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EXPLORING ELECTRIC VEHICLE ADOPTION IN NEW YORK CITY

JANUARY 2010

A GREENER, GREATER NEW YORK

The City of New York
Mayor Michael R. Bloomberg

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Executive Summary

PlaNYC, the City's comprehensive sustainability plan, established an aggressive strategy to reduce the City's greenhouse gas emissions in 2030 by 30% from 2005 levels. As part of that overall goal, transportation emissions, which currently account for 22% of New York City's total greenhouse gas emissions, would be reduced by 44% by 2030. PlaNYC also targeted a reduction in the city's levels of harmful particulate emissions and pollutants, to improve New York City's air quality.

Public transportation, bicycling, and walking are critical elements of the City's sustainable transportation system. In addition to using fewer automobiles, the City can also become more sustainable by making existing vehicles more efficient. In recent years, automotive manufacturers have begun to develop and produce a new generation of vehicles that are more energy efficient, emit fewer emissions, and use little or no gasoline. Among the most promising of these technologies are those that rely on electricity, either to enhance the distance a vehicle can travel before consuming gasoline, or through an entirely electric operation relying on battery storage technology. For those New Yorkers that will continue to rely on the automobile for their mobility needs, these electric vehicles can offer an improvement over gasoline vehicles in reducing both urban pollution and greenhouse gas emissions, helping to meet the City's PlaNYC targets. And, although they are currently more expensive to purchase than gasoline-powered vehicles, electric vehicles offer the potential to save drivers significant sums of money over time, in fuel and maintenance savings – by some estimates, electric vehicles may be 40% to 70% cheaper to operate, depending on gasoline prices and how far a driver travels each year.

In the last year, discussion of electric vehicles (EVs) has become increasingly prominent in the United States. Manufacturers have announced more than a dozen highway-capable electric vehicle models for introduction between 2010 and 2012. The Obama administration has committed more than $4 billion in support of the design, manufacture, and purchase of electric vehicles. And regulations requiring vehicle fuel efficiency are being strengthened in the U.S., effectively mandating the introduction of advanced vehicle technologies.

While electric vehicle technology offers the promise of reducing emissions of criteria pollutants and CO_2, New York City's unique transportation profile requires a tailored strategy to promote the adoption of EVs. Most New Yorkers do not own a car, and those who do may not drive them as far, or as frequently, as in other parts of the country. In addition, many New Yorkers park their cars on the street or in commercial garages. As a result, it is unclear who the target market for the first EVs would be in New York City, how many EVs would be purchased, what the key factors and barriers would be for early adoption, and how EV usage would impact our electrical grid. It is also not clear what incentives – infrastructure investments, subsidies, or other actions – may be needed to promote EVs.

To answer these questions, the City embarked on a study, in partnership with McKinsey & Company, a global management consulting firm, to identify what factors would drive early consumers to purchase electric vehicles, and what the City and other stakeholders could do to facilitate early adoption of this technology in the short term. McKinsey & Company is leading a global research effort that also includes the cities of Paris and Shanghai to evaluate the evolution toward an electric vehicle ecosystem. The study has found that:

There is a potentially large group of early adopters willing to change behavior to accommodate electric vehicles. A distinct population of "early adopters" is very positive about electric vehicles and willing to change habits to adapt to the requirements of electric vehicles. This may include, for example, switching from an on-street parking space to one in a local parking garage to access necessary charging infrastructure. The research also has found that New Yorkers' attitudes, rather than their driving or parking behaviors, are strong indications of their willingness to adopt electric vehicles. Specifically, early

adopters have expressed a desire to espouse an environmentally friendly lifestyle, possess vehicles with the latest technology, and/or to challenge themselves to reduce their fuel usage. These early adopters will also most likely reside throughout the five boroughs.

These early adopters will likely outstrip the available supply of EVs to the New York market for at least the next five years. The research projects that, by 2015, up to 14-16% of all new vehicles purchased by New Yorkers could be electric vehicles. Despite this strong interest from early adopters, only limited numbers and types of electric vehicles are expected to be offered in the New York region to meet projected demand. Given the long period from design to mass production, many manufacturers plan to pilot vehicles in small numbers to test their performance in varied conditions and environments before dramatically expanding production.

Thus, the study suggests targeting early policy actions to those issues that early adopters find most important. Efforts focused on other consumer segments should wait for several years. Given the likely strong demand among early adopters and the limited short-term supply of vehicles, initial actions would be most effective if they focused on helping early adopters enter the EV market. For example, likely early adopters may not fully understand the benefits and challenges of using an electric vehicle, so providing clear information could significantly boost early adoption. Survey respondents also voiced a desire to have a convenient and easy-to-understand process to install necessary charging equipment, at home or in a commercial garage. Early adopters expressed a desire to be recognized for purchasing an electric vehicle, by having a tree planted in their honor or some similar public display. And finally, auto manufacturers appear willing to dedicate some number of electric vehicles to markets like New York if there is sufficient demand.

Early adopters do not appear to need a high-density public charging network or local tax incentives. While the availability of charging at retail and curbside locations may be reassuring to the average driver concerned about range limitations, the study suggests that the earliest consumers will be willing to change their driving behavior and parking location, given their strong desire to purchase EVs. Thus, a dense public charging network will not be a strong priority for early adopters. Similarly, early adopters understand that electric vehicles will cost more than a comparable gasoline-powered vehicle – and they appear willing to pay a premium for the benefits that EVs will offer them. So, providing tax incentives, in the form of a local sales tax credit or auto dealer rebate, may only serve to subsidize early adopters who have already made the decision to purchase an EV, rather than attracting additional demand.

The projected level of adoption of EVs should not threaten the stability of the electric grid as long as most chargers are "smart", allowing charging to take place during off-peak hours. The study indicates ongoing coordination is required to support infrastructure planning that takes into account electric vehicles and continues to adjust planning as the growth of electric vehicles is better understood. Smart charging mechanisms that will help utilities accomodate when a vehicle is being charged may play a significant role in alleviating the need for additional infrastructure.

An opportunity exists for industry stakeholders to partner to prepare for, and encourage, EV early adoption. The City, auto manufacturers, Con Edison, and others all will have a role to play in the next five years to encourage early adoption of electric vehicles in New York City.

Context

Electric vehicles, or EVs, represent a clear economic and environmental opportunity – for governments, for drivers, and for manufacturers. Transitioning to EVs would mean a significant reduction in greenhouse gas emissions and local air pollution for all City residents, as well as reduced operating costs, a quieter ride, and less maintenance for City drivers. And yet, in the next five years at least, there will only be a limited number of these vehicles available for purchase, whether they be those that run on batteries alone or those that also contain a back-up gasoline engine to extend their range. On a national level, the Obama Administration is moving aggressively to support the ability of manufacturers and battery suppliers to meet emerging demand, as well as to subsidize the high upfront cost of these vehicles to consumers. New York City's unique transportation profile offers particular opportunities and challenges for electric vehicles, necessitating further research into the potential market in the next few years.

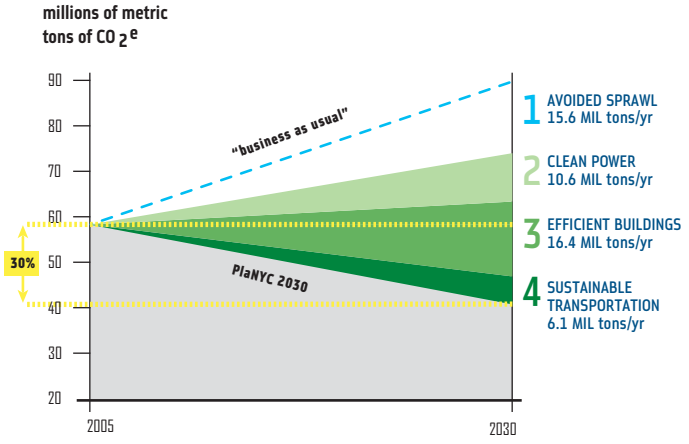
Electric vehicles could help achieve New York City's sustainability goals.

