The State of Massachusetts EV Policy

Assessing the Opportunities

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EXECUTIVE SUMMARY

Context

The Commonwealth of Massachusetts is interested in deploying electric vehicles (EVs) to meet the greenhouse gas emission targets outlined in its Clean Energy and Climate Plan for 2020 as well as other environmental and economic goals.

This assessment, performed at the request of representatives from Massachusetts government, has been completed in two parts. First, it provides an analysis of the opportunities and barriers of EV deployment in Massachusetts. This is intended to be an impartial analysis that will lend credibility to Massachusetts' interest in pursuing EV deployment. Second, this report assesses opportunities to strengthen the incentives of personal EV users, municipal and commercial fleets, and commercial interest in EV to encourage deployment of EVs throughout the State.

There are four analyses that have contributed to this report based on literature review, interviews, and quantitative data analysis. However, because of limited information there is a high level of uncertainty in the analysis. Much remaining research remains to be done.

Analysis and Key Findings

Landscape of electric vehicle policy and deployment

This section describes the common benefits of EVs that Massachusetts hopes to leverage, summarizes the federal funding opportunities, and provides brief case studies of selected areas successful in EV deployment. While no one-size-fits-all solution exists, Massachusetts can learn from States that have engaged a variety of stakeholders and engaged cross-cutting partnerships in order to secure funding and encourage deployment.

Personal electric vehicle deployment

This demographic analysis provides key factors needed to spur EV deployment by personal users. Based on these metrics, the report locates areas in Massachusetts in which personal EV use is most likely to be successful. These results suggest that there are widespread geographic opportunities to encourage personal EV adoption throughout the State.

Fleet deployment

This interview-based analysis provides insights into the reasons why EVs are being pursued, what is being done to add EVs to fleets and what support may be required to get them rolling.Both monetary and non-monetary assistance from Massachusetts could propel fleets to become an important first mover in EV deployment.

Commercial interests in electric vehicle deployment

Also based primarily on interviews, this section analyzes the interests and incentives of companies in Massachusetts who would benefit from EV deployment in the State. Commercial interests cite long-term information and support as the most important incentive to invest in EVs.

Conclusions

This report has attempted to survey the literature, data, and human resources available to provide information to inform Massachusetts' implementation of EV policy. There are two high level conclusions that resulted from the report.

Widespread opportunities throughout the State

The demographic analysis and survey of interest from a variety of stakeholders throughout the State suggest that there are opportunities for deployment of both personal EVs and fleets of EVs throughout the State. The Oregon case study suggests that engaging a variety of stakeholders can be effective in developing a unified rollout across the State.

Demand for State leadership

While many of the people interviewed suggested that direct financial incentives would be helpful in the short term, there was even stronger demand for long-term leadership from the State government. Commercial interests want information and stability in regulation in order to ensure long-term incentives for their companies.

INTRODUCTION

The deployment of electric vehicles (EVs) can have a variety of environmental and economic benefits to society. Substituting EVs for traditional gasoline-powered vehicles can reduce local air pollutants as well as global greenhouse gas (GHG) emissions. Reducing dependence on oil for transportation can also lead to lower fuel prices and price volatility for consumers. The development of this new industry can promote a variety of job creation opportunities.

Representatives from the Massachusetts government[1] commissioned this report because they are interested in encouraging EV deployment within the state in order to leverage these environmental and economic opportunities. They are especially interested in using EV deployment to meet the goals of their Clean Energy and Climate Plan. Challenges exist, however. Limited funding sources are available to provide financial assistance to potential investors, and it is difficult to generate widespread impetus to change the current transportation infrastructure. Moreover, because EVs are an emerging technology, there are limited data to inform best practices for policy implementation. This report aims to critically assess these challenges and opportunities in light of significant uncertainty.

Purpose of the study

The goal of this assessment is twofold. First, it provides an analysis of the specific opportunities and barriers of EV deployment in Massachusetts. This is intended to be an impartial analysis that will lend objective credibility to DOER's interest in pursuing EV deployment. This analysis will be informed by case studies of regions in which EVs have been deployed and the potential application of similar strategies to Massachusetts. It will also include an overview of federal funding opportunities, and how they might be leveraged to further MA's larger economic and environmental goals. Note that while a majority of EVs have been deployed in urban areas to date, this assessment covers the entire State of Massachusetts to cover the full scope of DOER's authority.

Secondly, given that the MA government is pursuing policies to promote EVs, this report assesses opportunities to align the incentives of potential EV users with those of commercial stakeholders interested in investing in charging infrastructure and EVs within the State. This analysis seeks to find opportunities to leverage mutual interests of users and commercial interests in order to promote market penetration of EVs.

Key Analysis

In order to perform these assessments, this report proceeds in four parts:

[1] Specifically, the authors of this report have been working with Stephen Russell of the Department of Energy Resources (DOER) and Linda Benevides of the Executive Office of Energy and Environmental Affairs.

- *Landscape of EV policy and deployment.* This section describes the common benefits of EVs that Massachusetts hope to leverage, summarizes the federal funding opportunities, and provides brief case studies of selected areas successful in EV deployment.

- *Personal EV deployment.* This demographic analysis provides key factors needed to spur EV deployment by personal users. Based on these metrics, the report locates areas in Massachusetts in which personal EV use is most likely to be successful.

- *Fleet EV deployment.* This interview-based analysis provides insights into the incentives required to encourage EV deployment in municipal and commercial fleets.

- *Commercial interest in EV deployment.* Also based primarily on interviews, this section analyzes the interests and incentives of companies in Massachusetts who would benefit from EV deployment in the State.

LANDSCAPE OF EV POLICY AND DEPLOYMENT

ENVIRONMENTAL AND ECONOMIC INCENTIVES IN MASSACHUSETTS

Greenhouse Gas Emissions (GHGs)

One of Massachusetts' primary interests in promoting EV deployment within the State is its potential benefits for reducing GHGs. The transportation sector accounts for over one third of GHG emission in the State; in combination with an increasingly low-emission electricity generation mix, electrification of transportation sector could produce substantial emissions reductions.

