as an indicator for pro-environmental behaviours. When given each one of the vehicle types to rate on a scale of strongly agree to strongly disagree, 63% of those who drive to York would consider buying a gasoline-powered vehicle, 19.1% a diesel-powered vehicle, 50.3% a hybrid EV, 21.9% a plug-in EV and 15.4% a fully electric vehicle. The findings do not suggest that 15.4% of the York University community will purchase a battery EV as several factors in vehicle purchase decision making are not accounted for here.

# Adoption of Electric Cars and Electric Charging

## Next Car Purchase

### Next Car Purchase:




### Age Analysis

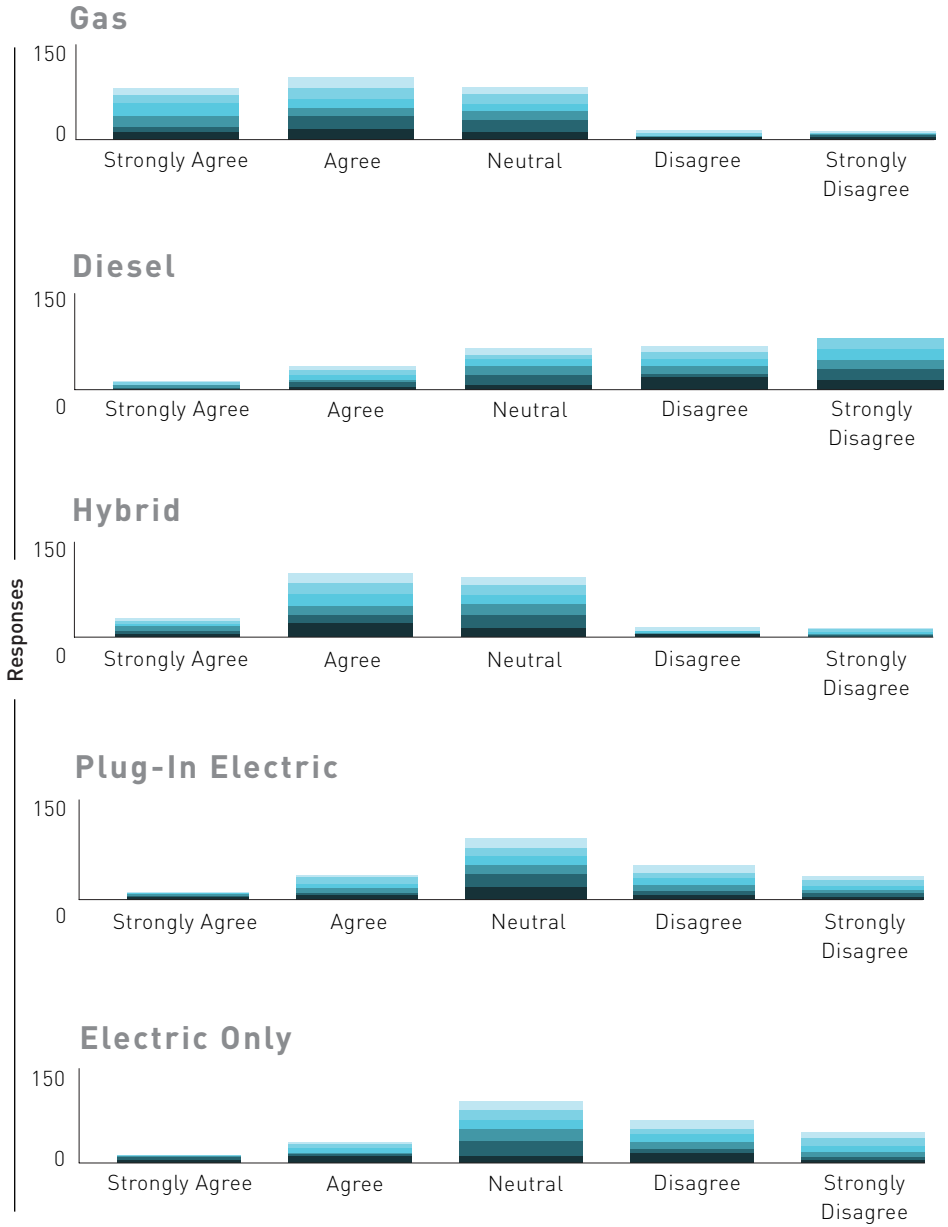
Younger participants prefer gas as well as hybrid vehicles more than older participants. The reason could be related to affordability. Oveall, diesel vehicles are the least preffered, especially by those 65 and above.

For plug-in electric and electric only vehicles, there was a bell curve of responses. Participants under 20, between 25 and 30 as well as 65 and above could be more willing to consider plug-in electric. Age category 25-30 year-olds stands out as most favourable towards battery EV purchases at 38%.

# Adoption of Electric Cars and Electric Charging

## Next Car Purchase

### Next Car Purchase:




HOUSEHOLD INCOME

- Less than $25,000
- $25,000 to $49,999
- $50,000 to $74,999
- $75,000 to $99,999
- $100,000 to $149,999
- More than $150,000

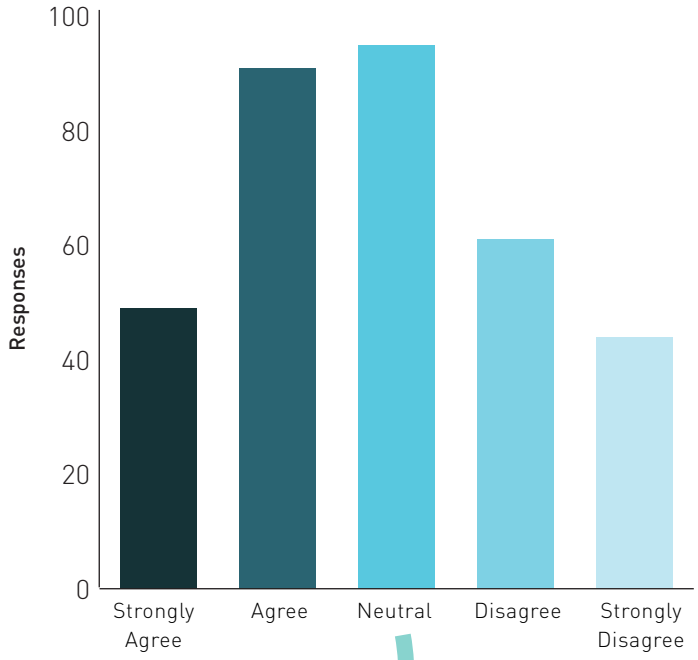
### Household Analysis

With the exception of the lowest income category, interest in hybrid vehicle purchasing appears roughly the same across all other income categories. Desire to purchase plug-in EV's also displays little or no relationship with increasing income levels. In addition, desire to purchase battery EV's is associated with income levels in an insignificant or minor way. The <$25,000 group displayed highly polarized attitude towards purchasing battery EV's (high percentage of agreement and disagreement); on the other hand, the degree of uncertainty is high (marked by the high percentage of "neither agree nor disagree") among respondents in the $25,000-$49,999 group.

# Electric Vehicles

## Charging Stations at York

**If possible to implement electric charging: willingness to move to a different lot even if in a less convenient location**



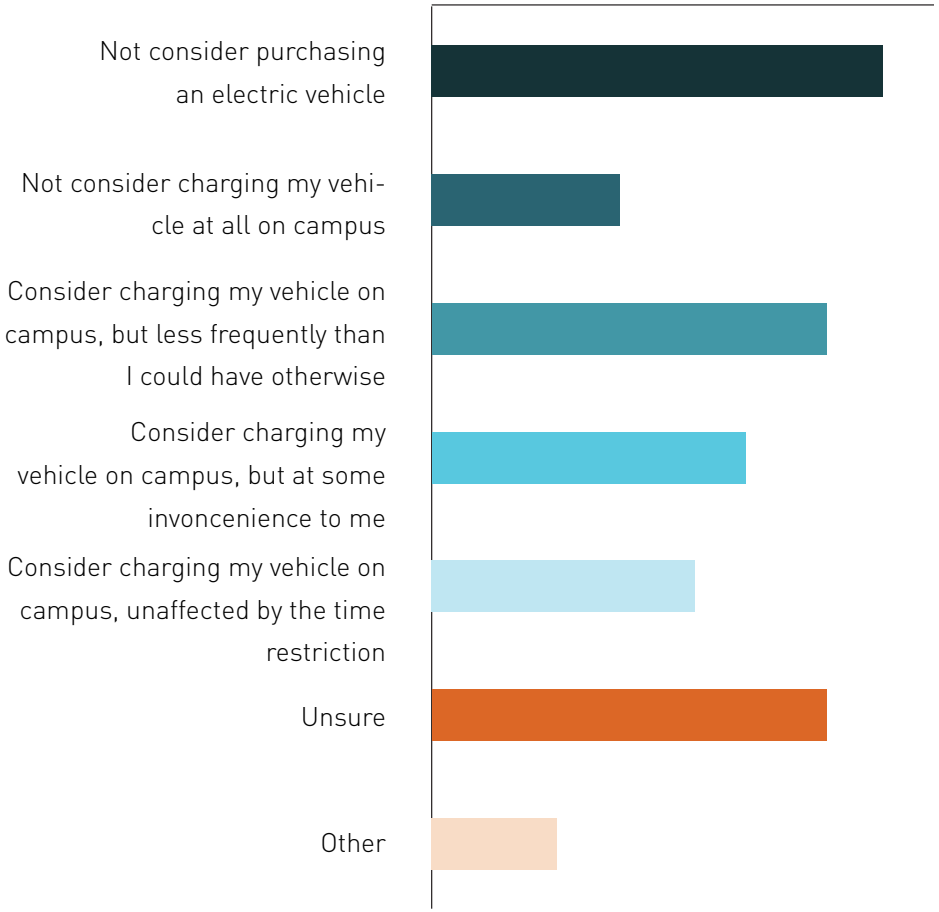

### Analysis

41.2% either agree or strongly agree with this statement, suggesting that a sizeable proportion of the university is not adverse to the notion. A further 7.9% do not gravitate either way. A final 30.8% either disagree or strongly disagree with this possibility.

# Electric Vehicles

## Charging Stations at York

**If electric charging stations are installed at York, but NOT available at peak electricity usage hours (e.g. 8:00-10:30am from September to April; 2:00-4:00pm from May to August), I would:**




### Analysis

The possibility of EV charging being unavailable at peak hours appears to be a disincentive to EV purchasing for just over one-fifth (21.2%) of drivers to York. Equal proportions (18.5%) of responses indicate (a) a willingness to charge on campus but less frequently than with peak hour availability and (b) being unsure about the statement. 27.1% of potential EV users would not mind or are willing to work around the peak hour restriction.

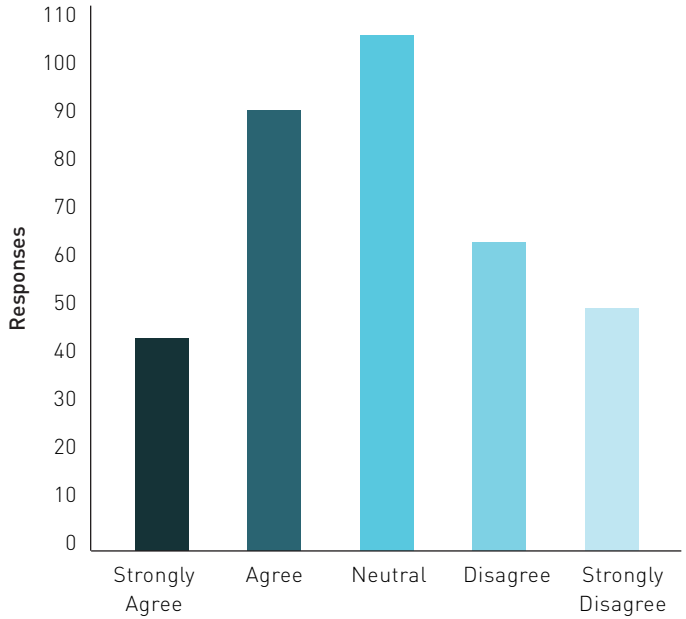
Options elaborated under "other" indicate that:

- EV charging would be inconsequential to many participants as they are unwilling to adopt EV's or are committed to commuting to campus without personal vehicles
- Lack of peak hour charging may be acceptable to some if no extra effort is required by the owner to make frequent trips to plug/unplug; some wonder about the possibility of the charging equipment to automatically time the process

# Electric Vehicles

## Charging Stations at York

**There should be a premium for charging during peak hours* of campus electricity load, when electricity is more expensive**




### Analysis

Respondents were almost evenly split on this question. A combined 38% of respondents either agree or strongly agree with this statement. A further one-third (32%) either disagree or strongly disagree. The remaining 30% neither agree or disagree.