PlaNYC, the City's comprehensive sustainability plan, established an aggressive strategy to reduce the City's greenhouse gas emissions in 2030 by 30% from 2005 levels. As part of that overall goal, transportation emissions would be reduced by 44% by 2030. Transportation accounted for 22% of the City's greenhouse gas emissions in 2008, with passenger vehicles and light trucks making up 74% of this total. Electric vehicles could provide a significant reduction in fuel usage, greenhouse gas emissions, noise, and local air pollution compared to conventional gasoline-powered vehicles. EVs do not emit harmful pollutants from the tailpipe that can exacerbate respiratory illness. As the highest levels of air pollution occur in areas of the city with heavier traffic, the transition to EVs would be an important step in improving local air quality.

The environmental benefits of electric vehicles over purely gasoline powered vehicles depend on a number of factors but are determined largely by the generation source of the electricity used to charge the electric vehicle's battery. The mix of generation sources that provide power to the New York City electric grid would prove favorable to electric vehicles, as approximately 40% of the electricity consumed in New York City is generated by clean energy sources such as nuclear and hydroelectric power.

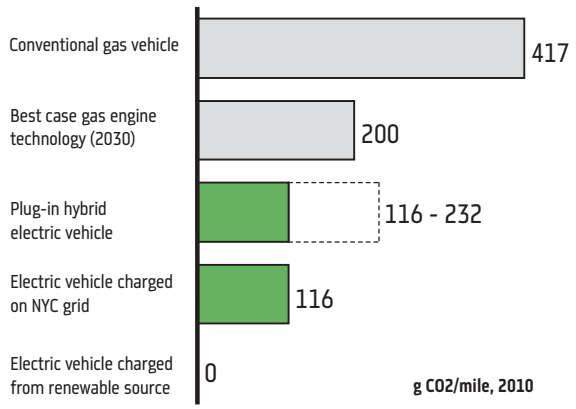
While widespread adoption of electric vehicles may increase greenhouse gas emissions at local power plants, the decrease in emissions from gasoline consumption would outweigh this impact, resulting in a net benefit of lower overall emissions. Further, centralizing the emissions from on-road vehicles at a small number of power plants rather than at a large number of vehicle tailpipes provides the opportunity for further emissions reduction by continuing to develop lower-emissions renewable sources such as solar and wind.

Figure 1: NYC Carbon Abatement Targets



Source: NYC Mayor's Office of Long-Term Planning and Sustainability

Figure 2: Wheel-to-Well Emissions Comparison for Combustion Engine and Electric Driving in New York City



Source: IEA, IAEA, AG Energiebilanzen, U.S. Dept. of Energy, McKinsey, Oak Ridge National Laboratory

Manufacturers will launch three basic types of EVs, in limited numbers, in the next several years.

In the last year, manufacturers have announced more than a dozen highway-capable electric vehicle models for introduction between 2010 and 2012. While manufacturers are producing a number of different electric vehicles, there are three basic categories. A plug-in hybrid electric vehicle is a vehicle that runs on electricity for a relatively short distance before automatically switching over to a gasoline-powered engine. An electric city car is a small car, which runs purely on an electric battery for 40-60 miles before needing to be recharged. A full-range electric car is a larger car with a longer range, approximately 100-200 miles on a full charge.

While there are now more than a dozen automakers that have publicly stated a commitment to research, develop, and/or produce an electric vehicle, the capacity for mass production does not yet exist. In fact, the development and testing period for new vehicle models can take several years, and it will not be until at least 2015 before a sizable portfolio of makes and models could begin to appear, even if the physical manufacturing capacity were in place.

The Federal Government is aggressively supporting EV development.

The Obama Administration has taken several steps to spur electric vehicle development, through both economic incentives and regulatory action. The President has set a goal of putting one million plug-in hybrid vehicles on the road by 2015 and dedicated over $4 billion to the design, manufacture, and purchase of these vehicles. In March 2009, President Obama announced two electric vehicle programs as part of the American Recovery and Reinvestment Act. The U.S. Department of Energy released a $2 billion solicitation in federal funding for EV batteries and related drive-train components, and a $400 million solicitation for transportation electrification demonstration projects. The federal government has also created a tax credit of up to $7,500 per vehicle to reduce the high initial purchase price for electric vehicles, with a cost of more than $2 billion. And in May 2009, President Obama announced his plans to implement new standards for vehicle emissions and fuel economy; it is expected that new cars and light trucks sold in the U.S. will be 30 percent cleaner and more fuel efficient by 2016. Increasing fuel economy standards will help U.S. automakers transition to the production of cleaner, more efficient vehicles, such as EVs.

Plug-in hybrid electric vehicle: GM Chevy Volt

Electric city car: Mitsubishi i-MiEV

Full-range electric car: Tesla Model S

Table 1: Characteristics of Three Basic Electric Vehicle Types

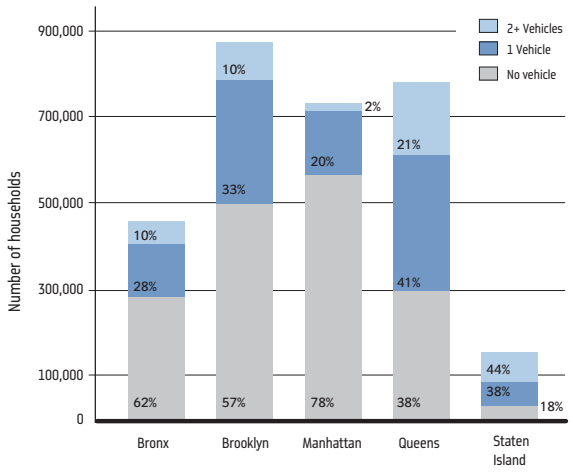
TYPE	RANGE	CHARGING TIME FOR A FULL CHARGE		ACCELERATION	OTHER FEATURES
		240V*	120V**		
Plug-in hybrid electric vehicle	• 40 miles on a full charge • After 40 miles, gasoline engine provides up to a 600 mile range	• 2 to 3 hours	• 7 hours	• Zero to 60 mph in 8 seconds (comparable or better than conventional cars)	• 200+ miles per gallon fuel efficiency through combined electricity and gas use
Electric city car	• 40 to 60 miles on a full charge	• 3 to 4 hours	• 10 hours	• Zero to 60 mph in 10 seconds (better than similar conventional cars)	• Low operating cost • Requires less maintenance • Fits into small parking spaces
Full-range electric car	• 100 to 200 miles on a full charge	• 4 to 5 hours	• 34 hours	• Zero to 60 mph in 6 seconds (better than similar conventional cars)	• Low operating cost • Requires less maintenance

*240V outlet is similar to the outlet used for an electric dryer. All newly constructed and rehabilitated New York City buildings are required to be wired for 240V.
**120V outlet is a standard outlet.

New York City's unique transportation profile requires market research to understand the initial consumer demand for EVs.

New York City is the most transit-dependent city in the United States. The transit system carries more passengers than the five next largest transit systems in the U.S. combined. Dense development patterns, a walkable – and increasingly bikeable – street grid, and the network of subways, buses, ferries, and commuter rails all allow many New Yorkers to travel without relying solely on an automobile. Not only is New York City's transportation profile different from the rest of the nation, but there are significant differences from borough to borough within the city itself. These characteristics make it essential to gain a fuller understanding of the potential for electric vehicle adoption specific to New York City.

Figure 3: NYC households by Car Ownership Level



Source: U.S. Census, 2000.

Car ownership

New York City's robust public transportation system and high density development patterns means that only 44% of households own a car, compared to 90% nationally. In Staten Island, which arguably is the most similar to the rest of the nation in terms of land use, 82% of households own cars. In Manhattan, however, less than 22% of households own an automobile. As a whole, New York City car-owning households also own fewer vehicles compared to the national average. In fact, only 29% of New York City car-owning households own two or more cars, compared with 62% nationally. In Staten Island, 53% of car owning households own more than one car (44% of total households), while only 10% of Manhattan car-owning households do (2% of total households).

Annual miles driven

Survey results show that New York City drivers travel an average of 8,900 miles per year in their cars, approximately 25% less than the U.S. average. Bronx residents drive the most, averaging 9,300 miles a year, while Queens drivers travel only 8,600 miles annually. Manhattan residents drive an average of 9,000 miles per year, yet compared to the other boroughs, a larger share of their driving mileage (40%) is devoted to social and recreational trips and a smaller share (24%) is devoted to work or school-related trips.