Massachusetts is positioning itself to leverage this opportunity. In 2008, the Global Warming Solutions Act passed by state legislature mandated an 80% reduction of GHG emissions from 1990 levels by 2050. Last year the Executive Office of Energy and Environmental Affairs published a Clean Energy and Climate Plan in order to implement this Act. The plan aims to achieve a 25% reduction in emissions by 2020 with 7.8% coming from initiatives in the transportation sector.[2] EVs could play a significant role in several of these initiatives:

- *Regional Low Carbon Fuel Standard (LCFS).* MA is seeking cooperation with other States in the Northeast to establish a regional standard for a LCFS. This would require a percentage-based decrease in the carbon-intensity of vehicle fuels in the region which could be met with increased EV deployment, biofuel production, or a combination of each.
- *Clean Car Consumer Incentives.* MA is exploring methods such as varying tax rates and registration fees dependent on vehicle mpg. Electric vehicles could be promoted by equating electric-fueled vehicles to high mpg vehicles, as is done in federal CAFÉ standards.
- *GreenDOT.* This initiative within MassDOT is focused on reducing GHG emissions, promoting public transit, biking and walking as modes of transportation, and encouraging sustainable development. While decreased use of personal vehicles is likely the most efficient way to promote all three goals, EVs may play a role in areas in the State in which alternate modes of transportation are not available or efficient.

Air Pollution

The U.S. EPA sets National Ambient Air Quality Standards (NAAQS) for six traditional air pollutants: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead.

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[2]MA Clean Energy and Climate Plan for 2020. http://www.mass.gov/Eoeea/docs/eea/energy/2020-clean-energy-plan-summary.pdf

Massachusetts has a history of nonattainment for both ozone and carbon monoxide, particularly in western counties in the State.[3] Tailpipe emissions from gasoline-fueled vehicles are a major contributor of carbon monoxide emissions and NO_x emissions, which forms ozone; electric vehicles have zero tailpipe emissions.

Job Creation

The Massachusetts Clean Energy and Climate Plan estimates that as many as 13,000 jobs could be created as a result of implementing transportation programs in the plan. While such forecasts are always highly uncertain (and the forecasters in this case have an incentive to yield high estimates), the underlying reasoning is valid.[4] In particular, policies that promote EV deployment would generate direct employment opportunities for companies in the State that help to produce EVs or EV battery or infrastructure. Increased activity in these industries could spur activity in related fields—such as information and technology services to help consumers install EV infrastructure in their homes.

Azure Dynamics, a company that specializes in the supply of vehicle control systems and powertrain systems for EV and hybrid vehicles, and lithium-ion battery producer A123 Systems are examples of Massachusetts-based companies that would directly benefit and generate job opportunities from increased EV deployment.

FEDERAL POLICIES TARGETING EV DEPLOYMENT

The U.S. federal government has implemented several programs to support EV deployment in the United States. Much of the funding from these programs came from the American Recovery and Reinvestment Act (ARRA). See the following page for a table taken from an MIT Energy Initiative report entitled that summarizes the legislative EV incentive programs to date.[5]

One example of a project that has been successful in securing federal funding is "The EV Project," a collaboration between ECOtality, a charging station provider, Nissan, and Chevrolet. ECOtality was awarded a $100 million Recovery Act grant from the U.S. Department of Energy to implement this project, which aims to deploy 14,000 chargers in 18 U.S. cities (Massachusetts not included)..[6] DOE selected grant awardees based on 1) strength of technical approach 2) ability to carry out project effectively and efficiently and 3) overall impact of the project.[7] It is likely that ECOtality's willingness to partner with well-established automakers and the widespread geographic distribution of the project helped it performance on DOE's metrics.

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[3]Mass DEP. A Massachusetts Status Report. http://www.mass.gov/dep/air/priorities/1990ca01.htm. 2000.
[4] See Appendix of the Clean Energy and Climate for description of methodology used
[5]MIT Energy Initiative Symposium."Electrification of the Transportation System." http://web.mit.edu/mitei/docs/reports/electrification-transportation-system.pdf. 2010
[6]ECOtality: the EV Project. http://www.theevproject.com/overview.php. Accessed April 2010.
[7]U.S. Dept. of Energt. Financial Assistance Funding Opportunity Announcement. http://www.er.doe.gov/sbir/Solicitations/FOA_ARRA_Phase_1.pdf. August 5, 2009.

	Program	Legislation	Description	Cost
Batteries, Infrastructure and Manufacturing Assistance	Advanced Vehicle Technology Program	American Recovery and Reinvestment Act	Provides direct investment for battery and infrastructure manufacturing deployment — $2.5 billion of which went to battery and component manufacturing plants	$5 billion
	Advanced Technology Vehicle Manufacturing Loan Program	Energy Independence and Security Act 2007	Direct loans to Nissan, Tesla, and Fisker for EV facilities in Delaware, Tennessee, and California. Manufacturers are eligible for direct loans of up to 30% of the cost to reequip, expand, or establish manufacturing facilities	$2.6 billion
	Battery Research and Development Grants from ARPA-E	American Recovery and Reinvestment Act	Direct grants for high-risk/high-reward research on next-generation batteries, specifically ultra-capacitors and metal-air batteries	$80 million
EV Deployment	Plug-In Hybrid Tax Credit	Energy Policy Act of 2005, adjusted with the Energy Independence and Security Act of 2007, Emergency Economic Stabilization Act of 2008, and American Recovery and Reinvestment Act of 2009	For batteries of at least 4 kWh in capacity, this program offers a $2,500 income-tax credit with an additional $417 for each added kWh of capacity, with a maximum credit of $7,500 for up to 200,000 vehicles	$1.5 billion
	Vehicle Electrification Initiative	American Recovery and Reinvestment Act	Provides grants to 11 localities for deployment and integration, includes the cost of vehicles, infrastructure, and workforce education programs	$400 million

Federal Funding Resources for EVs. MITEI. "Electrification of the Transportation System." 2010.

Policy Recommendation: In order to secure funding in the future, Massachusetts should seek to foster collaborations between companies with diverse technologies and interests throughout the northeast region.

While Massachusetts has been unsuccessful in securing federal funding to date, the Obama Administration plans to continue to make similar investments in EV deployment and infrastructure. In January of this year the Administration announced its plan to meet its goal of putting one million advanced technology vehicles on the road by 2015.[8] This plan includes three funding opportunities that could be leveraged by Massachusetts:

- *Rebates for EVs.* This policy would change the existing $7,500 tax credit described above into a rebate to make EVs immediately more affordable to consumers.
- *New R&D investments.*
- *Community grants for EV infrastructure.* Up to 30 communities would be awarded grants on a competitive basis to fund charging stations.

[8]U.S. Dept. of Energy. "Vice President Biden Announces Plan to Put One Million Advanced Technology Vehicles on the Road by 2015." http://www.energy.gov/news/10034.htm. January 26, 2011.