*Peak hours are:
8:00-9:30am from September to April
2:00-4:00pm from May to August

# Electric Vehicles

## Charging Stations at York

"They [EV charging equipment] should be as **convenient** as possible, requiring little intervention and being available in various locations."

"I think this would be a **great option.** [But] charging extra at peak hours would discourage people and go against the sustainability image of the university. The EV vehicles at the moment are **too expensive** for me which is why I didn't consider them when purchasing my car. Also finding ways to charge them is still a challenge."

### Comments Analysis: Please tell us any additional thoughts you have regarding electric vehicle charging stations being adopted at York University

17 of the 95 open-ended responses (or 17.9%) indicate general support for the initiative, with nine others (9.5%) being generally critical of the initiative. For respondents who are willing to consider EV charging options on campus, some expressed the desire for more affordable parking for EV-drivers (in 11 or 11.6% written responses), and some would like to see convenience of EV charging (in 8 or 8.4% of written responses). For others, practical reasons rule out the possibility of adopting EVs due to the inability to charge at home and/or use EV's (in 7 or 7.4% of written responses).

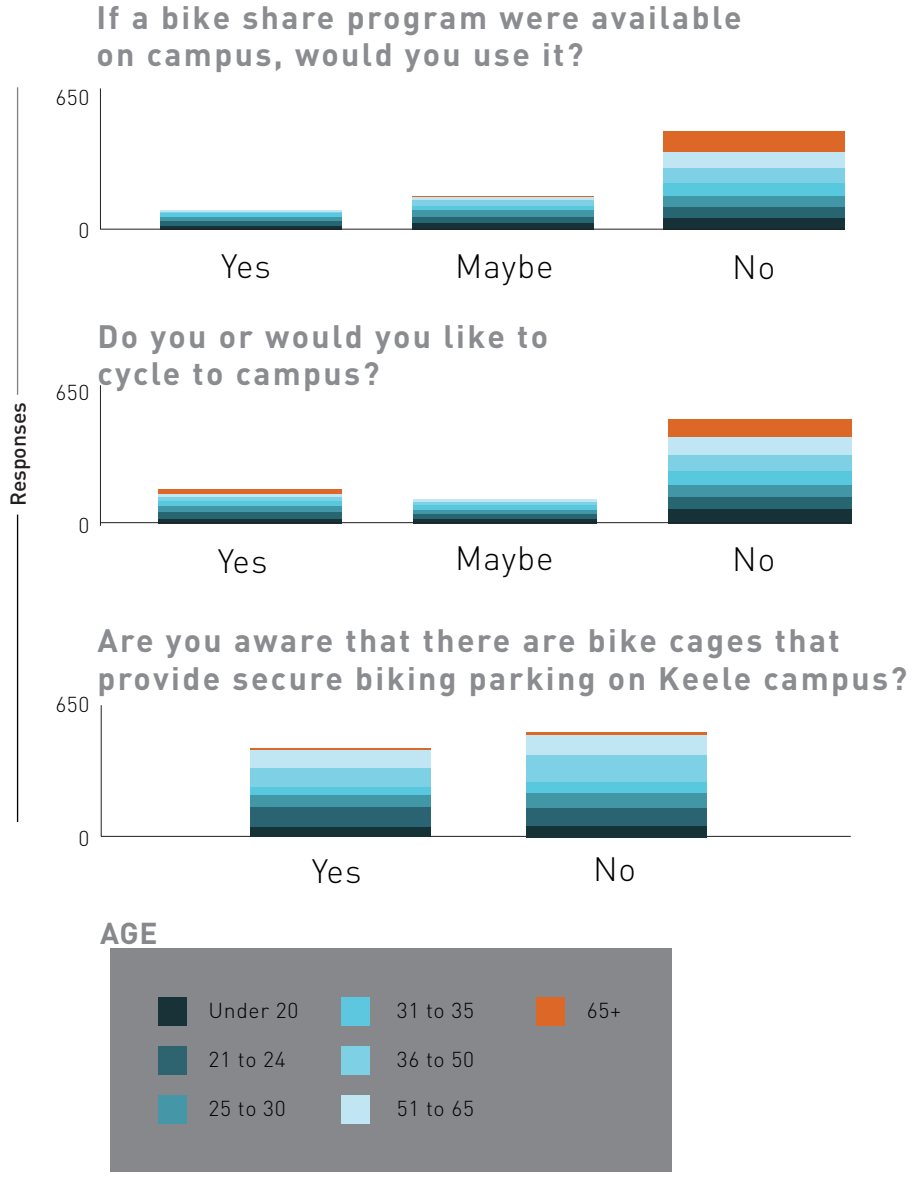
Some participants critical of the initiative offer specific reasons:

- The disposal of EV batteries and/or electricity generation used to power EV's are not environment friendly
- EV charging implementation at the university should not be motivated by revenue generation, as current parking rates are already perceived by many to be prohibitive

A few participants would like to see more information about how EV parking and charging can be integrated with Zipcar, AutoShare, Car2Go or campus fleets.

# Cycling

## Potential Bike Share Program




### Analysis

**If a bike share program were available on campus, would you use it?**

Respondents in their mid 30's are more willing to take up cycling than older individuals, either currently or prospectively. Participants 30 years and younger appear most enthusiastic about using a bike share program on campus with 18.8% saying yes and 32.6% saying maybe for a total of 51.4%.

The higher the household income, the less willing respondents are to use a bike share program on campus. This cannot be attributed to the awareness of bike cages on campus. It is possible that, income to the extent related to participants' role on campus and/or car ownership, is related to interest in using a bike share program. For instance, business wear required of some employees is not condusive to biking; high income earners tend to own vehicles and drive to York. Some drivers may not be aware of how bike share programs works. Faculty, staff and librarians appear to be less willing to use a bike share program on campus than students (undergrad and grads). This trend does not seem to correspond to the respective groups' awareness of bike cages on campus.

Under half of all respondents (45.4%) knew about the bike cages on the Keele campus.

# Cycling

## Potential Bike Share Program

### Continued Analysis

**If a bike share program were available on campus, would you use it?**

This question was posed rather ambiguously as it did not specify the locations that would have been included in a potential bike share network. As many of the previous questions specifically asked respondents to consider commuting options of getting to York, presumably from home or non-university settings, it is entirely within reason that many who commented in Q 30 had this context in mind. This weakness of the survey design notwithstanding, it appears that only 13.5% of the respondents see themselves using a bike share network on campus, 23.9% are indecisive and a numerical majority (62.6%) would not use a bike network.

About one-fifth (20.9%) of respondents are enthusiastic about cycling to campus. 16.0% are indecisive and a numerical majority (63.1%) are unenthusiastic.

# Cycling

## Cycling to Campus

"As a worker, I drive to meetings all over campus in my personal car. However, having an intercampus bike share network would be great. i.e. getting from the Kinsmen Building to Sherman Centre is far for walking but great for biking."

"I'm happy with most of my bike commute, but would love to see a multi-use path along the hydro corridor from Richmond Hill Centre to Keele."

"Mostly weather determines if I cycle, and darkness."

### Analysis

**Which factor(s) encourage or would encourage you to cycle more to campus?**

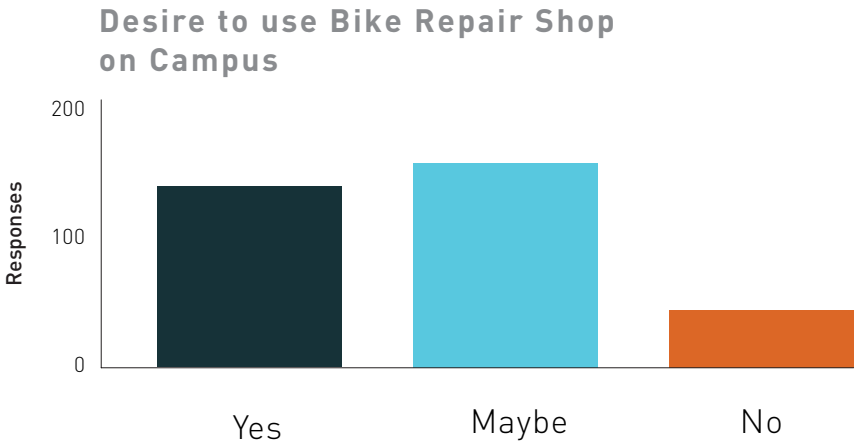
Only respondents who were either enthusiastic or indecisive about cycling to campus were directed to answer this question. The ability to exercise is the most pronounced incentive (at 81.1%); having a safer cycling network en route to campus follows closely behind (75.5%). Saving money and being outdoors/enjoying nature are important for 67.1% and 68.7% of the respondents, respectively. Seen in tandem with having a safer cycling network, learning to ride safely in traffic is a top-of-mind incentive for only 16.7% of the respondents. This suggests that from a bike safety point of view, people tend to view the lack of bike infrastructure as a more significant barrier for greater use. Similarly, access to bike infrastructure, including secure or sheltered parking/storage, shower facilities or lockers, are motivating for a significant part of respondents, at 57.1, 46.1 and 41.8% respectively.

In the open-ended responses, survey participants revealed the following:

- For many, cycling is too inconvenient for various reasons (in 20 responses)
- The demand for better cycling infrastructure as an incentive to cycling is fairly high (in 11 responses)
- Inclement weather and safety concerns, respectively, have influenced decisions to cycle for a handful of respondents