Trip purpose and frequency

Among drivers that reported driving in New York City at least once a week, Manhattan residents, unsurprisingly, reported the fewest number of automobile-based trips, at five per week, while Staten Island residents reported the most, at nine per week. Across all boroughs, the greater portion of driving trips was for errands, hovering under 50%. The survey indicates that a greater portion of households in Staten Island and the Bronx drive to work than households in Manhattan, Brooklyn, or Queens. Again, Manhattan residents were the least likely to use a car to get to work.

Figure 4: Annual Share of Vehicle Miles by Use*

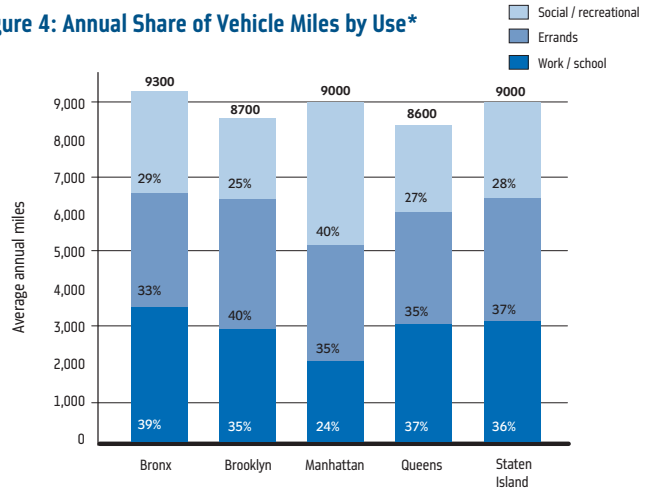
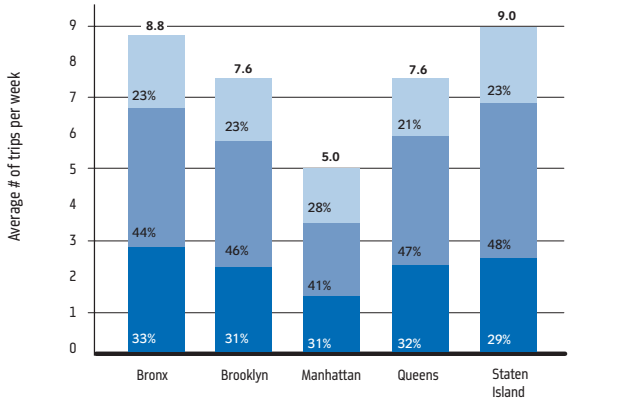


Figure 5: Share of Weekly Trip Frequency by Use*



*Among drivers that reported driving in NYC at least once per week.

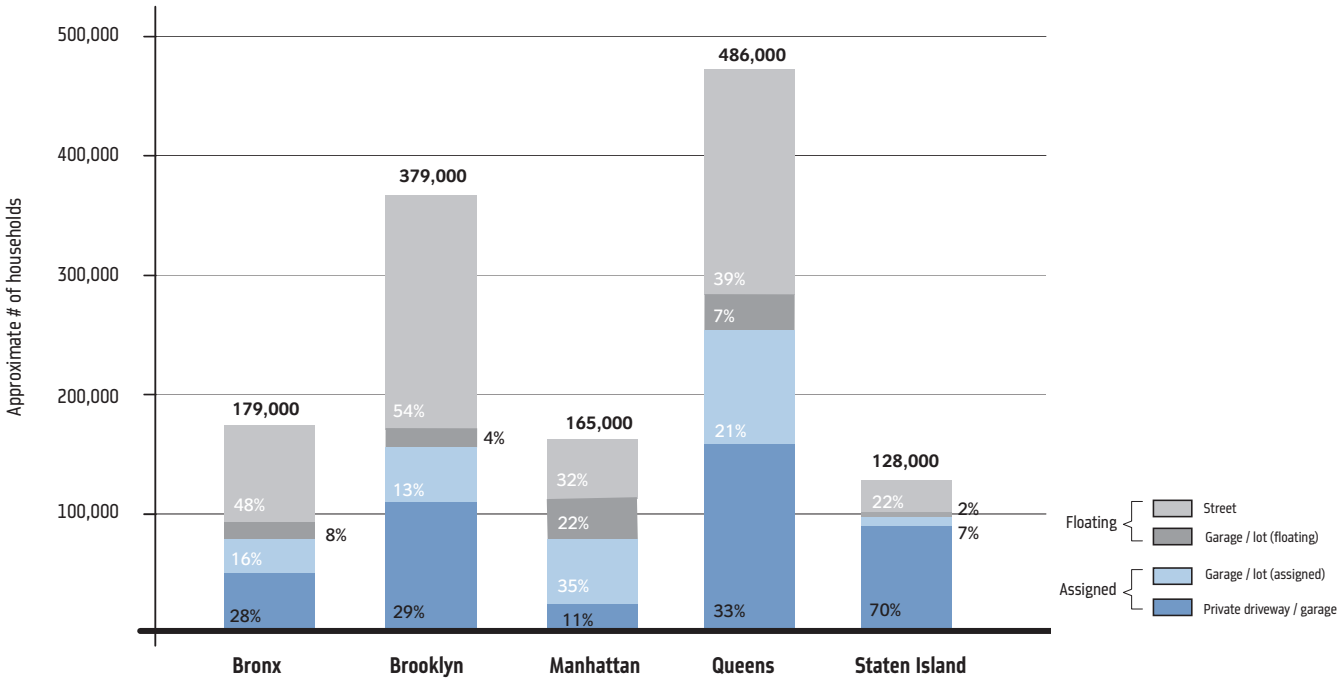
Source: New York City Electric Vehicle Adoption Survey, 2009.

Parking options

There is a sizeable share of car-owning households in New York City that have access to an "assigned" parking spot, where the vehicle always parks in a specific spot in a private driveway or garage, or a commercial garage or parking lot. This is contrasted with "floating" parking spots, where the physical location of the vehicle may change from day to day within the lot or garage. Survey results for car-owning households show that the level of assigned parking varies but represents a majority of households in all five boroughs. For example, approximately 50% of car owners in Manhattan have assigned parking; the figure rises to nearly 80% in Staten Island.

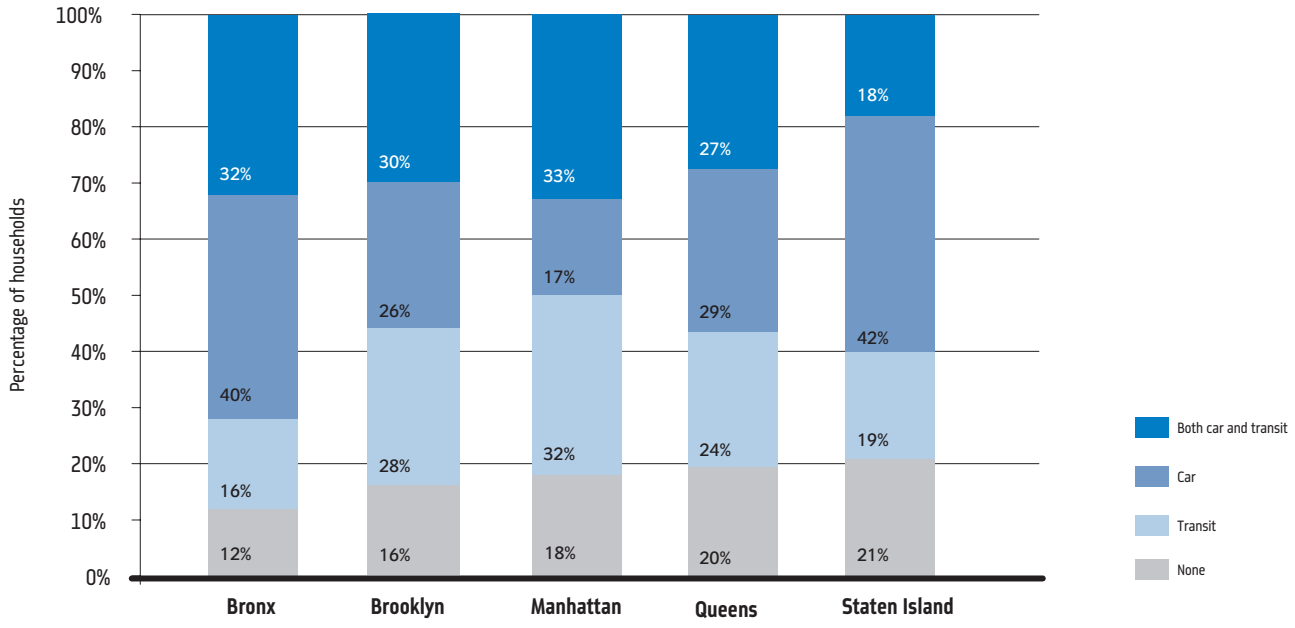
Figure 6: Parking Type Among Households With Vehicles

There is a significant share of assigned parking in NYC, ranging from ~50% in Manhattan to ~80% in Staten Island. Staten Island residents have the most "assigned" home parking.