The Administration proposed these three initiatives in its 2012 budget proposal, but at this point in time there is considerable political uncertainty surrounding the budget.

SUCCESS IN EV DEPLOYMENT: EXAMPLES FROM THE U.S. AND BEYOND

A report from the U.S. Department of Energy released in February of this year described the progress the U.S. has made in promoting electric vehicles. In the past six years over 1.6 million hybrid electric vehicles have been sold, demonstrating an interest in advanced vehicle technology, and the Administration predicts that over 45,000 electric vehicles will be supplied in the U.S. in 2011 and will continue to grow to safely meet the 1,000,000 total goal in 2015.[9]While these numbers are small in comparison to the 15-16 million light duty passenger vehicles sold in the U.S. each year, it reflects significant interest in an emerging technology.
There are an increasing number of analyses of areas in the U.S. that have been successful in promoting EV deployment. In particular, the Alternative Fuels & Advanced Vehicles Data Center within DOE recently released online case studies of four areas in the U.S. and their strategies toward deploying EVs and infrastructure.[10]

Policy Recommendation: While there is no one-size-fits-all solution to EV deployment, Massachusetts should review these and similar case studies and perform their own analysis to learn applicable lessons from other States.

For now this report will provide a high-level overview of a few different models. The specific cases chosen were intended to illustrative the wide variety of approaches, which may or may not be successful in Massachusetts.

California

California has a long history of promoting pollution-reducing policies in its transportation sector. This is due in large part to the fact that some parts of the State and the Los Angeles area in particular have some of the worst air quality in the country. In particular, California passed the Zero-Emission Vehicle (ZEV) mandate in 1990, which required 2% of vehicles sold in CA each year to have zero tailpipe emissions in 1998 and increase to 10% by 2003, fining automakers who failed to meet the requirement.[11]

This mandate is an example of technology-forcing policy. Instead of mandating a specific existing technology, it forced automakers to develop their own technology while being neutral towards the type of technology. While this placed a large financial burden on automakers and received

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[9] These estimates were based on auto manufacturers' production figures and media reports. While such estimates are likely to be overstated, the Administration said it chose more conservative estimates when it seemed appropriate.
[10]U.S. Dept of Energy. Alternative Fuels & Advanced Vehicles Data Center. http://www.afdc.energy.gov/afdc/vehicles/electric_deployment_case_study_oregon.html. Accessed April 2011.
[11]California EPA. Rulemaking to the California Zero Emissions Vehicle Amendments 2001. http://www.arb.ca.gov/regact/zev2001/zev2001.htm Accessed April 2011.

widespread outcry from the industry ending in a lengthy legal battle, it was successful in generating significant advances in batteries and electric drive trains.[12] California leads the country in electric charging stations, with 494 in the State, centered mostly around Los Angeles and San Francisco.[13]

Policy Recommendation: In light of the high expense of the technology-forcing policies implemented in California and Massachusetts' financial constraints, MA should not implement technology-forcing policies but rather incentivize interest in existing, economically-competitive technologies.

Oregon

Oregon is very similar to Massachusetts in its attitude towards EV and might provide a more relevant example of successful promotion of EVs. While Oregon does not suffer from air pollution to the extent to which California does, it passed climate change legislation in 2007 similar to Massachusetts' Clean Energy and Climate Plan, setting GHG targets at 10% and 75% reductions from 1990 levels by 2020 and 2050 respectively. It also has a large population of early adopters of new technologies.[14]

EV Project Oregon Advisory Team	
Cities • Corvallis • Eugene • Gresham • Portland • Salem	**State of Oregon** • Building Codes Division • Business Development Department • Department of Energy • Department of Transportation
Universities (Oregon Transportation Research and Education Consortium) • Oregon Institute of Technology • Oregon State University • Portland State University • University of Oregon	**Utilities** • Eugene Water & Electric Board • PacifiCorp • Portland General Electric • Salem Electric

EV deployment in the State initially took off in the city of Portland. Strategies used include[15]:

- EV tax incentives
- EV-only parking spaces
- Economic development initiatives to support clean-tech companies
- Buying EVs and charging stations for municipal fleets
- Fostering public-private partnerships

Because of its success in Portland, Oregon was able to leverage ARRA funding through ECOtality's EV project. This project will expand EV infrastructure in the State by installing 900 home-based stations, 1,150 Level 2 charging stations, and 45 fast-charging stations. These will be focused on the Portland-Salem-Corvallis-Eugene corridor, which encompasses 70% of the State's population.

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[12] Caleb, David and Goble, Robert. "The allure of technology: How France and California promoted electric and hybrid vehicles to reduce urban air pollution." Policy Sci (2007) 40: 1-34.
[13]U.S. Dept of Energy. Alternative Fuels & Advanced Vehicles Data Center. http://www.afdc.energy.gov/afdc/locator/stations/. Accessed April 2011.
[14]U.S. Dept of Energy. Alternative Fuels & Advanced Vehicles Data Center. http://www.afdc.energy.gov/afdc/vehicles/electric_deployment_case_study_oregon.html. Accessed April 2011.
[15]Electric Vehicles: The Portland Way. http://www.portlandonline.com/shared/cfm/image.cfm?id=309915.

Because this project spans multiple municipalities, four metropolitan planning organizations, and seven utilities, Oregon assembled a diverse advisory team to coordinate the project (see table above, taken from DOE Alternative Fuels & Advanced Vehicles Data Center.)

Policy Recommendation: Massachusetts should seek out corridors within the State to multiply the utility of EV deployment in individual areas. This task would require leadership from DOER with significant input from local stakeholders.

Better Place

Better Place is an Israel-based company that specializes in battery switching stations instead of (or accompanied by) traditional charging infrastructure. This type of infrastructure would allow users to pay a subscription fee to be able to swap their dead batteries for charged ones. These stations could operate like gas stations on a highway; users would not have to wait long periods of time for their battery to charge.

Better Place has had success implementing its technology in places like Israel, Denmark, and Australia and is still trying to gain traction in the United States. In Israel the cornerstone of its success has been a partnership with carmaker Renault, which makes cars that are compatible with Better Place's batteries.[16] None of the leading car manufacturers in the U.S. have made such an agreement, and the success of the battery-swapping requires a significant market share of EVs to be compatible with swapping technology. As a result it is unlikely that the Better Place model will take hold in Massachusetts in the near future.

Policy Recommendation: In the near future, Massachusetts should focus on traditional charging infrastructure instead of battery-swapping stations.

[16] Better Place. http://www.betterplace.com/. Accessed May 2011.