# Cycling

## Bike Repair Shop



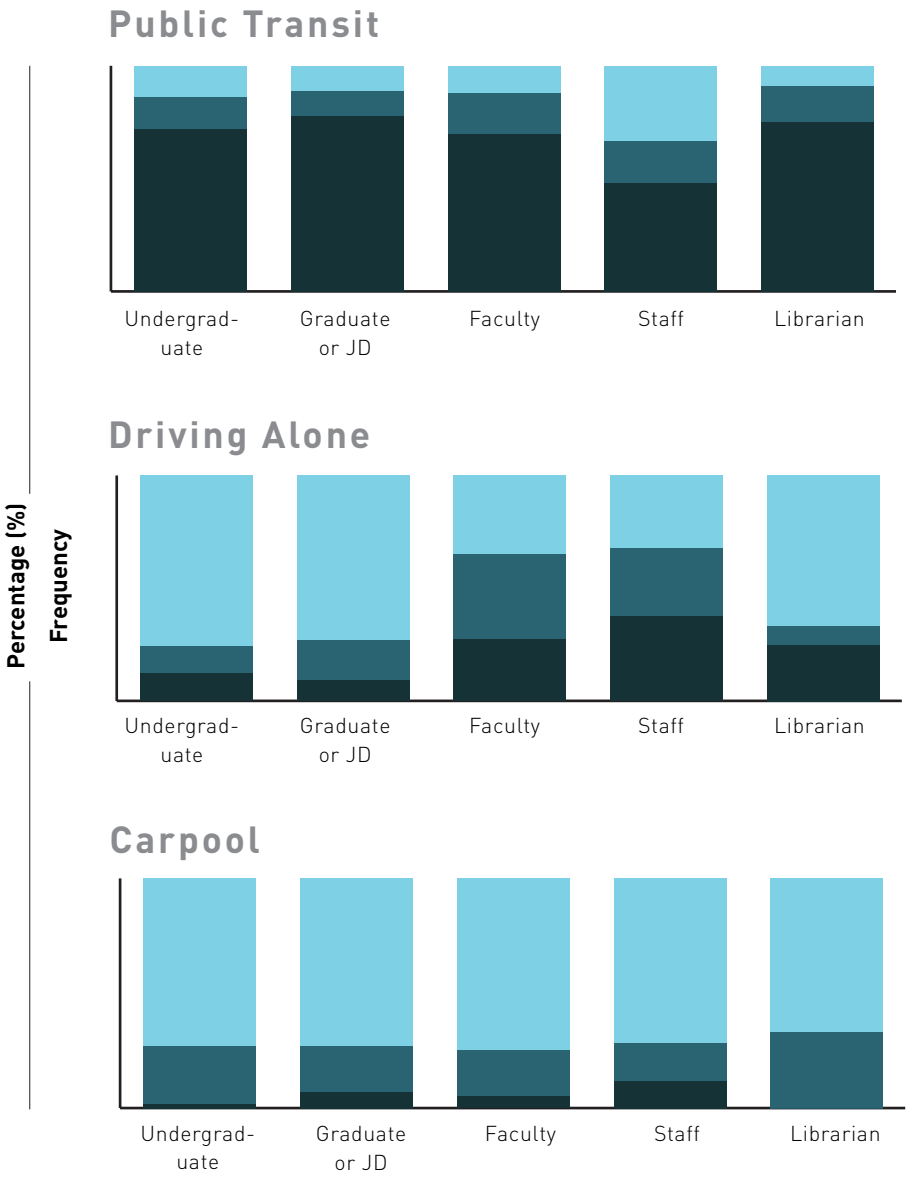

### Analysis

**Would you use a bike repair shop on campus?**

Those who want or might want to cycle to campus answered this question. 40.7% of this population answered "yes" and another 45.8% were indecisive. A final 13.5% would not use a repair shop. No reasons for this latter answer were volunteered in the comments.

# Discussion

## Role vs. Use of the Following Forms of Transportation:





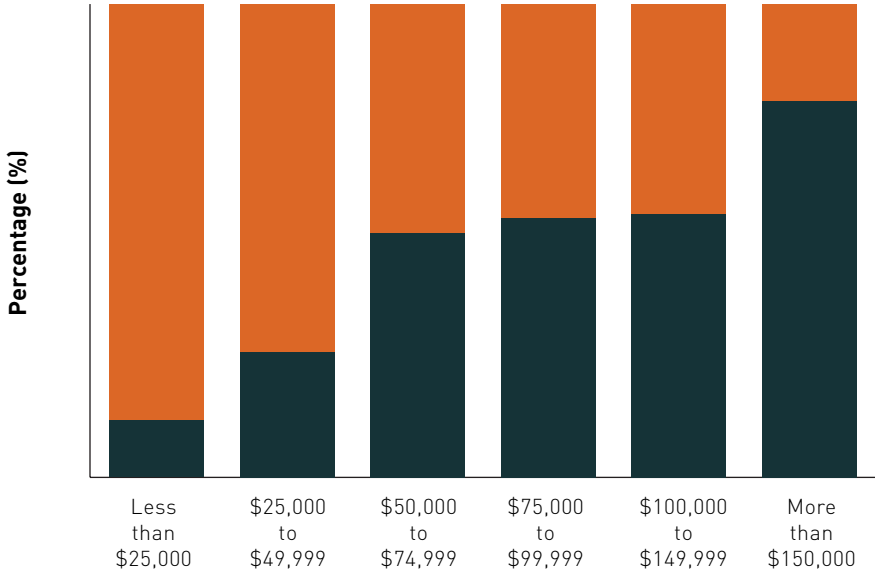
### Analysis

Public transit use is fairly comparable among groups (69.5-77.5% regular use for students and faculty) except for staff (47.9% regularly use). Staff are the largest regular drivers at 37.5% and also the most regular carpoolers at 12%. Though faculty members do use transit regularly, a large number of them are also regular (27.3%) or occasional (37.7%) drivers.

# Discussion

## Access to Car

### Access to Car vs. Income



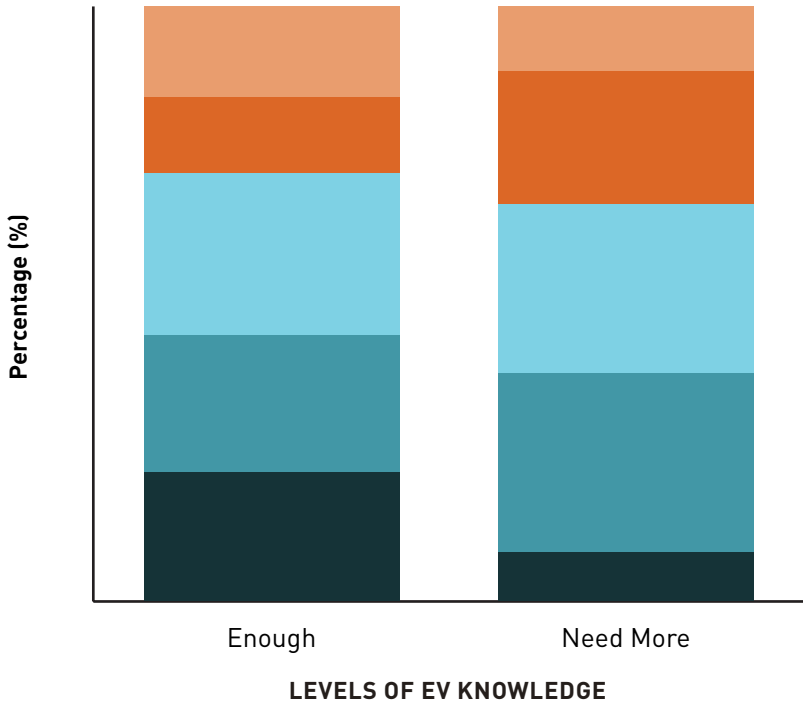

**Analysis**

Higher income is a good indicator of respondents' having access to a car. Faculty and staff have the highest car access as well as parking permits on campus.

# Discussion

## EV Knowledge

### Willingness to Move Parking Spots vs. Level of EV knowledge



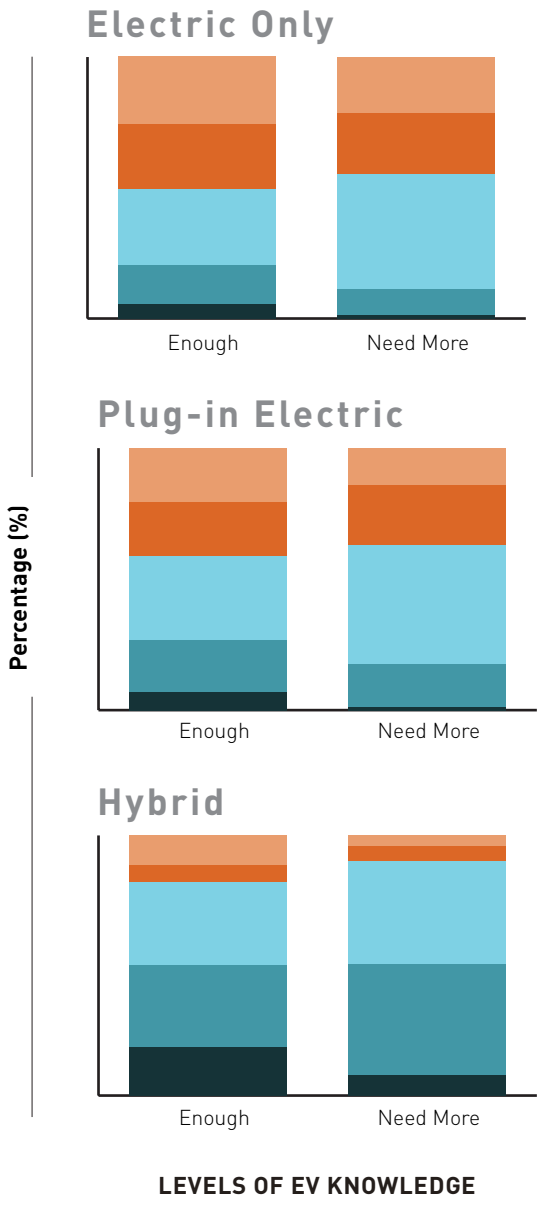

### Analysis

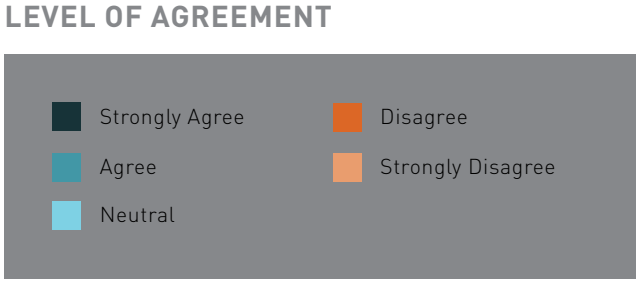
The level of understanding about EVs is generally associated with more willingness to locate to less convenient parking spots, if EV charging were made available.

Participants who responded more positively to the possibility of peak charging being unavailable are also those more likely to favour premium charging at peak hours. It could be speculated that peak hour restrictions (in both availability and cost structure) produce polarizing attitudes in participants; those who responded relatively more negatively to both questions appear to view peak hour restrictions as punitive and could potentially be discouraged from using the charging stations, if they are implemented.

# Discussion

## Level of EV Knowledge vs. Next Car Purchase as:




### Analysis

The level of understanding about EVs appears to be generally associated with more willingness to consider buying full EV's as the next purchase. One other difference worth noting is in the percentage of "neither agree nor disagree" responses for the two groups.

Respondents who indicate having more knowledge about EV's appear to be more polarized in their full EV purchasing mentality. That is, there is a higher percentage of unwilling purchasers from the group that indicated higher level of understanding. Similar trends exist when respondents consider buying plug-in EV's.

Interestingly, for hybrid car adoption, respondents who demonstrate different levels of understanding about EV's both demonstrate more willingness to buy hybrids. Those with higher level of understanding though still seem to display polarization (almost as many strongly disagree as stongly agree). Overall, the higher willingness to buy hybrids may well be related to higher market awareness of hybrids compared to plug-ins and full EV's. Therefore, as the public becomes more aware of the environmental features of all the EV's, they will be more willing to consider purchasing them.

# Discussion

## EV Adoption Incentives vs. Role

### Analysis

With respect to incentives for adopting EV's, undergraduate and graduate students would be somewhat more encouraged by having access to campus charging option than faculty, staff and librarians. Graduate students in particular appear consistently responsive to all incentives presented. Being granted priority EV parking yields a similar trend. Incentives achieved through government subsidies and tax exemptions, for instance, were quite pronounced among the student populations compared to faculty and staff. The consistently high demand for incentives among the student respondents may suggest that they are easily incentivized. However, caution should be exercised in reaching this conclusion since an equally plausible interpretation is that students need not one but several (perhaps concurrent) incentives to consider taking up EVs.

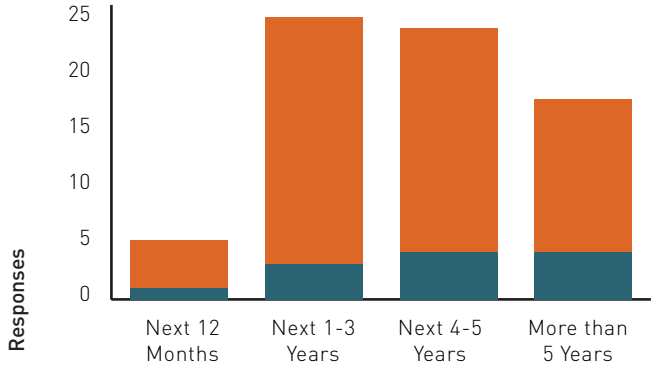
Faculty and staff responded somewhat less to monetary incentives than other respondents. Incentives that appear strong among faculty include battery range (or conversely range anxiety) to cover roundtrips to and from York University, as well as priority parking allotted to EV's.