Source: New York City Electric Vehicle Adoption Survey, 2009.

Figure 7: Mode of Travel to Work or School*



*Among drivers that reported driving in NYC at least once per week. Survey question: Over the last three months, which of the following did you use to travel to and from work or school? Source: New York City Electric Vehicle Adoption Survey, 2009.

Study Methodology

While a significant body of research exists regarding the overall benefits of electric vehicles, as well as potential technology and implementation challenges, insights from the consumer perspective have been limited, and research specifically on the residents of New York City is non-existent. As a result, the City, in partnership with McKinsey & Company, sought to conduct a market research study to:

- Determine potential "early adopters" of electric vehicles
  - Identify size and characteristics of EV consumer segments
  - Understand how NYC driving and parking patterns may affect EV uptake
- Recommend possible steps the City and other stakeholders could take to enable EV adoption
  - Identify and compare a set of potential initiatives and policies to influence customer behavior

McKinsey & Company is leading a global research effort that also includes the cities of Paris and Shanghai to evaluate the evolution toward an electric vehicle ecosystem.

The consumer research was conducted in four phases: informal interviews, an initial quantitative survey, qualitative research involving individual and group interviews, and a full-length quantitative survey.

Phase 1: Informal interviews

The research team conducted a series of 40-minute interviews with consumers identified through an informal network. These conversations helped the research team form initial opinions regarding who might adopt EVs, why they would adopt, and particular incentives that may be appealing. The interviews also helped the team understand impressions of, motivations for, and barriers to EV adoption.

Phase 2: Initial quantitative survey

A "quick" quantitative survey was designed to establish a basic fact base regarding current driving and parking patterns in New York City. The survey involved a final sample of over 1,600 drivers, with questions centered on household behaviors such as where they parked their vehicle, how often they used their cars, where they drove to/from, and how far they drove on a regular basis.

Phase 3: Qualitative research

The qualitative research began with interviews of individuals and couples. The research team conducted multi-hour discussions with consumers in their homes and parking/driving space to understand their driving behaviors, vehicle preferences, and perspectives on electric cars. The team then conducted focus groups of 4 to 8 individuals, to explore attitudes and consumer reactions to the specific types of electric vehicles. Finally, the team conducted two full-day workshops with more than 20 attendees each, comprising consumers and industry experts. These workshops were devoted to identifying potential actions that various stakeholders could take to drive EV adoption.

Phase 4: Full-length quantitative survey

In the full-length survey, 1,384 consumers were asked to complete a 45-minute survey. Respondents qualified for the survey if they: owned at least one car; did not reject electric vehicles outright; were between 18 and 65 years of age; were willing to buy or lease a new vehicle; and had a budget of greater than $15,000 for their next vehicle. The survey sample was representative of 28% of the total population of New York City, and 63% of the city's car-owning households. When exploring consumer preferences where there is a perceived societal preference – like being "green" – it is important to design research that will overcome this bias. In the quantitative survey, respondents were first educated about electric vehicles, their benefits, and potential drawbacks, so that they could more realistically envision what types of EVs would be available in the market in the next few years. Then, the survey took respondents through an exercise where they were presented with a series of scenarios and asked, given various realistic assumptions, which vehicle they would prefer to purchase, including a conventional gasoline-powered vehicle. These assumptions included what the car might look like, its brand and model, purchase price, potential operating costs based on different driving behaviors, and a set of other incentives, such as financial benefits (tax credit or dealer rebates), charging infrastructure options, and other actions.

Study Findings

There is a potentially large group of early adopters willing to change behavior to accomodate electric vehicles.

The study has identified three categories of consumer segments based on patterns of similar attitudes expressed by City residents toward electric vehicles in the quantitative survey: potential early adopters, probable late adopters, and probable laggards. It is interesting to note that the "early adopter" segment is twice as likely to adopt compared to the average of the other segments. 37% of the car owners were not included in the segmentation analysis because they were highly unlikely to buy electric cars for various reasons (e.g. they do not buy or lease new cars, their car budget is less than $15,000, etc.).

Attitudes towards technology and the environment will drive early adoption.

The study has found that the first EV consumers in New York City would be those who have expressed a clear desire to demonstrate an environmentally friendly lifestyle, to have the latest technology in their vehicles, and/or to challenge themselves to reduce fuel usage. In other words, it will be consumers' attitudes that will lead them to consider purchasing electric vehicles. Consumers' functional characteristics – driving patterns, household income, mode of parking, etc. – will help to explain whether, if these early adopters were to purchase an EV, they would prefer a plug-in hybrid electric vehicle, an electric city car, or a full-range electric vehicle. However, surprisingly, these functional characteristics provide little to no indication as to a consumer's likelihood to adopt an EV.

Early adopters will be found across geographic boundaries.

Early adopters appear to be dispersed across the City's five boroughs and socioeconomic communities; therefore, actions supporting adoption of electric vehicles should likewise be broad. At the same time, because the early adopter population is relatively diverse, policies and programs to support electric vehicle adoption will need the flexibility to accommodate a variety of challenges that adopters may face.

Figure 8: Attitudinal Segmentation of NYC EV Buyers

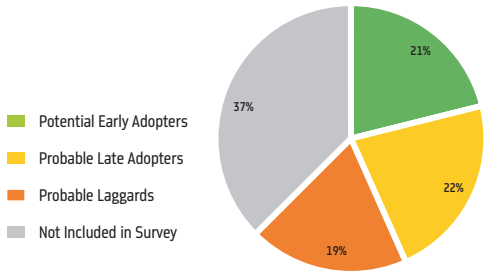


Figure 9: Attitudinal Segmentation by NYC Borough

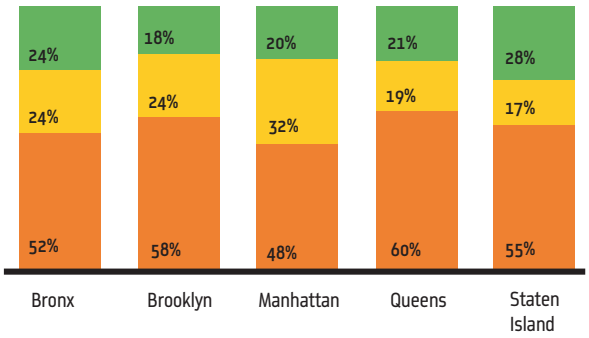


Table 2: Key Characteristics for "Early Adopter" Segments

Green Auto Aficionados	**7%**
Uses car everyday. Loves latest car technology & wants to be "green". Willing to pay upfront premium.	
Simple Greens	**7%**
Uses car on weekends and for occasional errands. Looking for basics in a car & wants to be very "green." Willing to pay premium but more budget-conscious.	
Progressive Pragmatists	**7%**
Uses car on weekends and for occasional errands. Looking for basics in a car & wants to be somewhat "green". Willing to pay premium to some degree.	
Early Adopters	**21%**

Source: New York City Electric Vehicle Adoption Survey, 2009.