PERSONAL VEHICLES DEPLOYMENT

EVs are a new technology that have not yet made a significant commercial impact at the scale predicted for the next five years. With several EV models hitting the market starting this year, there is great uncertainty about who will buy EVs, how they will drive them and where they will need charging infrastructure.

Two main barriers limit the widespread adoption of personal EVs. First, the cost of EVs remains high (even with substantial governmental subsidies) and savings from reduced fuels costs are not sufficient to make up the difference in the short-term. Second, the autonomy of electric vehicles is still limited (from 40 - 100 miles) and the fear of running out of battery charge is likely to discourage some potential buyers.

There is limited observational data to rely on. The best indicators we have are surveys of potential EV adopters; these surveys develop a list of metrics aimed at evaluating a person's likeliness to buy an EV based on their demographic information.[17]

The goal of this section is similar: to identify the most relevant data on consumer demographics to gain an understanding of probable first adopters of EVs. This analysis uses data from the census of 2000 and location data on people who have reserved the Nissan LEAF (provided by Massachusetts DOER).

RELEVANT DEMOGRAPHIC FACTORS

As we have few observational data on where EVs are first appearing, we have to rely on external factors and correlations to identify likely areas of early adoption. There is no extensive survey in Massachusetts asking consumers their preferences for buying an electric car in the years to come. The most reliable database that is available at the State level is currently the 2000 census[18].

Based on two main limitations to EV adoption– cost and autonomy – it is possible to define the profile of a characteristic early adopter of electric vehicle. The following list presents a set of six relevant parameters[19]:

1) Income: EVs are still more expensive than other cars; best estimates say that the cost surplus would be paid in four years if gas and electricity prices stay the same. Only high-

[17] See for example the conclusions of the Accenture study on Electric Vehicles: "Changing the game: Plug-in electric vehicle pilots" (Feb 2011)
[18]The 2010 census is to be released soon and will feature up-to-date data
[19] These factors were cited in interviews or presentations with different stakeholders.

income families would likely invest now for an electric vehicle given the long and uncertain payback period.

2) Level of Education: Understanding of the benefits of an EV on air pollution and climate change tends to grow with the level of education. A high level of education is strongly correlated with income.
3) Number of cars in the household: As the autonomy of an electric car is limited and a network of swapping stations is not likely to appear soon, long trips will still require gas-powered cars. Households with a greater number of cars are more likely to buy an EV as they will still have one or more traditional vehicles for longer trips.
4) Length of daily commute: EV buyers' daily commute must be within the range limits of EV batteries in order to be useful on a daily basis. Manufacturers currently promise batteries lasting up to 40-100 miles but it is likely that buyers will take a safety margin. As a consequence someone commuting more than 40 miles per day does not seem likely to be an early adopter of EV.
5) Possession of a driveway: As public charging will not be available early on, it is critical for an EV owner to be able to park her car at home where she can have a personal charging station. The Nissan LEAF for example requires a full night of charging every 100 miles.
6) Early adopter of green technologies: As the short-term price of EVs remains high, ecologically-minded people are more likely to be first adopters.

MASSACHUSETTS' LIKELY EARLY ADOPTERS

This analysis uses three of the six relevant pieces of information described above to find regions in the State likely to have early adopters:

- High Income
- Number of cars possessed by the household
- Daily Vehicle Miles Travelled (VMT) per vehicle which accurately represents the average length of the daily commute.

As previously explained, education is strongly correlated to income so high income is a fairly accurate representation of high-level education. We will also make the assumption that driveways are common in the suburbs and in rural areas, but not in cities and town centers. Finally, we exclude ecological consciousness due to lack of an open and credible database.

The three following maps represent respectively:

- Percent of Households with High Income (fig.1): darker green areas are the most favorable.
- Number of Registered Vehicles per Household (fig.2): red areas are the most favorable.
- Average VMT per Vehicle (fig.3): yellow to light red areas are favorable as two daily commutes can be made without charging the car (if we consider a car with 100 miles autonomy).

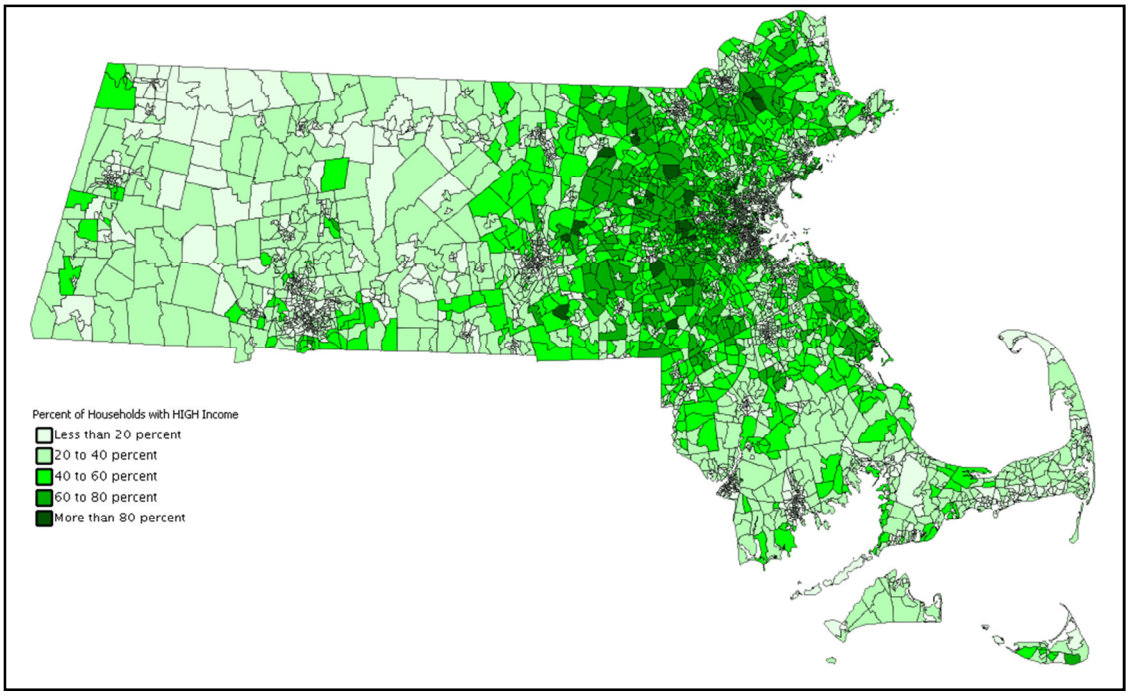

Figure 1. Percent of Households with income higher than $75,000 (source: census 2000, MassGIS)