# Discussion

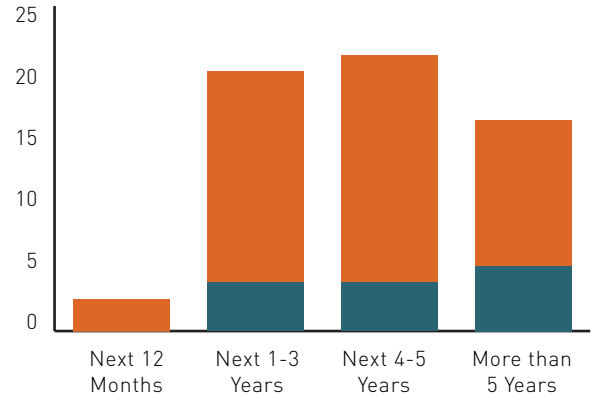
## Next Vehicle Purchase

### Timeline of Next Vehicle Purchase

#### Plug-In Electric




#### Electric Only





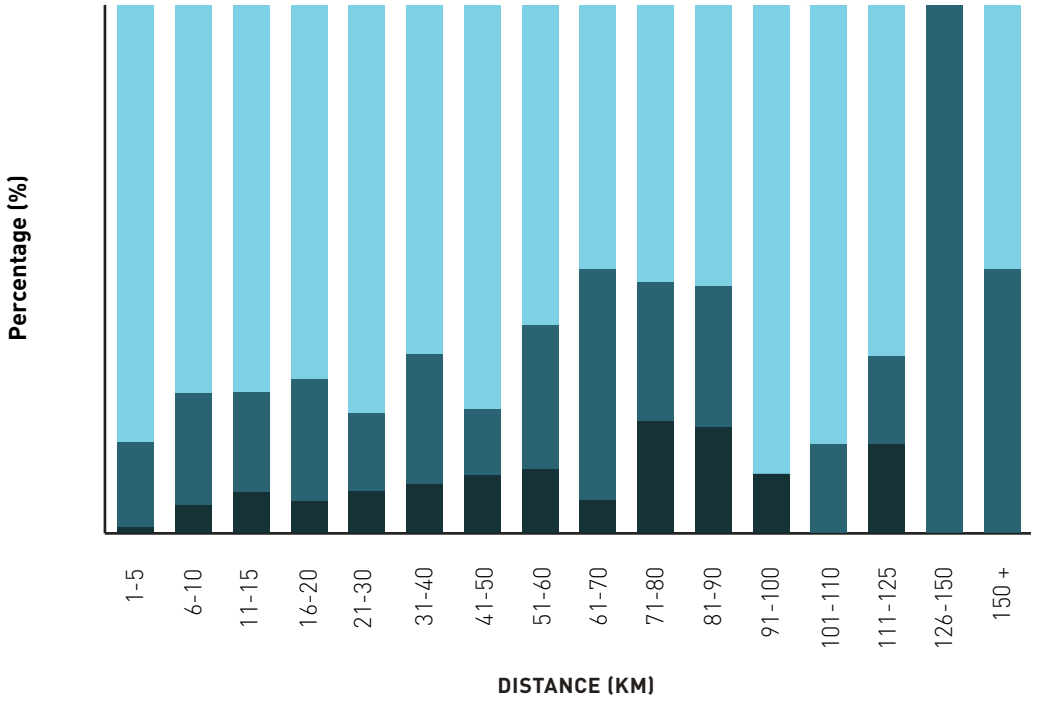
### Analysis

Within the next 12 months, only one respondent strongly agrees that he or she will purchase a plug-in electric vehicle. In the next 1-3 years, there are four respondents who strongly agree that they will purchase either a plug-in electric vehicle or an electric vehicle, two of whom strongly agree to purchasing both. In the next 4-5 years, seven respondents strongly agree to purchasing either a plug-in or electric vehicle, again with two respondents agreeing they will purchase both. The result is that in the next few years there will very likely be a handful of vehicles on campus that are either plug-in electric or electric only vehicles, especially considering that our survey only sampled approximately 2% of the York University population.

# Discussion

## Carpooling

### Carpool Frequency vs. Commute Distance



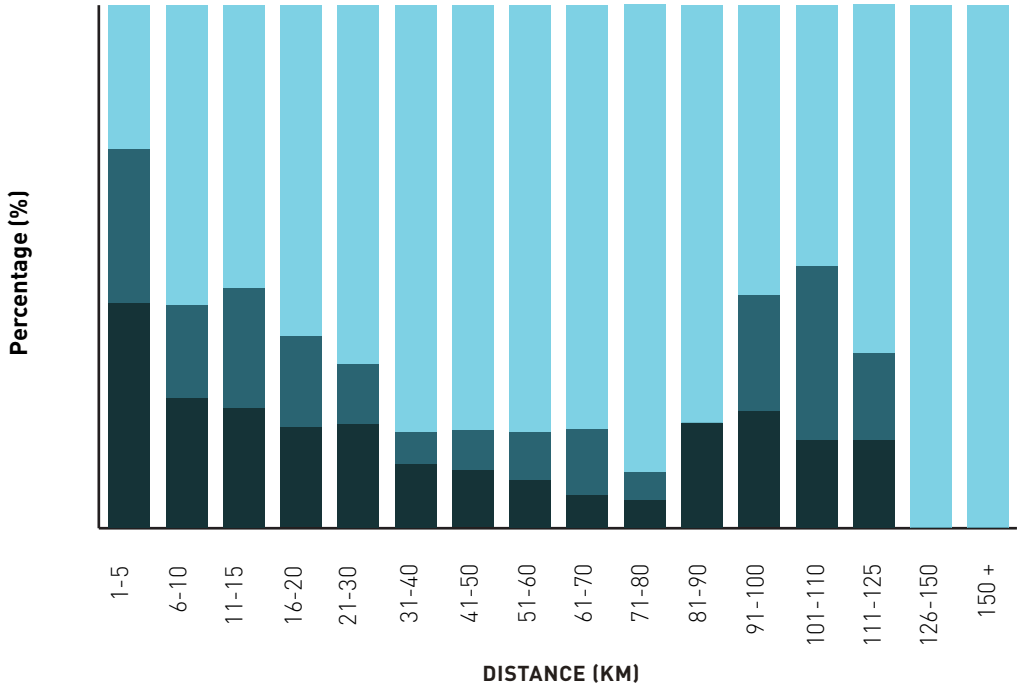

### Analysis

Generally, the longer it takes people to travel to and from York U, the more likely they are to carpool. Those commuting over 125km each way, though, only carpool occassionally. Note: the sample size for the 126-150 and 150+ options are quite small, since only 5 respondents total commute these two distances .

# Discussion

## Cycling

### Already cycle or desire to cycle vs. Commute Distance



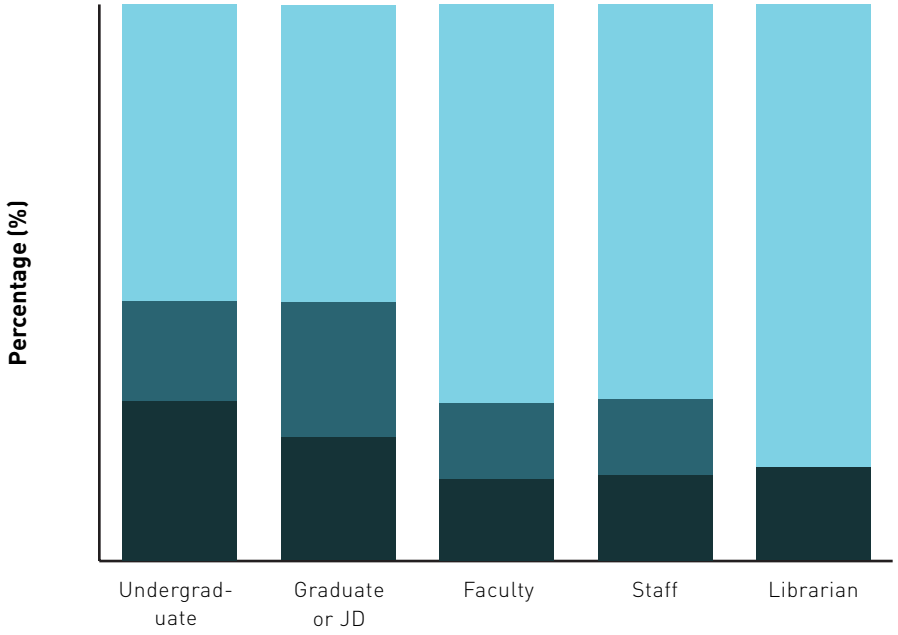

### Analysis

Individuals with longer commuting distance tend to cycle less or have less desire to cycle. The survey also found a reverse trend with higher intrest in cycling commuting between 81-125 km to be quite favourable to cycling as a mode of travel. It may be that some of the respondents in these categories already incorporate cycling as part of their commuting routine (for example to get to transit). However, since only one respondent in the 61-150 km groups indicated that they currently occasionally cycle to commute to York, it is more likely that these responses reflect a desire to cycle to work, but cannot due to the distance they live from work.

# Discussion

## Cycling

### Already cycle or desire to cycle to campus vs. Primary role




### Analysis

As the groups that make up the majority of drivers and permit holders at York University, staff and faculty are incidentally the least able to and/or willing to take up cycling as a mode of travel to campus. Students are more interested, with both undergraduate and graduate students showing a total interest, including definitive or possible interest in cycling to campus, at 46.5%.

# Recommendations

## Electric Vehicles

The survey indicates that only a handful of York community members will be driving to York University with either plug-in hybrid or battery electric vehicles in the next few years. Of the 15 survey respondents who indicated that they strongly agree that they will purchase either a plug-in or fully electric vehicle, 13 (86.7%) have a one-way commute of under 40 km, and so it is likely that most would be able to travel to York and return home on a single battery charge from home. Still, respondents indicating a longer commute and high interest in purchasing electric vehicles travel as far as 111-125 km, and so some charging stations might be needed for these users if they have a vehicle with a smaller range (i.e. 130 km per charge vs. ranges up to 480 km for lithium batteries).

As a result, it is recommended that York University create a demonstration project utilizing an electric vehicle charging station. This charging station could be set up to service two parking spots. The parking garage that would provide the most visibility of the demonstration project is the York Lanes Parking Garage.

### Charging Station Option

An analysis of possible charging stations performed by University of Toronto Engineering students found that it would be possible to install a Schneider Electric Indoor Level 2 charging stations in the outdoor parking garages, as long as some protection was built above and beside the stations. This is the most economical option to proceed with, costing $800. See **Figure A**.

Use of one Schneider Electric Indoor Level 2 as a demonstration project is not expected to place undue stress on York's power system. Costing likely a few thousand dollars a year in electricity, the project will use approximately 0.02% of York University's $10 million electricity budget, easily funded by ongoing conservation efforts with the YorkW!$E initiative.

It is further recommended that Parking Services track how many permit holders own electric vehicles, and how many require a charging service, to plan for future expansion of charging stations on campus. If the demonstration project using indoor charging stations works well, this could be expanded to the other two parking garages; otherwise, more expensive outdoor charging stations will have to be employed.