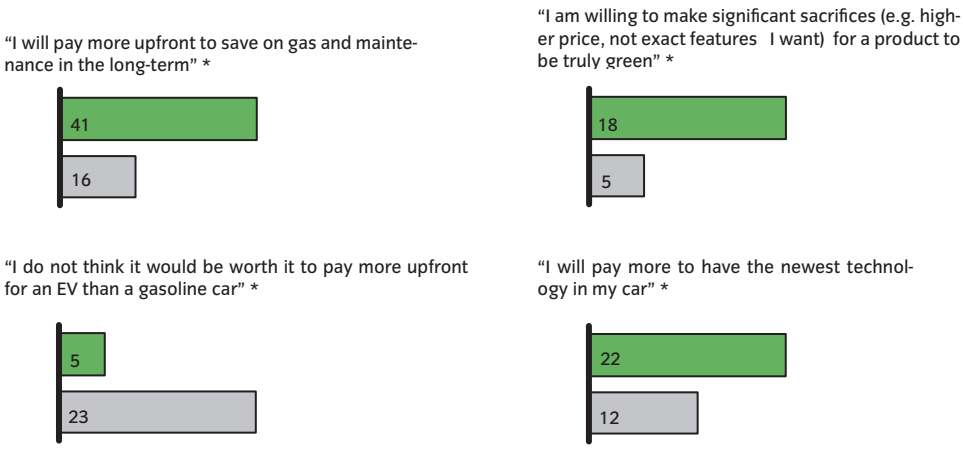
Early adopters will be willing to pay more to purchase, and find charging for, their EVs.

Electric vehicles are currently more expensive to purchase than gasoline-powered vehicles, yet survey results suggest that early adopters would be willing to pay this premium to have the latest vehicle technology or live an environmentally friendly lifestyle. Compared with other segments, early adopters also appear more willing to pay a higher upfront price to save on maintenance and fuel costs over the long run.

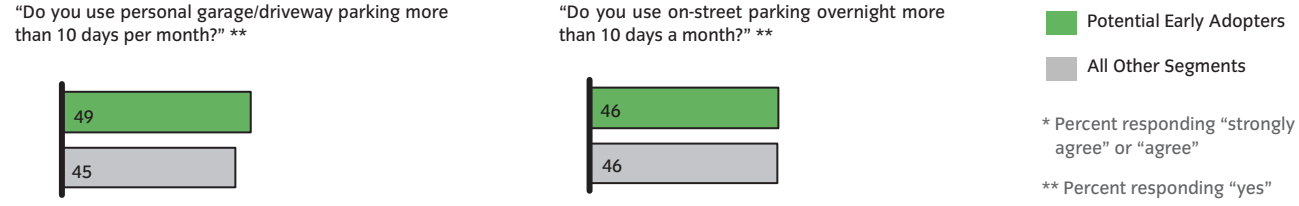
Similarly, while early adopters reported very similar parking behaviors as other segments – 46% in both groups reported using on-street parking overnight more than ten days a month – the survey suggests that early adopters will be more willing to change their parking behavior to improve their access to charging infrastructure. For example, almost twice as many early adopters would pay more to obtain an assigned parking spot if it meant that this were a requirement for charging an electric vehicle.

Figure 10: Survey Responses - Early Adopters vs. Other Segments

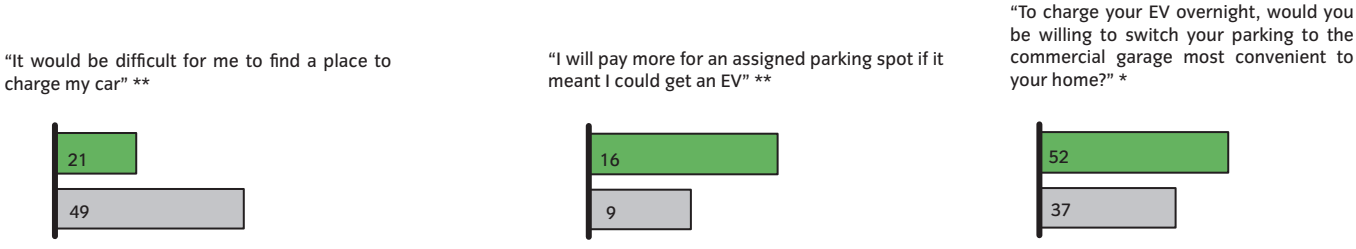
Early adopters would be willing to pay more to buy an electric vehicle.



Early adopters have the same parking options as other segments.



Early adopters would be willing to change where they park to charge their electric vehicles - even if they had to pay a premium to do so.



Source: New York City Electric Vehicle Adoption Survey, 2009.

These early adopters will likely outstrip the available supply of EVs to the New York market for at least the next five years.

By 2015, the study projects that up to 14-16% of new car buyers in New York City would be willing to buy an electric vehicle. Of this, 9% of the demand would likely be for plug-in hybrid vehicles, 6% would be for shorter-range electric city cars, and the remaining demand would be for full-range electric cars.

Figure 11: Electric Vehicle Demand Potential in New York City

Percent of new vehicle sales in NYC by 2015

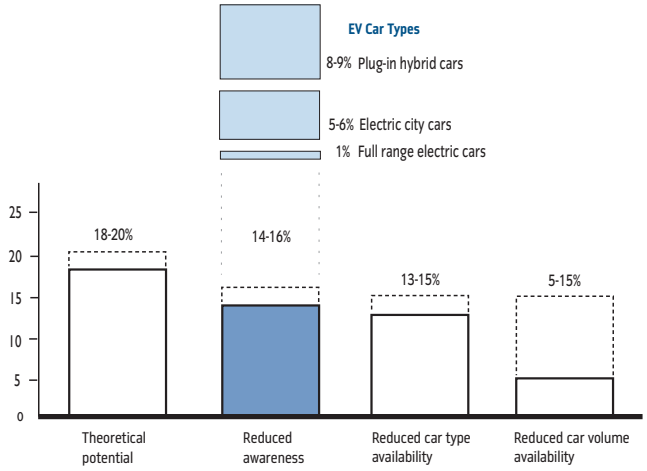


Table 3: Alternative Demand Scenarios and Impacts

	Theoretical potential	Reduced awareness	Reduced car types	Reduced car volume
# of EVs (1,000s)	50 - 60	50 - 60	50 - 60	15 - 45
% of all NYC cars	2.5 - 3.5%	2.5 - 3.5%	2.5 - 3.5%	0 - 2.5%
Tons of CO2 abated per year (1,000s)	170 - 180	170 - 180	170 - 180	50 - 150
Awareness level	100%	80%	80%	80%
Model availability	Preferred brands	Preferred brands	Limited brands	Limited brands
Volume availability	100%	100%	100%	Limited

Source: New York City Electric Vehicle Adoption Survey, 2009.

If fully captured, this theoretical demand potential would mean that electric vehicles would amount to 2.5% of the city's total vehicle population by 2015, or about 50,000 vehicles in total. However, this demand potential assumes a number of factors that may not materialize in the next several years without concerted effort from various stakeholders. First, the study assumes that at least 80% of the consumers will have a firm understanding of EVs, which existing research suggests is the current level of understanding amongst U.S. consumers for existing gas-hybrid vehicles like the Toyota Prius. Second, the study assumes that there will be a sufficient volume of EVs available for purchase. Third, the projection assumes that while consumers will not always be able to buy their most preferred brand, they will be able to purchase EVs in a variety of models that meet their needs and desires. Fourth, the study assumes that by 2015, vehicle prices will decline as a result of reduced battery costs. Fifth, the study assumes that consumers will take advantage of the existing federal tax credit of $7,500 for newly-purchased electric vehicles.

Actual adoption of EVs by New Yorkers may be significantly less if these assumptions do not materialize. In fact, the survey projects that it may be as low as 5% if, for example, auto manufacturers do not provide sufficient volumes and/or types of electric vehicles.

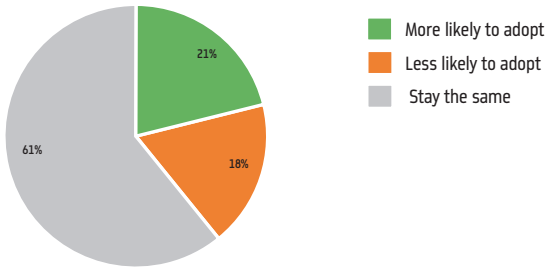
Thus, the study suggests targeting early policy actions to the issues that early adopters find most important. Efforts focused on other consumer segments should wait for several years.

Given these findings, in the near term, the study suggests that there are several opportunities that key stakeholders, such as the City, auto manufacturers, utilities, and others, could pursue, all of which focus on addressing the most critical issues for potential early adopters. As these issues are addressed over the next several years, stakeholders may then begin to consider taking additional actions to stimulate demand among other consumer segments, including building a limited network of public charging infrastructure, lowering vehicle purchase price, etc.