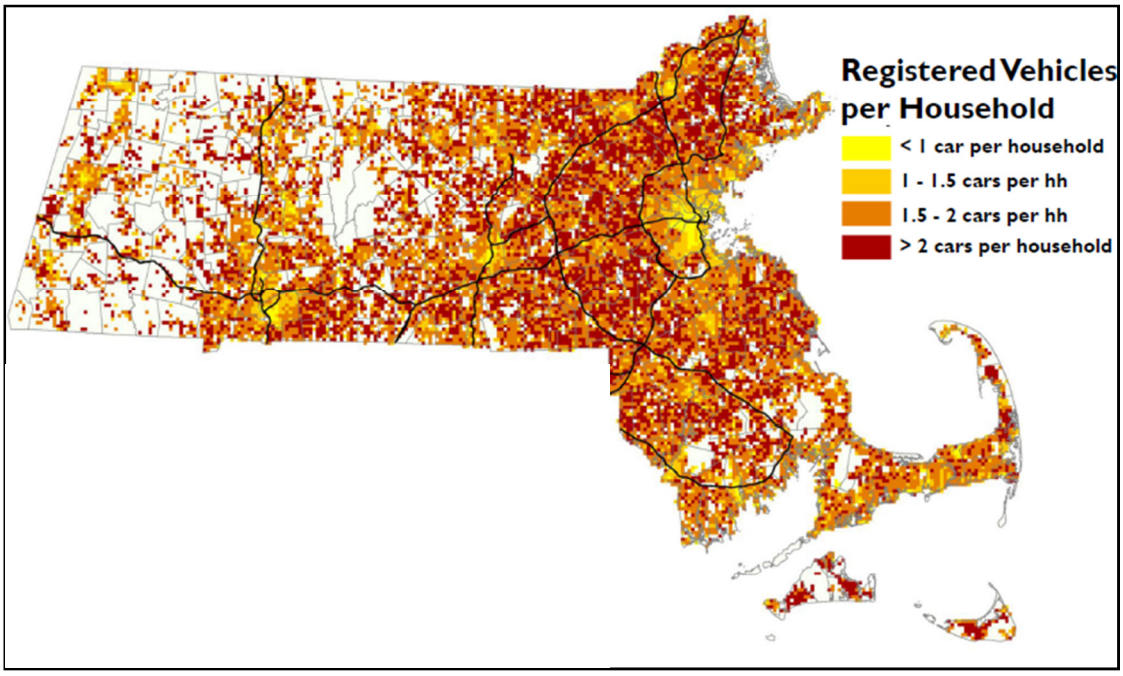

Figure 2. Number of vehicles per household (source: census 2000, MA RMV, MassGIS, MAPC)

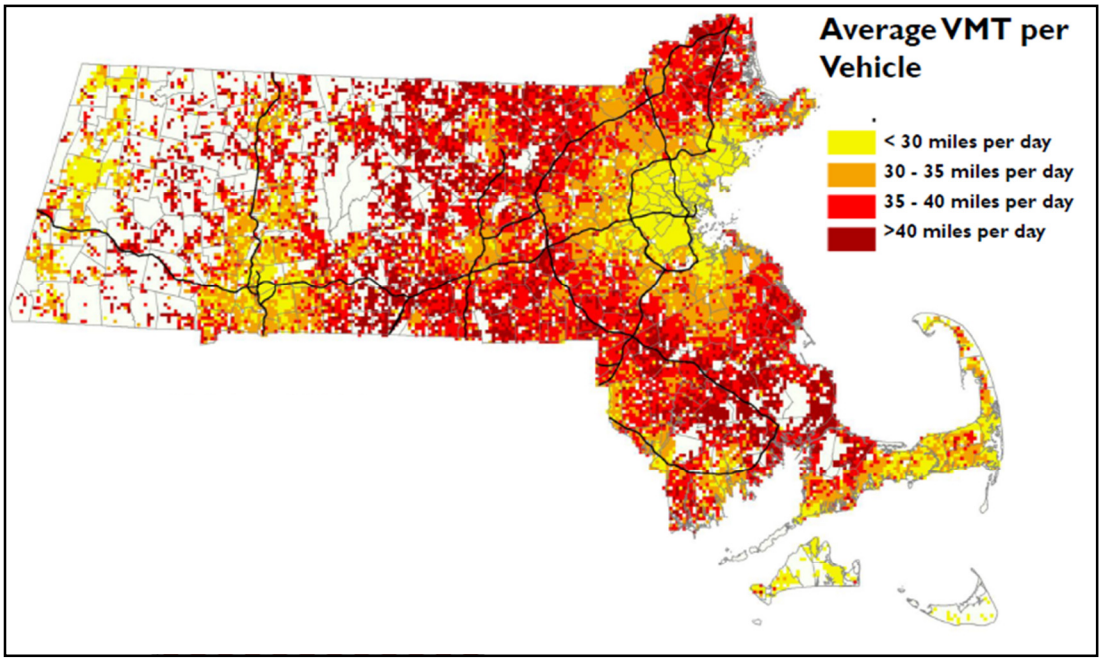

Figure 3. Average VMT per vehicle (source: census 2000, MA RMV, MassGIS, MAPC)

A visual correlation of these three maps identifies areas where EVs are most likely to appear early in significant numbers. The map below (fig.4) identifies these areas plotted along with the population.