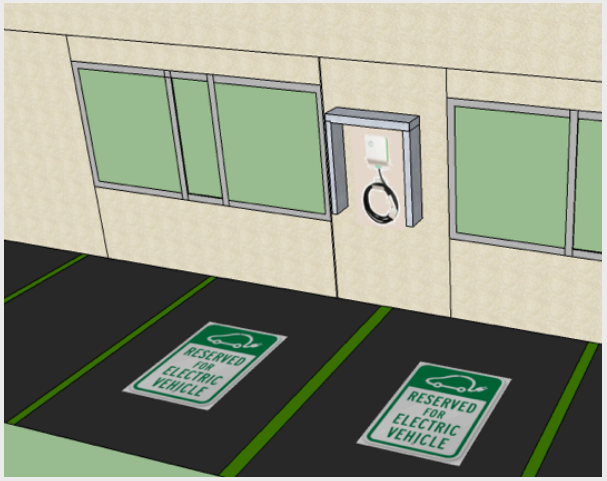



**Figure A - Visual of Design**. The Schneider Electric Indoor Level 2 charging station could be mounted on the wall and protected by the 5mm-thick polycarbonate shielding 250x150mm (top) and two 350 x 150 mm (sides). This will protect the station from any precipitation entering from the openings, highlighted with green.

# Recommendations

## Other Vehicles: Parking & Carpooling

Of the 234 survey respondents that have a monthly parking permit with York University, 59% never carpool, while only 5.6% always carpool (they never drive alone). Considering that many still do not know about the carpooling initiatives available at York University (Carpool Zone, the Diamond Pool Parking Program or Priority Carpool Parking), that the cost of parking continues to be a challenge for community members, and that reduced costs is the factor that is most encouraging for users to start carpooling or why they already do, we recommend that York University work with Smart Commute to make these programs better known and utilized. This should be done more explicitly with both new staff (for example in the onboarding checklist) as well as on York University websites. For example the Transportation website (including public transit, shuttle, cycling, car sharing) is separate from the Parking website. Both, however, include information about carpooling, though it isn't always labelled as such, forcing the website users to really dig to find the carpooling information. From several respondents, itis suggested that increased flexibility in parking fee structure could encourage increased use of parking services, so it is recommended that York University explores options in this area.

With regards to parking lot maintenance, snow removal continues to be an item that is highlighted by IRIS survey respondents (this issue was raised in the Accessibility report of 2012). We recommend that York University evaluate its snow removal practices to determine how this can be improved. One user suggested ploughing overnight or early morning.

## Public Transit

The number of respondents with monthly parking passes that report never taking public transit now is the same number as those who report that they will not take the new subway. This indicates that permit holders are not likely to shift away from having their parking space with the arrival of the subway. Furthermore, only 45.8% of respondents indicated that they will always or mostly use the new subway. Therefore, most survey respondents will continue to use other means of transportation, including other forms of public transit, to access the campus. 5.8% of respondents who currently never use public transit indicated that they will sometimes (67.2%) or regularly/always (32.8%) use the new subway.

While currently 18.9% of respondents overall never use public transit, 30.8% indicated that they will never take the new subway. Since there will be a new bus terminal, 407 Transitway, and most non Toronto Transit Commission transit is expected to arrive there, these responses could indicate that many public transit commuters are unaware of the coming changes to their commute with the arrival of the subway on campus in 2017. As such, students, staff and faculty will have to be made more aware of these changes closer to the subway opening. Furthermore, some respondents are concerned about the potential loss of services like Van Go once

# Recommendations

public transit services like Go Transit move to the Transitway. Given these changes in public transportation that will be occurring at the Keele campus with the arrival of the Yonge-University-Spadina subway extension, additional communication with the York University community will be needed to ensure that accessibility and other challenges will be adequately addressed. Use of focus group discussions are recommended.

## Cycling

While the majority of survey respondents do not cycle to campus, 36.9% do or would like to, and 37.4% are interested or possibly interested in using a bike share program. These rates compare to the 9.2% who currently cycle occasionally or regularly to campus. There is a significant difference in interest in cycling and current cycling uptake. While cycling facilities would incentivize about half of respondents to cycle more, three-quarters of respondents indicate that a safer cycling network is needed for them to cycle more. As such, we recommend that York University and the York University Development Corporation do more to work with the surrounding municipalities and planning agencies to encourage more investment in cycling infrastructure on routes to campus, especially safe cycling infrastructure like separated bike lanes. In tandem, the University should work to continuously improve the cycling infrastructure on campus. Consideration should be given to making any new bike lanes on campus separated lanes.

# Conclusions

The aim of this report was to determine the interest in electric vehicles of York University community members to plan for the need of electric vehicle charging stations and provide recommendations on how to address the transportation issues that community members have raised.

The survey and research has highlighted that plug-in hybrid and battery electric vehicles could be becoming more popular, but that significant uptake has not yet begun. None of the survey respondents currently drive one of these two vehicle types. Only a handful of respondents do plan on purchasing a plug-in or battery electric vehicle in the next few years. As such, York University should move forward carefully with a demonstration project at this stage, to ensure that service can be obtained, while not investing too pre-emptively in technology that that is still evolving quickly.

While this survey touched on other transportation issues—cycling, carpooling, and public transit usage—it is acknowledged that much of the infrastructure and programs that will help increase uptake in these modes are the responsibility of other organizations and government. York University could increase efforts in communicating current and future initiatives. York University should ensure that the proposed changes be communicated to community members in a timely fashion, and ensure adequate time for consultation for changes that will affect community members. Furthermore, as infrastructure around the University improves, especially at the Keele campus, York University may face increased demand for cycling facilities and some decreased demand for parking services as carpooling uptake slowly improves, and some who never took public transit begin to.

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# Appendix A

## Electric Vehicles

| | Hybrid Electric Vehicle (HEV) | Plug-in Hybrid Vehicle (PHEV) | Battery Electric Vehicle (BEV) |
|---|---|---|---|
| Motor | Internal combustion engine and electric motor | Internal combustion engine and electric motor | Electric motor |
| Features | Powered mainly by its gasoline engine<br><br>Electric motor provides assistance during peak power demands and can power the car at low speeds and over short distances | Operates on combination of gasoline and electricity<br><br>Typical all-electric range of 20-40 km on a full charge<br><br>Recharge electric battery from domestic 110 V or 220 V outlet in 6-8 hours<br><br>Gas engine is refuelled like a regular car | All electric (no gasoline or diesel engine)<br><br>Range of 100-200 km on a full charge<br><br>Recharge electric battery from standard 110 V or 220 V outlet in 6-16 hours |
| Environmental Considerations | Uses less fuel<br><br>Lower tailpipe emissions | Uses much less fuel<br><br>Very low tailpipe emissions | No tailpipe, so zero "tailpipe" emissions or pollutants |

| | Hybrid Electric Vehicle (HEV) | Plug-in Hybrid Vehicle (PHEV) | Battery Electric Vehicle (BEV) |
|---|---|---|---|
| Lifestyle Considerations | No need to plug in to charge the battery<br><br>Uses regular gasoline<br><br>Driver experience is the same as for conventional vehicles | Uses regular gasoline<br><br>Can charge battery at home or other locations where an outlet is available<br><br>Battery can be charged in 6-8 hours, usually overnight<br><br>Can be driven between 20 and 40 km in electric mode, using no gasoline<br><br>Gasoline engine takes over when batteries are run down | Car can be charged at home or other locations where an outlet is available<br><br>Full charge typically takes 6-8 hours at 220 V or 14-16 hours at 110 V<br><br>Public charging locations are currently limited, so you might have to plan ahead for longer trips |
| Availability in Canada | Available now | Limited availability, but more expected in 2011-2012 | Limited availability, but more expected in 2011-2012 |

Detailed comparisons between HEV, PHEV and BEV. Unless otherwise specified, this report's usage of EV's shall refer to PHEV's and BEV's.

Source: "Electric Vehicle Primer" by Transport Canada (2010)

# Appendix B

**Technical Aspects of EV's and Charging**

## Comparison of end-of-pipe emissions between conventional and electric vehicles

Conventional combustion engine vehicles emit up to 30 kg of greenhouse gas emissions for every hundred kilometres of driving, and hybrid cars emit roughly two thirds of conventional emissions at about 20 kg (Ministry of Transportation Ontario, 2011). Electric vehicles, however, emit zero greenhouse gas emissions at the tailpipe (Van Vliet et al., 2011). Greenhouse gas emissions associated with electric vehicles are dependent on the method of electricity generation used, but are not emitted in the physical operation of the vehicle. In Ontario, the majority of electricity is produced through hydro, nuclear and wind (Ministry of Transportation Ontario, 2011) and thus produce relatively low greenhouse gas emissions. The Ontario Ministry of Transportation state that the electricity mix in Ontario is 53% Nuclear, 24% Hydro, 15% Coal, 7% Natural Gas, and 1% Wind. The greenhouse gas emissions for electric vehicles in Ontario are therefore approximately .04 kg of carbon dioxide equivalent per 100 km driven (ibid). In Ontario the average electric vehicle emits almost one hundredth of greenhouse gases associated with conventional vehicles.

## Technical Requirements for common plug-in charging

There are three different levels of charging stations, which differ in their allowable charging voltage, the complexity of their installation and the amount of time they take to charge.

- **Level 1 Charging Station** – 120VAC, 16A (1.92kW). Compatible with ordinary household electrical outlets, the Level 1 station normally takes 8 to 12 hours to fully charge an electric vehicle. It provides AC energy directly to the vehicle's on-board charging system, which has an internal AC/DC converter. Because Level 1 stations are "plug and play" with regular residential outlets, they can be installed in the home without professional help.

- **Level 2 Charging Station** – 208 to 240VAC, 12 to 80A (2.5 to 19.2kW). Level 2 stations provide a fast charge time of three to six hours. They, too, provide AC energy to the vehicle's on-board charging system where conversion to DC energy is done. Because of safety concerns related to their higher voltages, Level 2 stations must be permanently installed by a licensed electrician. These stations can be used either indoors or outdoors and are suitable for public or private installations.

- **Level 3 Charging Station** – 300 to 600VDC, 400A Max. Level 3 charging stations, which are also DC fast chargers, provide DC electricity to the car's battery. Because AC-to-DC conversion is not required, they take only 20 to

# Appendix B

**Technical aspects of EV's and Charging**

30 minutes to charge the vehicle. This method of electric vehicle charging will dominate the public charging infrastructure, serving as "gas stations" for electric vehicles.

More detail on levels of car charging (Levels 1-3) can be found at these websites:

- http://www.afdc.energy.gov/fuels/electricity_infrastructure.html
- http://evsolutions.avinc.com/electric_vehicles/new_way_to_refuel/different_ways_of_charging/
- http://www.pidtechinsights.com/2012/12/04/relay-requirements-for-electric-vehicle-charging-stations/

Companies that are currently providing commercial-grade charging stations include:

- **www.suncountryhighway.ca/chargers:** a Canadian company that is currently planning to create an entire system of charging stations across Canada so that any electric vehicle could potentially make it from coast to coast from station to station.

- **www.plugndriveontario.com/charge-my-car/chargers-2** is a non-profit website promoting electric vehicles. This particular page provides a list of companies that provide infrastructure that could be accessed eventually.

## Types of Chargers currently being used

- Charge battery by plugging into a 120V or 240V (twice as fast at charging) socket—most common method

- Magnetic inductors that charge the car without any exposed contacts
  - This option is the safest, particularly when using higher voltages

  The magnetic induction system
  - (Magna Charge) uses inductive paddles that fit into a hidden slot in the car. The paddle acts as half a transformer (other half is in the car) and the insertion of the paddle into the car completes the transformer and power transfers into the car.

- Avcon Plug: copper to copper contacts as opposed to the inductive paddle
  - Quite safe in any kind of weather because the contacts remain covered

- Battery switching:
  - A company called Better Place, with membership to their program, actually owns the battery in the car and instead of charging, the station replaces the battery in "less time than it takes to fuel a car"—this is available is certain European countries, and is experimental here.