Lack of information and educational resources on EVs

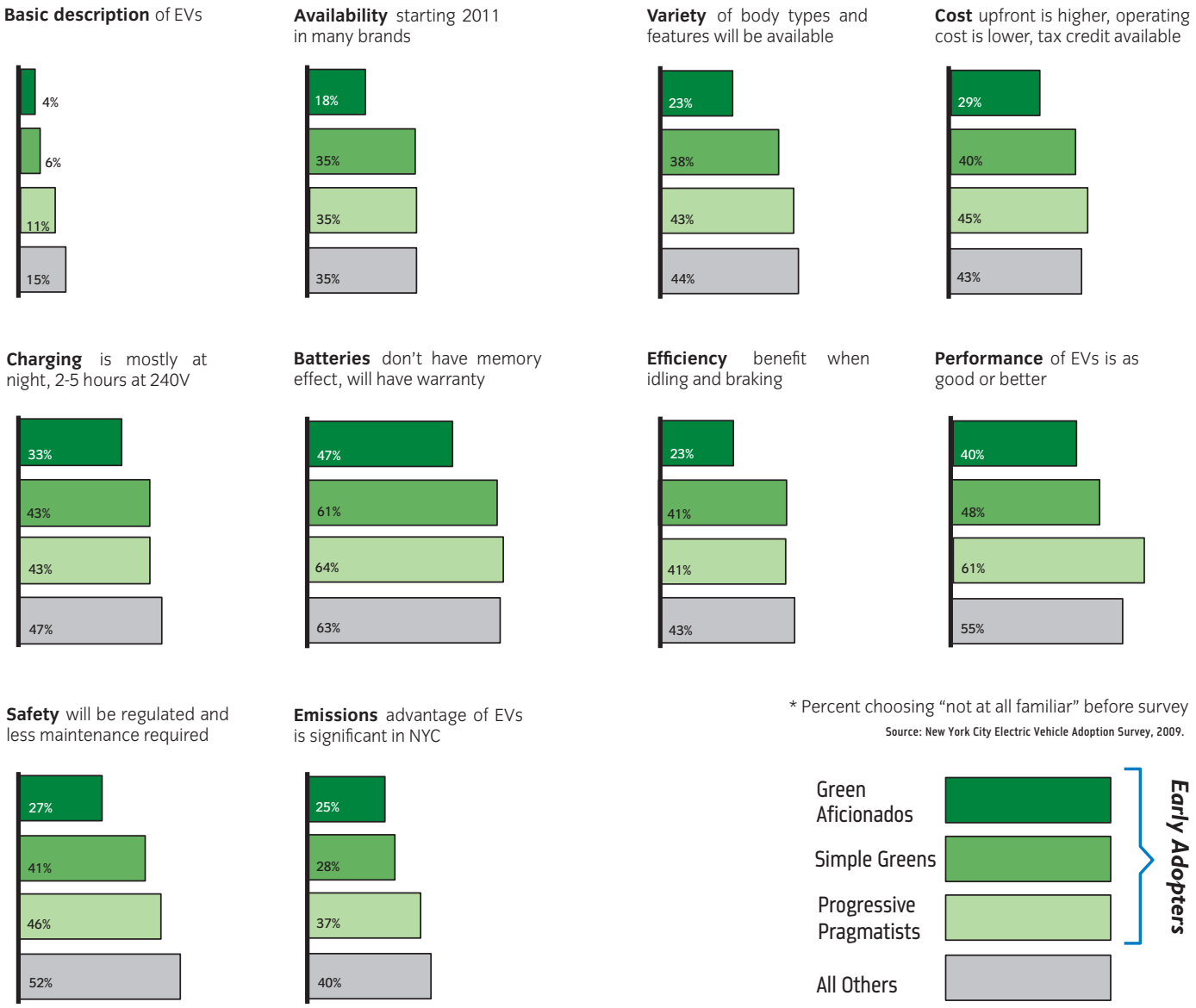
Despite substantial and increasing coverage of electric vehicles in popular media, the study indicates that although basic familiarity with EVs is high among New York City residents (88%), far fewer (30%) are knowledgeable of the specific benefits and limitations of electric vehicles, let alone differences between various models of EVs. Contrary to expectation, many of the early adopters that were identified began the survey with only an average level of familiarity and knowledge of electric vehicles. Providing basic information on electric vehicles, however, dramatically increased interest in EVs during the course of the study: in fact, 21% of consumers were more likely to adopt an EV after being educated about EVs.

Figure 12: Impact of Education on Likelihood of EV Adoption



Source: New York City Electric Vehicle Adoption Survey, 2009.

Figure 13: Survey Responses - Unfamiliarity with EV Facts Even Within Early Adopter Segments*



There appears to be a critical opportunity for stakeholders to play a role in developing a targeted education campaign to help New Yorkers better understand EV technology. Options could include establishing an information hotline through the City's 311 system, distributing material through local automobile dealerships, and/or developing a dedicated showroom where interested consumers could test-drive multiple EV makes and models.

Potential complications for "home" charging installation

Throughout the qualitative and quantitative research, consumers voiced concern regarding how and where they would be able to "fuel" their electric vehicles. The research shows that early adopters will have a strong requirement for convenient, dedicated charging where they park their vehicle for the longest duration – at "home", whether that is in a personal garage or driveway, or at a commercial garage. Interestingly, early adopters did not express a strong need for public charging infrastructure to be available throughout the city. In fact, for a sizable portion of the population, the ability to avoid refueling at public stations will be one more reason that consumers may shift to an electric vehicle.

Given the importance of home charging, another critical step could be to alleviate barriers that currently seem to prevent access to charging among early adopters. These potential barriers include: the cost and complexity of the installation process; difficulty ne-

Table 4: Overview of Typical Charging Facilities

PARKING TYPE	BENEFITS	CHALLENGES	COST TO INSTALL CHARGING EQUIPMENT*
Private garage	• Inexpensive to install • Convenient to use • Available for nightime charging	• Only some NYC car owners have private home garages	$1,500 to $2,500
Commercial garage	• Convenient to use • Available for nightime charging	• Only some NYC car owners have access to commercial garages near their homes	$2,000 to $3,500
Surface parking lot	• Visible location to create confidence for EV technology	• Only some NYC car owners have access to surface parking lots near their homes • Limited time to charge if parking hourly • Vandalism is possible	$3,000 to $6,000
On-street parking	• Widely available • Visible location to create confidence for EV technology	• Vandalism is possible • Enforcement challenges if reserved for EVs only	$4,500 to $7,500
Rapid charger and battery swap stations	• Fast charging time	• Technological challenges • Expensive to implement	$40,000+

* Numbers are an estimate; actual costs can vary based on number of charging spots, charger technology, and other factors.

gotiating with garage operators in commercial and apartment garages to provide charging; and an overall lack of standardization in commercially-available charging equipment and plugs.

There appears to be a critical opportunity for stakeholders to play a role in developing a targeted education campaign to help New Yorkers better understand EV technology. Options could include establishing a "one-stop-shop" website, distributing material through local automobile dealerships, and/or developing a dedicated showroom where interested consumers could test-drive multiple EV makes and models at the same time.

Recognition for EV early adopters

The survey shows that providing consumers with public and visible recognition for their actions could influence early adoption significantly. As described earlier, attitudes towards living an environmentally friendly lifestyle or buying the newest vehicle technology will drive the first New Yorkers to purchase electric vehicles. Not only do early adopters want to be the first on their block to own the latest vehicle technology, they want to be recognized as such – and they would like everyone else on their block to be aware of this fact as well. Therefore, actions such as planting a tree in their name to further underscore the environmental impact of their decision could increase early EV adoption.