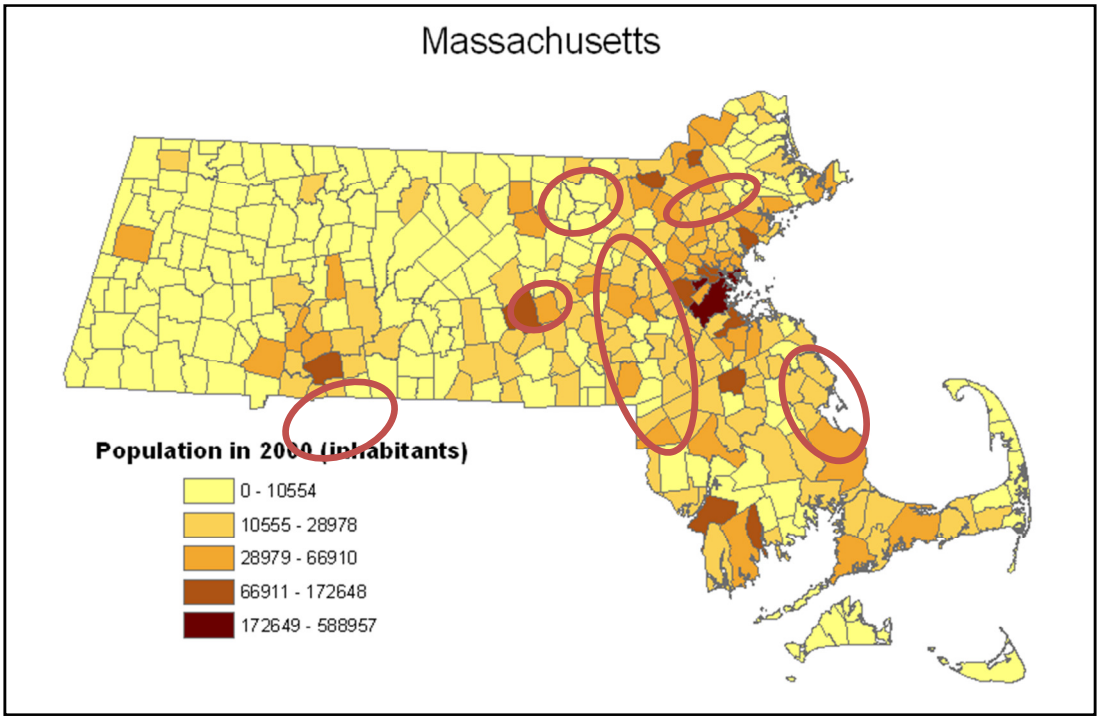

Figure 4. Likely areas of appearance of EVs

Out of this broad analysis, we identify six large areas where EV clusters are likely to appear (circled in red on the map above): South Springfield, North-East Worcester, East Lowell, South Lawrence, West Greater Boston and South-East Greater Boston. This analysis is inherently qualitative and uncertain due to lack of availability of data sets and limited resources.

Policy Recommendation: Additional analysis should be done with quantitative data using a weighted average of the six factors identified in order to yield more accurate and precise results.

Using the commuting data from these areas, it is possible to assess whether users would need public charging. The availability of these public charging stations could be critical to providing the psychological security needed for the adoption of electric vehicles in some areas.

VALIDATION USING NISSAN LEAF PRE-ORDERS

Already available on the market in some States, the Nissan Leaf is the first mass-produced EV set to hit Massachusetts in late 2011. The database of Leaf preorders is publically available. There is a reservation fee of $99 which suggests that a large percentage of these consumers will actually buy the car when it is available on the market. Despite the small number of cars reserved, we are able to distinguish patterns that make it easy to recognize five of the six areas on the number of Nissan Leafs per inhabitant map below (North-East Worcester does not seem to score well here).

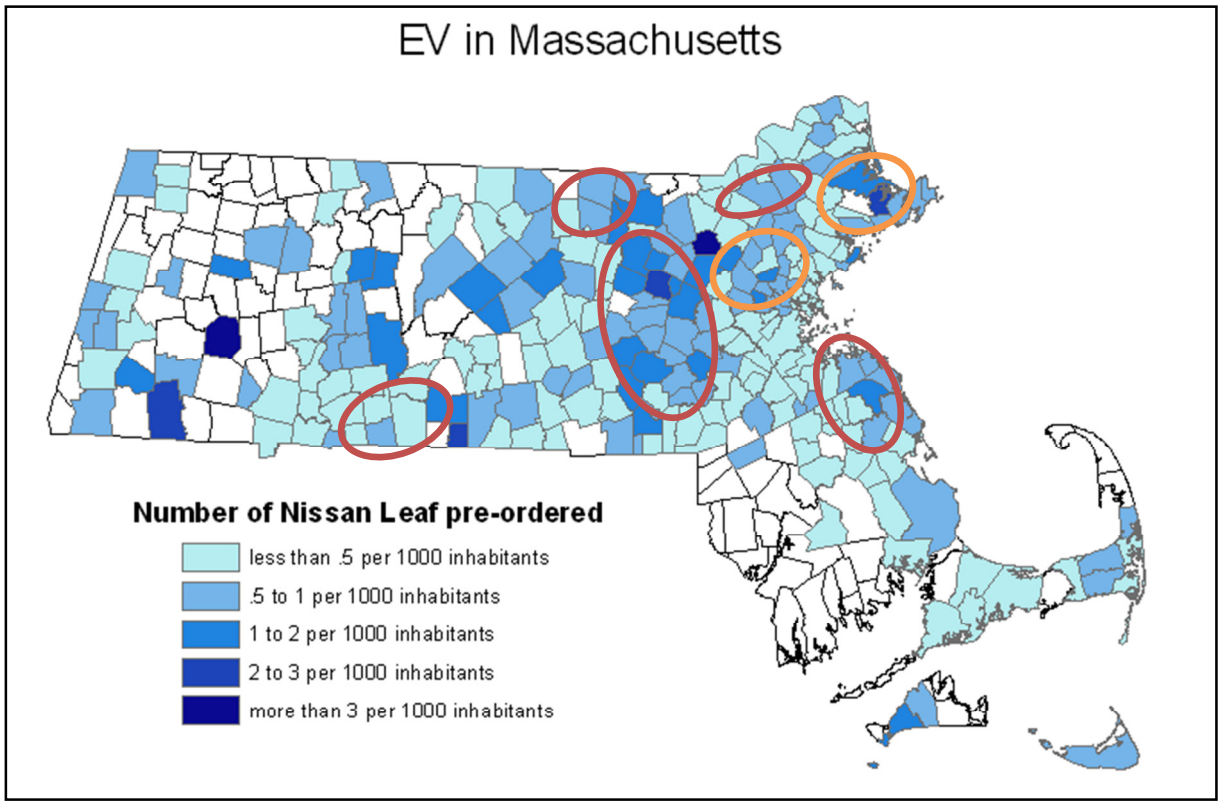

Figure 5. Number of Nissan Leaf in reservation in Massachusetts

Two new areas are identified on the map (in orange) that were not obvious from the quick analysis of the relevant factors considered earlier[20]: Gloucester/Rockport and North-West Inner Bostonian Metropolitan Area.

As a conclusion, the factors that chosen seem to be relevant when compared to the effective Nissan Leaf pre-orders.

Policy Recommendation: Massachusetts should survey early adopters to identify which factors were relevant in their purchase in order to improve this analysis.

[20] Other high-value areas are not considered as significant as they cover a very small portion of the population and a very small number of Nissan LEAF reserved.