# Appendix B

**Technical aspects of EV's and Charging**

## EV Charging Equipment Providers

The following electric vehicle charging equipment manufacturers offer Level 2 units to residential and commercial customers, with many also offering Level 1 equipment and DC charging:

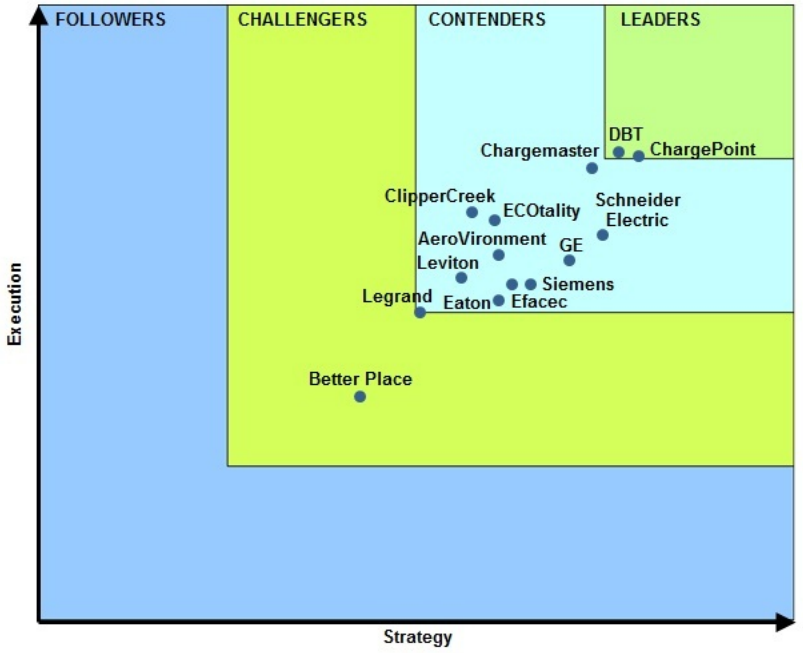
**Top 10 Vendors**

1. ChargePoint (formerly Coulomb Technologies)
2. DBT
3. Chargemaster
4. Schneider Electric
5. General Electric
6. ECOtality
7. ClipperCreek
8. AeroVironment
9. Siemens
10. Efacec

## ChargePoint

ChargePoint is the leader in electric vehicle charging station infrastructure with networked charging stations installed in municipalities and organizations worldwide (14 countries). It provides a vehicle-charging infrastructure, with an open system driver network.

The ChargePoint Network (www.mychargepoint.net) provides multiple web-based portals for hosts, fleet managers, drivers, and utilities. The network connects charging stations ranging in capability from 120 Volt to 240 Volt AC charging and up to 500 Volt DC charging. In addition, drivers could take advantage of web-based services which display station maps, payment way, whether a charging station is available, reservation, etc. These services achieve demand-side economies of scale as more drivers use and interact through the web applications.




Source: Navigant Consulting (2013)

# Appendix C

## Market Demands for Electric Vehicles in North America

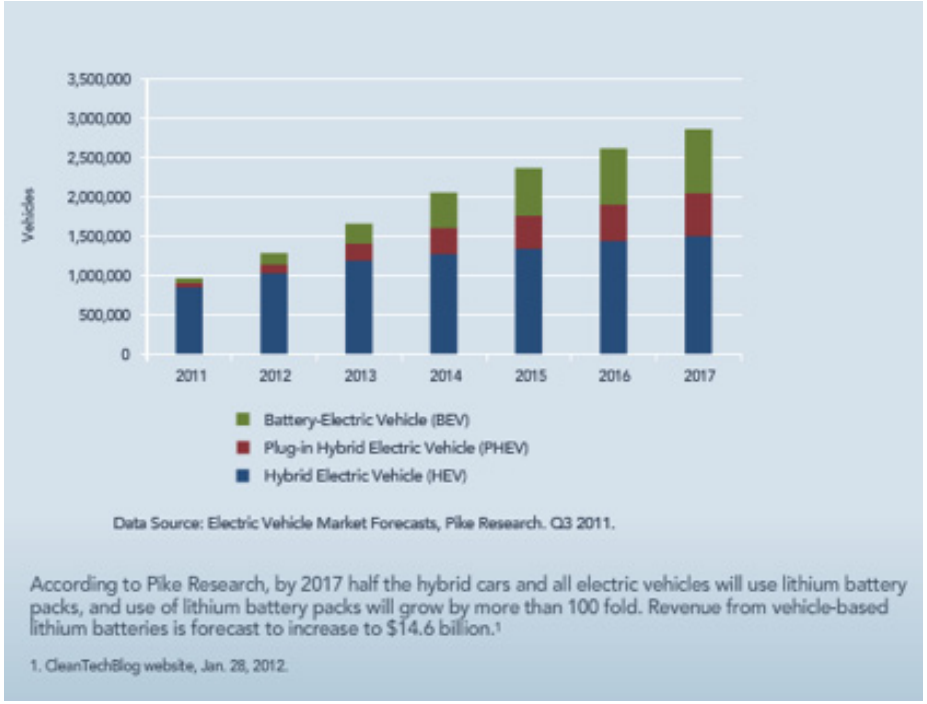
- According to the survey done by KMPG (2013) and Accenture (n.d.), there is higher consumer demand for Plug-in Hybrids versus Full Electric vehicles.

- KMPG even argues that "[p]lug-in hybrids are thought to have the greatest sales potential by 2018, leaping ahead of conventional hybrids…"

- In the longer term, the report by Finpro, quoting the Electrification Coalition, forecasts hybrids to be on the decline after a peak in sales around 2025.

- There appears to be no overall North America new-car sales forecast for electric cars.

- World Forecast from From Navigant Consulting (2013) research: "Despite political targets that are likely to be missed, these assumptions point to robust growth worldwide for electric vehicles, with hybrids growing at a compound annual growth rate (CAGR) of 6%, and PEVs (combined plug-in hybrid and battery electric) growing at a CAGR of 39% between 2012 and 2020. While Japan is anticipated to be the largest market for hybrids in 2020, the United States is anticipated to be the largest market for PEVs that year. However, European countries, with the combination of high gas prices and supportive government policies, are anticipated to have the highest concentrations of plug-in electric vehicles."




Source: Navigant Consulting (2013)

# Appendix C

**Market Demands for Electric Vehicles in North America**

## Electric Car Market Forecast and Technology

- Range-anxiety in Full-Electric vehicles means that adopting charging stations may be necessary to induce EV use by long-range commuters.

- Forbes, in their article Electric Cars and the Power Grid: Are They Coming Together? states that: "Data concerning the habits of EV owners in an Austin, TX suburb, indicated that over a two month period the residents generally tended to recharge at the same time – when returning from work." (Kelly-Detwiler, 2013). However, York University is a mostly non-residential site, and will experience different charging behaviour compared to residential sites. Non-residential charging may increase electricity demand for midday off-peak hours during the winter months.

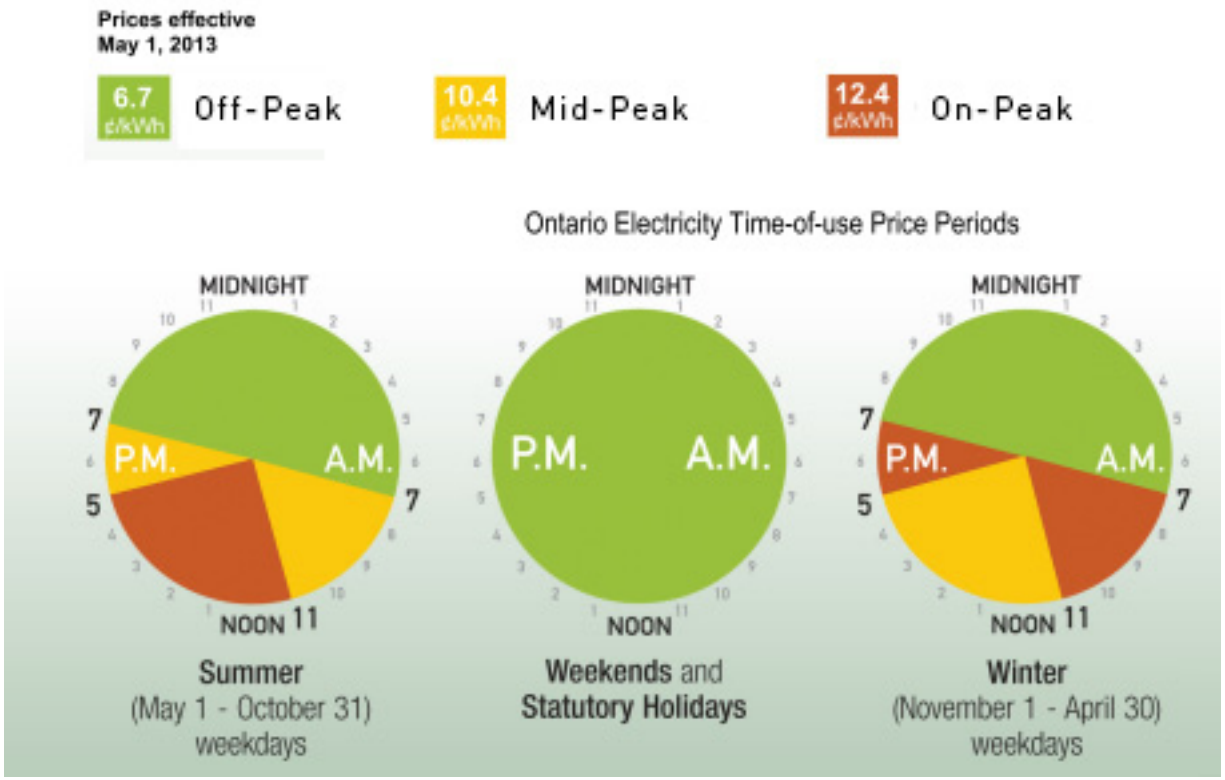

Source: http://chargepointamerica.com/files/CT2100-bollard-front.jpg

# Appendix C

## Market Demands for Electric Vehicles in North America

- The upfront cost of installing electric charging stations is heavily dependent on excess capacity of the electrical distribution system on campus. Where excess capacity exists, new wiring to the parking spot is required. Where excess capacity does not exist, more electricity will have to be purchased or the university will have to find more capacity - likely by ongoing conservation efforts.

- Most of the charging on campus will take place during peak hours, especially during the summer. "Smart Meters" can reflect this differential. The following chart reflects the current consumer electricity rates in Ontario:




Source: Ontario Energy Board (2013)

# Appendix C

**Market Demands for Electric Vehicles in North America**

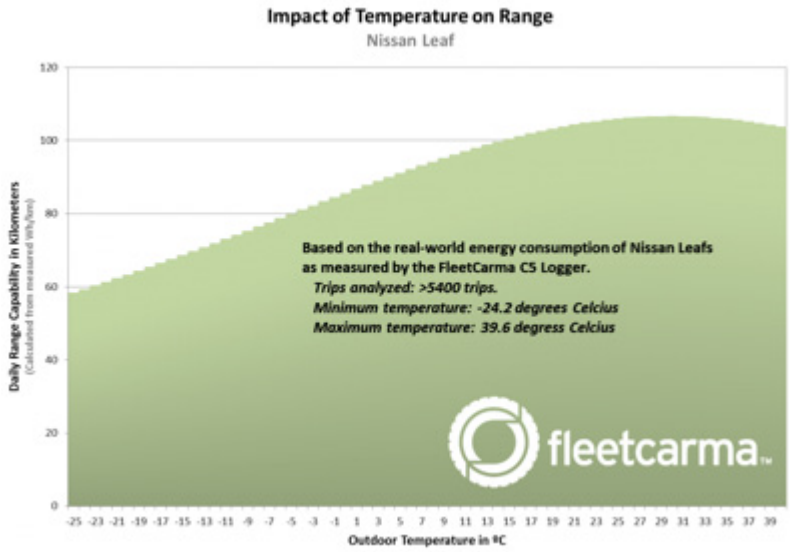
## Technological forecast for EV efficiency

- According to Tesla Motors, their grid-to-wheels efficiency is 88%. On their website, they state: "[o]verall, drive efficiency of the Tesla Roadster is 88% - almost three times more efficient than an internal combustion powered vehicle." Increased charging efficiency can make this number slightly higher, but there still must be loss in the energy conversion process.