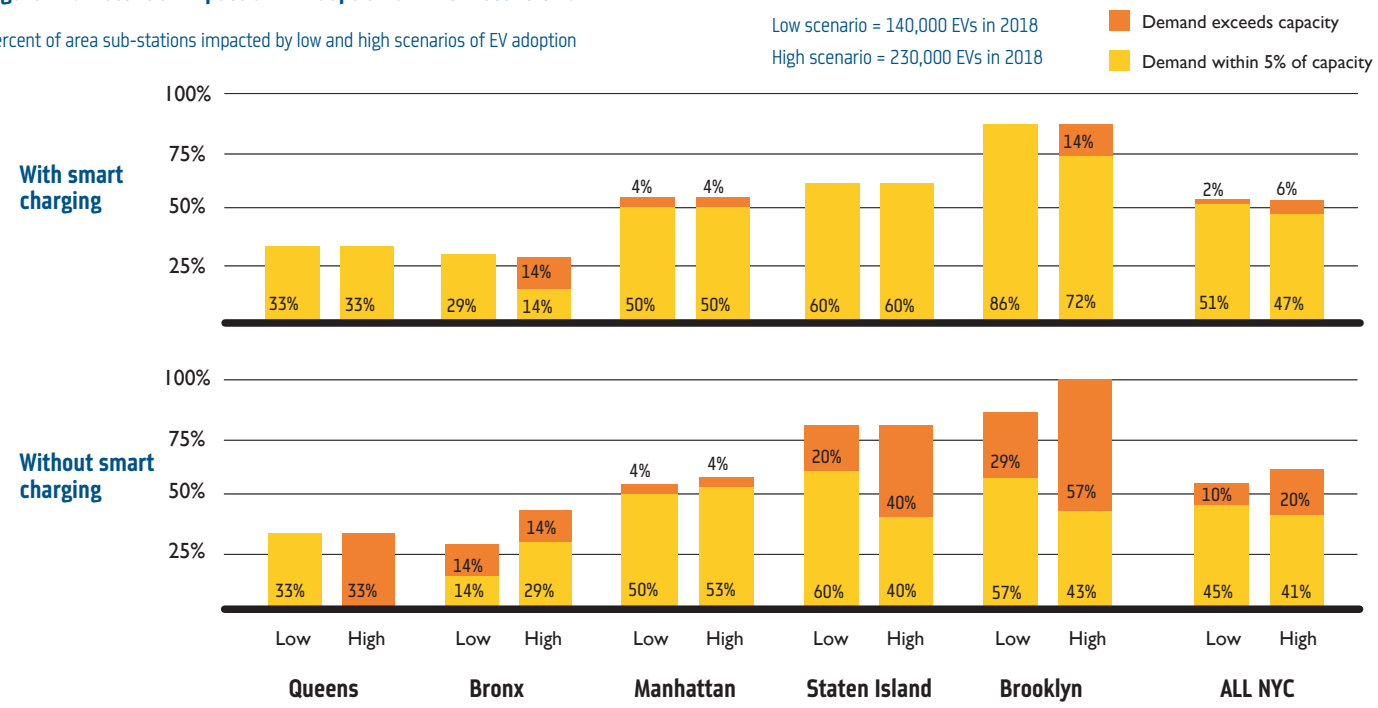
Constrained vehicle supply through at least 2015

Research suggests it may be possible to secure a concentrated level of supply for New York City residents, which would partially alleviate the short-term supply constraint noted earlier. Indeed, manufacturers have already begun to divert a small supply of electric vehicles to select pilot cities where the technology is most likely to gain traction. For example, BMW has recently provided New York City with ten Mini-E vehicles for use at the Parks Department and SCOUT Program.

Mayor Bloomberg announces use of MINI E electric cars provided by BMW to City, August 2009

Figure 14: Potential Impact of EV Adoption on NYC Electric Grid

Percent of area sub-stations impacted by low and high scenarios of EV adoption



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Source: ConEd analysis, New York City Electric Vehicle Adoption Survey, 2009

Early adopters do not appear not need a high-density public charging network or local tax incentives.

Two perceived obstacles towards EV adoption, as evidenced in popular media and industry discussions alike, are access to public charging and the high upfront cost premium for EVs. As the argument goes, without a dense network of charge points throughout the city, consumers will be unlikely to buy electric vehicles, and similarly, until the cost of these new vehicles comes down significantly, they will remain unsold.

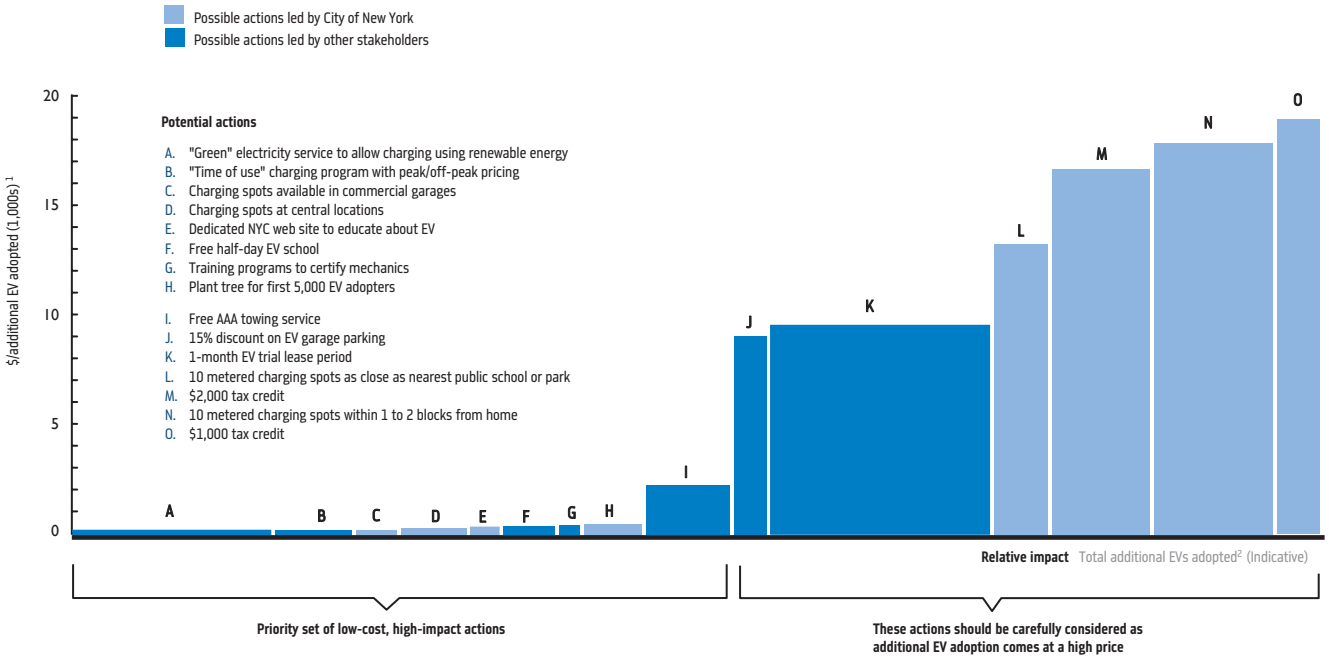
As noted earlier, however, early adopters in New York City appear willing to pay a premium for the experience of owning an electric vehicle and are flexible about adjusting their driving behaviors to rely mostly on home charging. As a result, actions such as investment in a high-density public infrastructure or additional financial incentives beyond the current federal tax credit up to $7,500 do not appear to stimulate significant incremental demand among the early adopters. For example, if consumers were offered $2,000 off the EV purchase price, whether through dealer rebates or local tax credits, the survey suggests that it could cost roughly $26,000 in funds to create demand for one additional electric vehicle. This is because for every $2,000 rebate or tax credit that successfully created demand for an additional EV, twelve other consumers may receive the incentive even though they would have purchased an EV regardless. Similarly, building high-density public infrastructure does not seem to cost-effectively influence the behavior of consumers during the early phases of EV adoption (see Figure 15).

Projected EV early adoption should not threaten the stability of the electrical grid as long as most chargers are "smart", allowing charging to take place during off-peak hours.

The electrification of road transport in New York City could shift substantial energy demand from the existing fuel infrastructure to the electric grid, resulting in potential changes to the magnitude, timing, and location of electrical demand on the City's electrical infrastructure. If this demand shift is not planned for, adoption of electric vehicles would be inhibited, either by costly upgrades to maintain reliability or a slower plug connection, resulting in negative public opinion. It is important to estimate future impacts of electric vehicles on the grid and incorporate the anticipated adoption of electric vehicles into the utility's planning process.