FLEET DEPLOYMENT

Commercial and municipal fleets are seen as possible first movers on electric vehicles. Adoption of EVs by fleets could be significant in the near term as these fleets tend to be highly visible and would provide exposure to EVs for consumers. Fleets tend to operate out of a central parking area where it would be easier to setup charging infrastructure. Such fleets would drive a large number of miles per year but less than 50 miles per day. Many corporate and municipal organizations have been setting environmental and energy goals that would increase their willingness to pay the additional upfront costs of EVs.

The goal of this section was to contact stakeholders at both commercial and municipal organizations that manage or plan their vehicular fleets. The method of analysis was phone interviews centered on the following topics:

1. Nature of Interest in EVs – organizational goals, fleet size and use, concerns
2. Expected Infrastructure Needs – where charging would occur, how often
3. Support Sought from the State – if interested in EVs, what can State do to promote
4. Current Plans for EVs – when and how many EVs being considered

We interviewed commercial and government entities that have previously shown an interest in electric vehicle adoption. Previous interest was important since there is limited knowledge in the community at large about EVs; it was necessary to contact those who had already invested time and effort into understating EVs. Due to this selection of interviewees, it is important to note that their responses may be biased by this fact and should not be seen as representative of all fleet managers across the State.

MUNICIPAL FLEETS

The following cities and towns were interviewed: Boston, Cambridge, Northampton, Belmont and Framingham. A full list of those interviewed is in Annex. The map below displays their location in Massachusetts:

The following narrative describes the responses received from the municipalities. All participants named have given their consent for the use of their name and summarization of their statements.

Nature of Interest in EV

The main reasons for municipal interest in EVs are the climate and energy goals that have been established in their organizations. For example, Belmont recently created a climate action plan and formed a new energy committee. Several cities have policies that require them to purchase either high efficiency or alternative fuel vehicles for their fleets.

Most cities are targeting four-door sedans in their EV fleets. Cambridge noted that their fleet is mostly pickup trucks (a class of vehicles with no EV equivalent), but they do use several Ford TransitConnects that are available as EVs. High-mileage and idling trucks, such as dump trucks and bucket trucks were also suggested.

The main concerns noted were reliability, costs and functionality. Cambridge said that EVs they had used in the past required frequent repairs and could not be serviced by their city mechanic. Both Belmont and Framingham thought the size of their towns might limit the possible fuel cost savings. Northampton expressed concerns about EVs being able to handle extra loads on the vehicles for electronic equipment; Belmont was unclear if they could replace their All-Wheel Drive vehicles with EVs.

Expected Infrastructure Needs

Overall, concerns about charging infrastructure were not as great as the concerns for EVs themselves. Northampton was concerned about overloading the distribution network and is working with NSTAR to identify issues around potential sites for stations. Both Boston and Cambridge are planning on charging their EVs at roadside charging stations in front of a municipal building; these stations would be available for their use during the day and public use at night. Most others plan to use parking spots for charging. Belmont mentioned that compared to alternative fuels storage, such as biodiesel tankage, charging infrastructure would be easier to install.

Support Sought from the State

The support that municipalities were looking for from the state was connected to their main concerns: cost and reliability. Upfront costs were mentioned by all municipalities with different incentives suggested, such as rebates and similar programs as have been available for hybrids. Cambridge noted that a clear understanding of fuel usage and GHG comparisons to conventional vehicles would increase their ability to get funds allocated for purchasing a more expensive EV. For reliability, Framingham and Belmont both suggested that the state could help them by providing the set of information they would need on reliability and maintenance to support and maintain EVs. Several cities had applied for grants from the state for charging infrastructure and had very positive responses.

Current Plans for EVs

EVs are being considered in several time horizons: present day, within a year and 3-5 years out. All municipalities similarly reported that EVs would mostly be purchased in a few numbers but that they would be highly visible.

For charging infrastructure, cities and towns will be tracking demand from their citizens in order to decide where to install charging stations. Boston noted that each neighborhood will present different challenges and is considering options that included use of public alleyways. Instead, Boston is focusing on requirements and permitting for in-home and parking garage charging. Northampton has funds to install infrastructure and is doing an analysis of where they will be best served, including parking garages.

Two cities are working with others to advance EVs. Northampton is working with the Pioneer Valley Planning Commission to make I-91 an EV charging corridor. Boston is working with the National Mayoral Collaborative to compare progress with other major cities. Boston also noted that they are trying to understand what model would be best for their city. LA, London and Houston were mentioned as examples.

COMMERCIAL FLEETS

During the timeframe of the report, only one commercial fleet manager was able to be reached; formal confirmation for permission to use their name has not yet been received. They will be referred to as "Company."

Nature of Interest in EVs

Company is pursuing EVs for both organizational and operational goals. Company has organizational goals of reducing their carbon footprint and impact on foreign oil imports. They believe this is the way business should be done but note that it must be done within a financially sustainable business model.

Operationally, Company sees advantages in EVs over their current diesel fleet. The main metrics they are looking to improve with EVs are reliability, vehicle length of life, reduced travel times and improved driver health. Some suggested advantages include: issues with particulate traps on diesel engines while delivering within a city, limited maintenance for EVs instead of four times per year for diesel, projected lifetime of 20 years instead of 230,000 miles, reduction of delivery time by 45 seconds, and lack of diesel fumes in delivery box.

The main disadvantages are capital costs and uncertainty of operation. Company is currently undergoing tests of EV delivery trucks in locations across the country to identify what geographies, settings, climates, distances and miles travelled are the best and whether capital costs will be offset by benefits.

Expected Infrastructure Needs

Company will charge their fleet where they are parked. They do not expect any problems with charging during the days and expect they will be able to go up to 2 days without needing a charge. The cost of infrastructure on a large scale is substantially greater than the diesel equivalent but receive benefit from utilities by charging in off-peak hours.

Support Sought from the state

Company noted that there is an excise tax in Massachusetts that puts additional costs on more expensive vehicles. Since EVs will be more expensive than their diesel equivalents, this would act as a disincentive to purchase EVs in the State. In comparison, Company will receive $20,000 for each vehicle in California. They have found that motivation for many areas to provide incentives is based on air emission reductions to meet EPA NAAQS standards.

Current Plans for EVs

Company is currently rolling out 53 trucks over the next several months to test how they work in different environments. The locations being tested include Atlanta, Portland, Kansas City, Cincinnati, Oregon, Texas and California. No plans currently for Massachusetts due to lack of funding although there are two large delivery centers in the State with 35 trucks.