- CANADA'S CLIMATE: According to a study done by fleetcarma (Allen, 2013) on the effect of ambient temperature on EV battery capacity, extremely cold temperatures (-25°C) reduced the battery of the Nissan Leaf to 60% of its rated capacity.

- The highly efficient drivetrain of a modern electric vehicle leaves little room for drivetrain efficiency improvements. Moreover, general vehicle design practices, such as lighter body panels, lower rolling resistance tires, and lower aerodynamic drag, can be implemented in gasoline vehicles as well. Hence, EV efficiency improvements may be borrowed from the automotive industry in general.

- Lighter weight and higher capacity batteries! This department shows significant potential for improvement, especially with the technological gains in the electronics industry.




Source: FleetCarma (2012) cited in Allen 2013

# Appendix D

**EV Case Studies**

**An EV charging market is currently in test phases all over the world, with local governments leading most initiatives. As such, case studies which have moved beyond pilot testing are rare. However, the following case studies (along with existing consumer surveys) will be very useful as York University conducts detailed feasibility analysis of providing EV charging infrastructure in the future.**

## Public Electric Car Charging initiatives in Greater Toronto Area

Public Car Charging stations are growing in popularity in Toronto due to the City's support (City of Toronto, 2013). In November 2009, Toronto City Council approved, The Power to Live Green: Toronto's Sustainable Energy Strategy. This plan committed the City to five key initiatives, intended to support the expansion of sustainable transport options in Toronto. As of December 2012, the City has replaced over five hundred standard vehicles with low emission vehicles, including a number of electric and plug in hybrid options.

The Toronto Atmospheric Fund's FleetWise EV300 Initiative is working with public and private car fleets across the GTA to transition to plug-in hybrid or full electric vehicles (City of Toronto, 2013). Recommending proper vehicles, training staff and gauging performance has allowed FleetWise to assist sixteen fleet parners to make the switch, including the Toronto and Region Conservation Authority, Toronto District School Board and the University of Toronto.

# Appendix D

## EV Case Studies

In addition, there now are a number of public electric car charging stations throughout the city of Toronto. These locations are listed below:

| LOCATION | DETAILS |
|---|---|
| **Bay-Wellington Tower (Brookfield Place)**<br>181 Bay Street<br>M5J 2T3 | **4 - Level 2 AC Charging Stations**<br>• Mon. to Fri. 6:00 am to 6:00 pm Parking: $5.25/15 min, Max: $32.00<br>• Mon. to Fri. 6:00 pm to 6:00 am Parking: $10.00 Flat Rate |
| **Parking Lot (Daniels Corporation)**<br>7 Widmer<br>M5V 1P7 | **1 - Level 1 AC Station combined with 1 Level 2 AC Station**<br>• Second level of parking lot<br>• One reserved EV parking spot beside Autoshare reserved parking spot |
| **Evergreen Brickworks**<br>550 Bayview Avenue<br>M4W 3X8 | **2 - Level 2 AC Charging Stations**<br>• Two dedicated EV parking spaces<br>• Two standard parking spaces with access to extension wands from existing chargers |
| **Leggat Chevrolet Ltd**<br>360 Rexdale Boulevard<br>Etobicoke<br>M9W 1R7 | **2 - Level 2 AC Charging Stations**<br>• Call in advance: 416-743-1810<br>• Mon. to Thurs. 9:00 am to 9:00 pm<br>• Fri. and Sat. 9:00 am to 6:00 pm |
| **Royal Bank Plaza North Tower**<br>200 Bay Street M5J 2J5 | **2 - Level 2 AC Charging Stations**<br>• Located on Level P2 (directly in front of the 'down' ramp from Level P1) |
| **Sheraton Hotel**<br>123 Queen Street West<br>M5H 2M9 | **1 - Level 1 AC Station**<br>**1 - Level 2 AC Station**<br>• Located in Driveway |
| **Ed Mirvish Way**<br>On Street | **2 - Level 2 AC Charging Station**<br>• **East side, 24 metres north of King Street West** |
| **Elizabeth Street**<br>On Street | **1 - Level 2 AC Charging Stations**<br>• East side, 9 metres south of Foster Place (1 space). Vehicles parked at this location will still be subject to the pay-and-display parking fee. |
| **Wellington Street West**<br>On Street | **2 - Level 2 AC Charging Stations**<br>• South side, 37 metres east of Clarence Square (2 spaces). |

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## UCLA Discounted Cash Flow (DCF) Study

The report summarizes the transitioning to electric vehicle (EV) market from the conventional vehicle market in the Los Angeles metro area. It assess the financial survival of non-residential EV charging stations by examining the cost recovery for commercial site owners and implementing a Discounted Cash Flow (DCF) model that meet the requirements for an Electric Vehicle Supply Equipment (EVSE) investment and installation to make profit. A DCF model uses future cash flow projections, that is, the revenue and discounted value to the capital to arrive at a present value, i.e. the cost in order to evaluate the potential for investment. It was designed to allow a site owner to assess the profitability of an EVSE investment according to the site location. Three non-residential scenarios were used: A) a grocery store, B) a mall and C) a workplace. The financial model accounted for the revenue by researching on current pricing strategies and business models for existing functional charging units such as 350 Green, Clean Fuel Connection, Ecotality and EVGo by using primary research only. It accounted for the cost of providing machinery, installation, electrical and parking costs as well as government subsidies and cost of equity in relation to the model. Profitability was analyzed based on utilization: that is, the number of charges per day or charge fixed fee, electricity cost, charger cost and installation cost.

It was found to be unbeneficial for site owners to invest financially in the EV market because they have minimal control over revenue and costs in relation to EVSE's. The revenue variables that were examined revealed very low values for the operative costs because site owners depended mostly on consumers for matching their high utility, premium, installation and electrical costs. From a cost perspective, governmental regulations were seen to increase installation costs and demand charges also acted as a barrier because the electricity panel, meter and conduits had to be metered separately. Since the use of electric vehicle is still seen to be increasing, the authors provided some recommendations. Site owners should join together as a functional union to increase purchasing power with a large order and use long term contracts with the users to guarantee usage and constant monthly revenues. Further research is needed to evaluate the demand of consumers, the impact of EV usage and indirect profitability from EVSE business.

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**EV Case Studies**

## UBC Wireless Electric Charging Stations

University of British Columbia researchers have developed a wireless charging device for electric cars that could get more of these vehicles on the road. (Zacharias, 2012). This new system uses remote magnetic gears to overcome the concern with previous wireless systems about potential health effects on humans from high power and high frequency electromagnetic fields. (ibid).

The system developed at UBC operates at a frequency 100 times lower than other wireless systems and with negligible exposed electric fields. (Zacharias, 2012). Eliminating radio waves, the system uses a rotating base magnet driven by electricity and a second located within the car. The base gear remotely spins the in-car gear which in turn generates power to charge the battery. (ibid). "One of the major challenges of electric vehicles is the need to connect cords and sockets in often cramped conditions and in bad weather," says David Woodson, managing director of UBC Building Operations (Canadian Press, 2012). A significant concern for charging cars wirelessly has been the high power and high frequency electromagnetic fields and their unknown, potential health effects on humans."

The UBC researchers came up with so-called "remote magnetic gears," a system that has been successfully tested on campus service vehicles (Canadian Press, 2012). Whitehead said it involves two magnets, one in the parking spot that rotates on electricity from the grid and the other within the car. The outside magnet remotely spins the in-car gear, generating power to charge the battery. Recharging starts as soon as the car pulls into the parking spot (Canadian Press, 2012)

Critics point out it could possibly emit stray radio waves or heat up nearby metal objects unless it is engineered just right - two issues that the wireless electric vehicle industry knows could sink the technology if the public perceive them to be dangerous. "Perceive" is the key word here, as the industry strongly affirms that their power transfer technology has been fully tested and shown to be completely safe. "We crossed that threshold two years ago," says David Schatz, vice president of sales & business development at WiTricity, a top maker of automotive recharging equipment. "The codes and standards are being written now (Ashley, 2012).

John M Miller, center director in the power electronics and electric machinery research group at Oak Ridge National Laboratory in Tennessee says the system has "Too many moving parts; it all comes down to the number of energy conversions that are involved." Here, the energy goes from electrical to mechanical and back to mechanical and then to electrical, the electrical engineer explained. And each step entails a loss in energy efficiency that adds up. (Ashley)

WiTricity's Schatz pointed out that leading automakers have already settled on designs that will be introduced "around 2015 to 2017". The biggest interest is to place them in so-called plug-less hybrids, he says. In addition, the industry expects forthcoming devices to "be approaching the size and shape of a sheet of paper and lightweight to boot," something that is perhaps at odds with the UBC magnetic system. WiTricity's power-transfer technology – sometimes known as wireless electricity - has no moving parts and exploits a high-efficiency coupling between transmitter and receiver—a one-step energy transfer

(Ashley).

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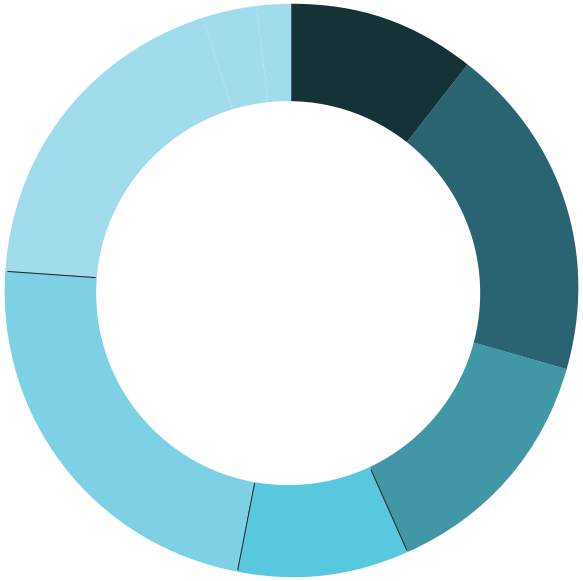
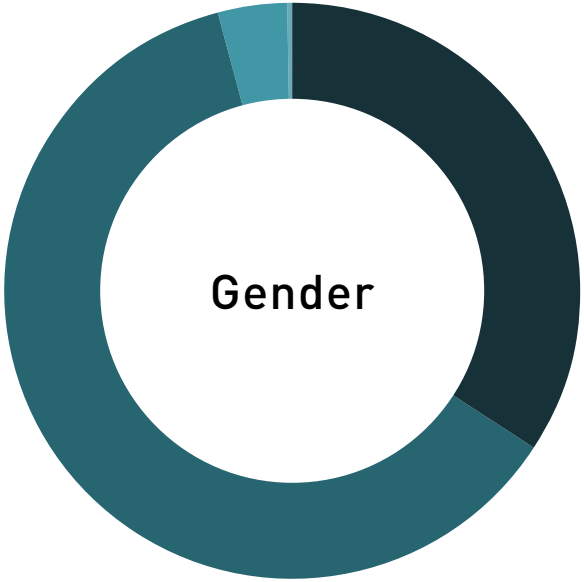
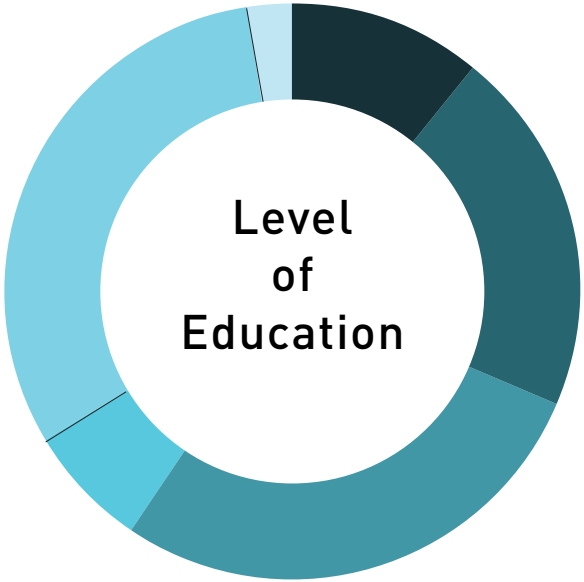
# Demographics