New York City's electric grid is unique in both its configuration and in demands placed upon it. Given this complexity, the study team cooperated with the operator of New York City's electric distribution system, Con Edison, in conducting analysis of the electric grid impacts from adoption of electric vehicles. The analysis took an upper and lower bound for the adoption of electric vehicles in 2018 (11% and 7% of the New York City residential fleet, respectively) and has determined what percent of area substations in the City's grid may face capacity constraints under a variety of scenarios, if load growth from electric vehicle adoption meets projections. The actual outcome within this range, however, would depend on both the level of adoption for electric vehicles and the presence or absence of "smart charging" mechanisms that moderate charging of the vehicle's batteries during peak periods. "Smart charging"

Figure 15: Selected Potential Actions to Encourage EV Early Adoption



1 Height of each column represents amount of money spent to have one additional EV adopted as a result of action taken; note: incremental impacts of actions are not additive
2 Width of each column represents total # of additional EVs adopted as result of action taken; note: incremental impacts of actions are not additive

can allow EVs to charge at night when system wide demand for electricity is low. In this way, electric vehicles can tap into existing generation capacity that is not being used rather than create demand for new capacity. Looking at the capacity at a borough level suggests that smart charging might have a significant opportunity in alleviating the need for additional infrastructure support.

The study suggests continued investigation is required to support infrastructure planning that takes into account electric vehicles and continues to adjust planning as the growth of electric vehicles is better understood. While this analysis has focused on impacts to area substations in the City, electric vehicles could also accelerate the need for localized upgrades if "clustering" of adoption in a single neighborhood on a certain block dramatically increases electric load in a small area. These issues will certainly be planned for and will require monitoring of electric vehicle adoption on an ongoing basis.

An opportunity exists for industry stakeholders to partner to prepare for, and encourage, early EV adoption.

It is important to recognize that the EV industry is rapidly evolving due to actions taken by different stakeholder groups and rapid technological innovation. Twelve mass-market electric vehicles have been committed by 9 major automakers in the next 3 years. Experts expect a 6-8% decline in battery prices every year, which in turn will reduce the price premium barrier for many consumers. In light of the potential impact that such uncertainties and changes can have on New York City, the study suggests an opportunity exists for close coordination to implement near-term actions and revisit assumptions in the coming years.

CONCLUSION

By 2015, market research suggests that there may be a sizable number of New Yorkers willing and able to transition to an electric vehicle. These consumers will be attracted to the potential for EVs to make their lives even greener or because EVs represent the latest trend in vehicle technology. Because of the benefits they believe EVs will offer, this early adopter community may be willing to overlook the higher initial price of electric vehicles as well as find ways to park and charge these cars, even in the absence of subsidies or public "fueling" areas. In fact, this group of consumers appears to be larger in number than what auto manufacturers can likely produce in the next five years, both in terms of total numbers of EVs as well as the specific vehicle models that these early adopters will prefer.

A targeted focus on the issues that will most likely unlock this initial adoption would be a logical first step for those interested in driving electric vehicles into consumers' garages. In particular, there are a set of low-cost actions that appear to have disproportionately high impact in this regard: educating these potential consumers, helping them find and install the necessary "smart charging" equipment to re-fuel their vehicles, and recognizing them for being leaders in this new technology. Stakeholders will need to coordinate in new ways to reach these consumers, but if they do, there will be great benefits – to local air quality and to drivers' and manufacturers' pocketbooks.

Appendix

The Frequently Asked Questions below were presented to consumers during the third and fourth phases of research.

What is an electric vehicle?

"Electric vehicle" is a term used to describe any car, truck, or SUV that is able to drive on electric power instead of using gasoline. This electric power comes from a battery that is recharged by plugging into an electrical outlet. Some of these electric vehicles drive on electric power only and do not use gasoline. Other electric vehicles operate on electric power, but they also have a gasoline engine in addition to the electric motor.

When will these electric vehicles be available?

There are very few electric vehicles on the market today, but many major manufacturers will offer them beginning in 2010-2011.

How does the cost of electric vehicles compare?

Electric vehicles are currently more expensive to manufacture than traditional gasoline vehicles but it is not yet clear how that may change. There is currently a $7,500 federal tax credit for purchasing an electric vehicle, up to a maximum of 60,000 vehicles per manufacturer.

The day-to-day cost of driving an electric vehicle in New York, including electricity and maintenance, will be 40% to 70% less than a gasoline vehicle costs to operate, including gasoline and maintenance. If gas prices increase, the savings from using electric cars will be higher. The price of electricity may also increase in the future but the price of electricity is more consistent and changes more slowly than gasoline prices. Electric vehicles offer a favorable total cost of ownership only when lower operating costs offset the higher purchase cost. Therefore, higher annual mileage, which allows drivers to take advantage of the lower operating cost, proves favorable to the total cost of ownership of EVs.

How do I charge an electric vehicle?

Most owners will charge their electric vehicles when they park at night. Electrical outlets may already exist where they park or they can be installed in a driveway, personal garage, parking lot, parking garage, or might be available in the street. Electric vehicles can be charged from a standard 120 volt outlet but will charge faster from a 240 volt outlet. These 240 volt outlets are already present in most homes and are used for electric stoves, electric dryers, and large air conditioners. If the owner doesn't already have an outlet near where they park, any electrician can perform the installation.

How long will the batteries last?

Electric vehicles contain advanced batteries that can be recharged and unplugged at any time during charging and will last about 7-10 years. Drivers will be able to charge every night without worrying about shortening the battery's life. When drivers go on vacation, they can leave their vehicle unplugged and it won't run down or they can leave it plugged in and it will stop charging automatically. State laws in New York, New Jersey, Connecticut and several other states require manufacturers to warranty batteries in electric vehicles for at least 10 years or 150,000 miles.

What is it like to drive an electric vehicle?

Electric motors deliver comparable or better acceleration compared to gasoline engines. This means that most electric vehicles will accelerate faster from 0 to 60 mph than similar cars powered by gasoline. Electric vehicles may need to be plugged in more frequently than you are used to refilling your gas tank but you can recharge from anywhere there is an electric outlet.

How "green" are electric vehicles?

Driving on electric power results in no tailpipe emissions but the electricity to recharge your car may come from power plants that burn fuel. Electric driving is especially "green" in New York City where a large amount of electricity comes from upstate low-emission sources like hydroelectric dams and nuclear.

A wide range of potential stakeholder actions were identified through qualitative research and then tested for impact through the quantitative survey.

Charging infrastructure

- Able to install charger at "home" garage
- Able to install charger at "home" garage & public charging available within 2 miles of home
- Able to install charger at "home" garage & public charging available near closest school or park
- Able to install charger at "home" garage & public charging available within 1-2 blocks of home
- Public charging at central locations (Times Square)
- Public charging near big shopping centers (IKEA, Target)
- Public charging at major transportation areas (Jamaica, Citifield, JFK, LGA)
- Public charging at hourly/daily commercial parking garages
- Free installation of charger at "home" garage
- Battery swap stations where gas stations exist today
- Fast-charging stations where gas stations exist today

Tax credits and rebates

- $0 tax credit on upfront price of car
- $1,000 tax credit on upfront price of car
- $2,000 tax credit on upfront price of car
- $3,000 tax credit on upfront price of car
- $2,000 OEM rebate on upfront price of car

Consumer awareness

- Training program to certify mechanics to work on EVs, creating "green jobs"
- Free half-day EV school providing consumer education and experience with an EV
- Dedicated NYC website and hotline to educate customers regarding EV
- EVs appear on cover of major magazines and driven by major political/entertainment figures

Other potential actions

- 15% discount on garage parking space, with EV charging infrastructure available
- 30% discount on garage parking space, with EV charging infrastructure available One month trial lease period
- Free AAA/towing service anywhere in city and immediate loaner vehicle if requested
- Guarantee EV will have resale value similar to gasoline vehicle
- Option to upgrade vehicle to newer technology in future at predetermined price
- Free unlimited Metrocard for 1 year
- EV preferred lanes on select major roads
- Low-emission-vehicle-only areas of city
- Free rental car for 10 days over 2 years
- "Time of use" charging program with different rates for peak/off-peak rate
- "Green" electricity to charge EV only with renewable energy
- "Green apple" license plate just for EVs
- City to plant street tree in name of first 5,000 New Yorkers who buy an EV
- City declares goal for increasing number of EVs in fleet by 2015
- EVs on cover of magazines and driven by politicians and entertainment figures

Tables and Figures

Figure

Table

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