- Under 20
- 21 to 24
- 25 to 30
- 31 to 35
- 36 to 50
- 51 to 65
- 65+
- Undisclosed

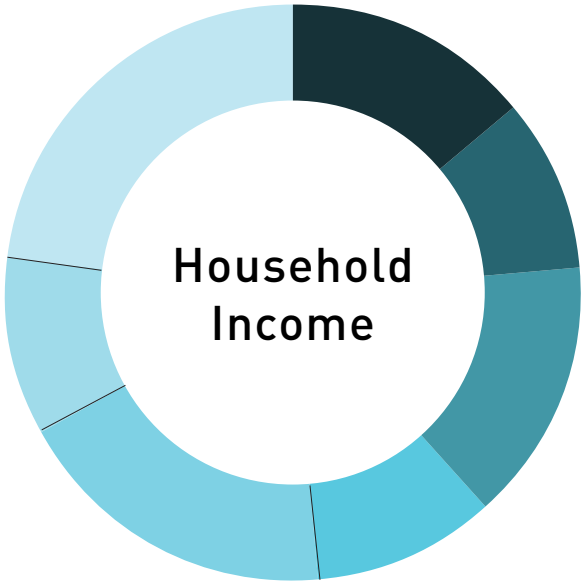



- Male
- Female
- Undisclosed
- Other

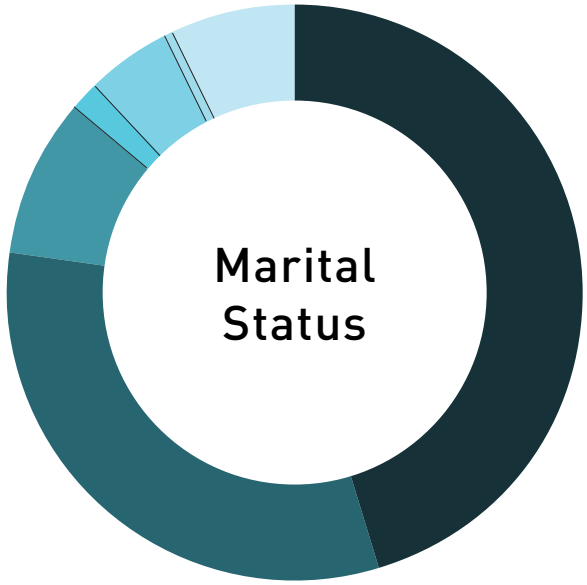



- High School
- University/College
- University/College Graduate
- Some Post Graduate
- Post Graduate Degree
- Undisclosed

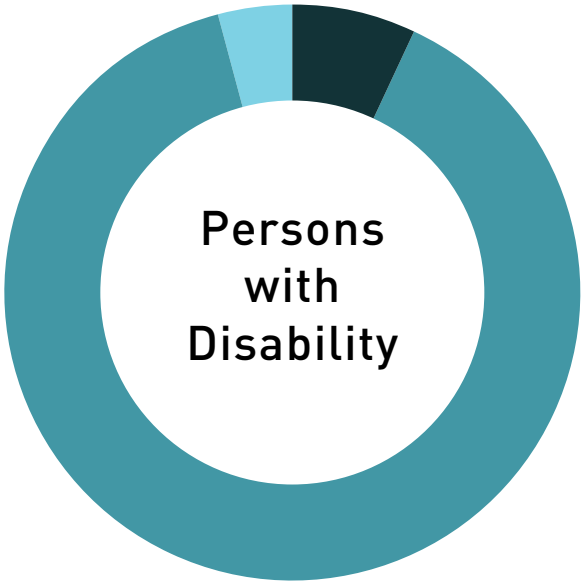
# Demographics




- Less than $25,000
- $25,000 to $49,999
- $50,000 to $74,999
- $75,000 to $99,999
- $100,000 to $149,999
- $150,000 +
- Undisclosed

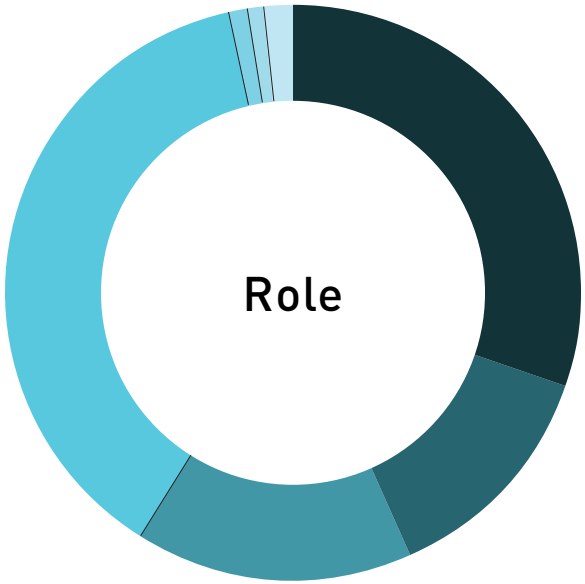



- Single
- Married
- Common-law
- Separated
- Divorced
- Widowed
- Undisclosed

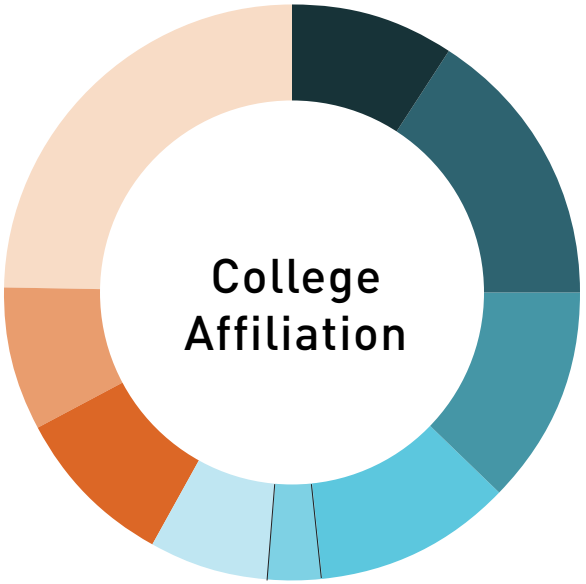



- Yes
- No
- Undisclosed

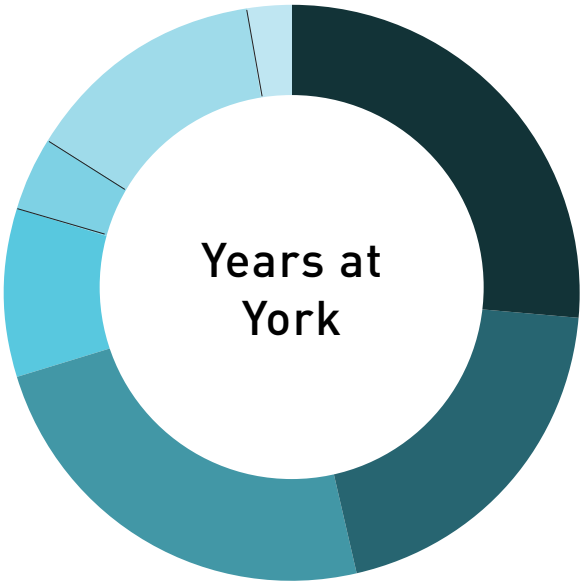
# Demographics




- Undergraduate
- Graduate or JD Student
- Faculty
- Staff
- Librarian
- Undisclosed
- Other

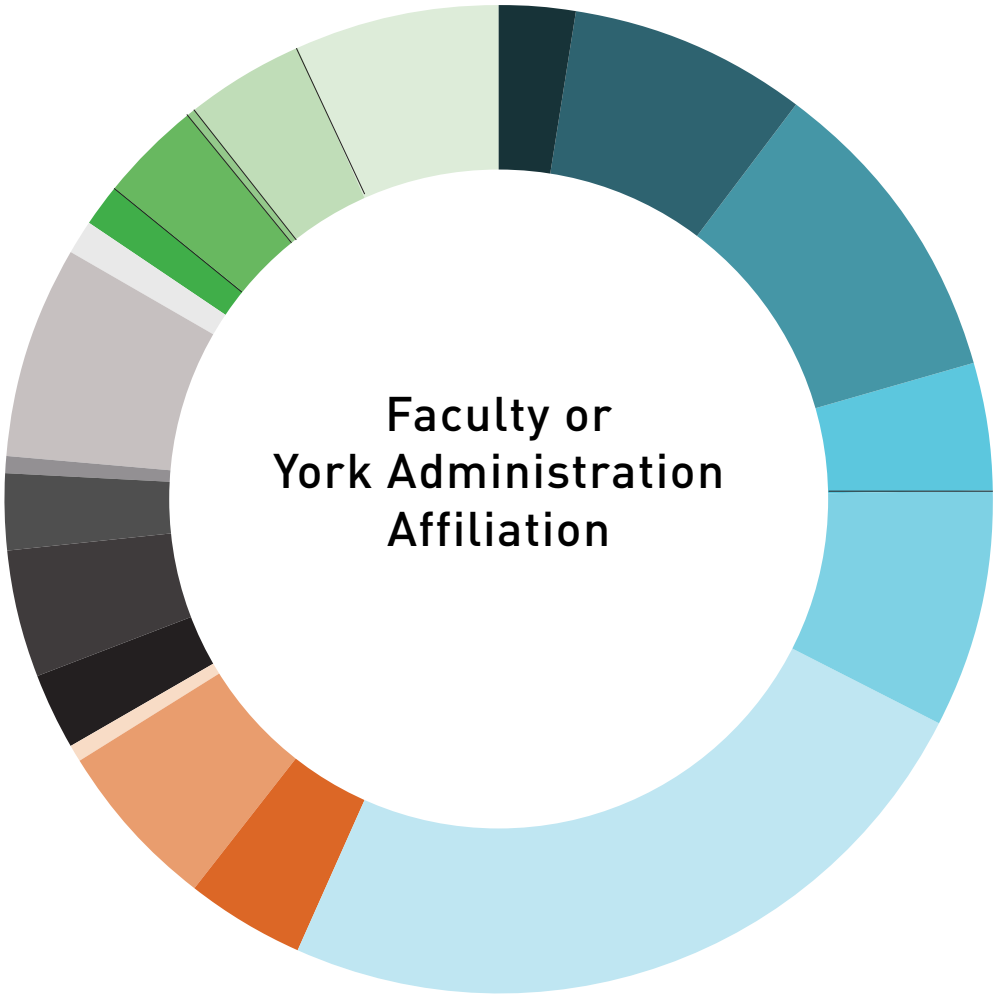



- Calumet
- Founder
- Glendon
- McLaughlin
- New
- Norman Bethune
- Stong
- Vanier
- Winters




- 1 to 2 years
- 3 to 4 years
- 5 to 10 years
- 11 to 15 years
- 16 to 20 years
- 20 +
- Undisclosed

# Demographics




- Faculty of Education
- Faculty of Environmental Studies
- Faculty of Fine Arts
- Faculty of Graduate Studies
- Faculty of Health
- Faculty of Liberal Arts and Professional Studies
- Faculty of Science
- Glendon Campus
- Lassonde School of Engineering
- Osgoode Hall Law School
- Schulich School of Business
- Academic - Not a Specific Faculty
- Advancement
- Finance & Administration
- President
- Research & Innovation
- Vice - Provost Students
- Seneca@York
- Not Applicable
- Undisclosed