POLICY RECOMMENDATIONS

Policy recommendation: Massachusetts should pursue both monetary and non-monetary assistance to promote EVs for municipal fleets. Monetary supports must be at least equal to incentives available for hybrid vehicles. Non-monetary assistance should include information on reliability, maintenance and environmental impact as well as an EV rollout toolkit to simplify charging infrastructure installation.

Policy recommendation: For commercial fleets, Massachusetts should remove any additional cost burdens on the purchase of EVs and structure incentives to match the commercial leasing agreements.

COMMERCIAL INTERESTS

In this section of the report, commercial interests in electric vehicles in Massachusetts, investigate commercial interest.

The goal was to contact key stakeholders who have an interest in the development of EVs in Massachusetts. These commercial stakeholders provide relevant critical information for policy process.

The term commercial interest was interpreted in a broad sense, and spans companies such as Azure Dynamic in Woburn, which manufactures electric vehicles for fleet use in partnership with Ford, through to retailers such as Company who might be interested in installing charging stations in their customer parking facilities. See the Annex for a comprehensive list of companies.

The method of investigation was phone and email-based interviews centered on the two questions below:

- What makes Massachusetts attractive, or not attractive, in terms of bringing your own funding into the State?
- What State incentive programs do you think would help make Massachusetts more attractive for electric vehicles in the future?

Below are the summarized responses to these questions. It should be noted that there was a trade-off during this part of the analysis about providing anonymity to the interviewees and thereby facilitating a more candid response. The compromise position adopted was to make this tension explicit to the companies interviewed. When a company wanted to be off record, the company was not referenced.

WHAT MAKES MASSACHUSETTS ATTRACTIVE FOR PRIVATE SECTOR INVESTMENT?

Another attractive feature identified by several companies was that Massachusetts has lots of universities, which provide both skilled labor for high tech companies, as well as initiative for start-ups. For example, MIT alumni started three of the companies (Azure Dynamics, A123 and Ally Automotive). As Dan Bodard, the CEO of Ally Automotive pointed out, this also raises public exposure to emerging technologies, and so willingness to try new things, in this case, EVs.

Zipcar is another EV positive feature for Massachusetts. Zipcar already makes extensive use of the Toyota Prius hybrid car, and is testing the unreleased 2012 Toyota Prius plug-in hybrid electric vehicle (as seen below on the MIT campus during Earth week 2011) in four cities in the US, namely Boston, Cambridge, Portland and San Francisco. This suggests that Zipcar finds Massachusetts an attractive location for EV deployment for two reasons. First, Zipcar most likely sees MA as an

attractive place to deploy new plug-in-hybrid technology as two of the four cities chosen lie in MA. Zipcar did not confirm whether this was because Zipcar's headquarters are in Boston, or if because they saw Massachusetts as an attractive deployment State; the final motivation is probably a combination of the above two. Whatever the reason for the Prius deployment, the second benefit for the state is in commercial and private exposure to hybrid technology, which will increase public and private awareness.

It should be noted that Zipcar is unlikely to adopt battery electric vehicles in the next ten years. This is primarily because their business model is based around customers being able to take a Zipcar at any time, which means that charging time cannot be scheduled.

Finally, Azure Dynamics pointed out that while a commonly quoted negative aspect of Massachusetts is the cold weather, their experience in fleet electric vehicle manufacture has conclusively proved this to be incorrect. It has been claimed that the cold weather slows down electrochemical processes, and there less energy for a given charge can be drawn from the battery. Through a combination of insulation, heating and thoughtful design, Azure Dynamics says that this is not a problem for cold weather climates such as Massachusetts.

WHAT MAKES MASSACHUSETTS UNATTRACTIVE FOR PRIVATE SECTOR INVESTMENT?

As mentioned in the report Introduction, ECOtality is a California-based company that received $97 million in funding from the federal Government in 2009 from the Recovery Grant[21]. The company selected several cities to gather information on EVs. Neither Massachusetts, nor any other North Eastern city (except Washington DC), was one of them. While the company says that they chose cities based on suitability, many of the sources interviewed agreed that the cities of choice were based more on political factors than actual suitability. Also, ECOtality is a California based; it is likely that like Zipcar, they chose cities close to home. From this we draw the conclusion that the fact that federal funding did not come to Massachusetts should not be interpreted as Massachusetts is not an attractive place for EVs.

However, in the short term, the lack of financial incentives was quoted as the most unattractive feature of Massachusetts. Specifically, it means that car manufactures such as Nissan or Chevrolet are not releasing EVs in Massachusetts, which means that even if there is interest in EVs, people cannot buy them. Secondly in terms of fleet EVs, Azure Dynamic pointed out that financial incentives are one of the greatest catalysts for fleet EV adoption. For example, even though the company is headquartered in Massachusetts, most of their sales happen in States that have greater financial incentives such as California. They said that capital reduction financial incentives are more attractive for fleet deployment because charging infrastructure costs are normally much less than the EVs themselves. Therefore from the perspective of fleet EVs, it is often better to have financial incentives than State built public charging infrastructure.

In the medium term, financial incentives were seen as less important, particularly for private user adoption of EVs. This means that there is a tradeoff depending on what Massachusetts wants to

[21][22]achieve. In the short term, a lack of funding was clearly seen as a very negative aspect for both public and private EV adoption. However, in the medium term, as EVs become available for sale (for example Chevrolet Boston said that they expect the Volt in November, and the Nissan Leaf should be here in Fall- although when contacted they were not so sure) and are more widely seen, it is likely that the number of EVs in Massachusetts will increase.

Policy Recommendation: If the state wants to have EV early adoption, more financial incentives should be added to EVs. However, if MA's objective is long term reduction of non-renewable carbon based transportation fuels with the aim of reducing greenhouse gases, smog and energy dependence, then short term financial incentives make less sense.

It was pointed out that what is maybe more important than only financial incentives in the medium term is a clear action plan of EV adoption. Colorado was quoted as a State that has put together clear leadership for the future of clean energy that is paying off in terms of investment in the State.

WHAT COULD BE DONE TO MAKE MASSACHUSETTS MORE ATTRACTIVE TO PRIVATE SECTOR INVESTMENT?

In this section, we will break up suggestions of how make Massachusetts more attractive for EV investment and adoption into three subsections, namely the short term, medium term and long term. While we do not recommend which is a better route to take, it should be noted that depending on the States goal, the different time frames are less or more attractive.

Short term

Based on interviews with Azure Dynamic and Ally Automotive we draw the conclusion that if Massachusetts' goal were to be an early adopter and so possibly capture investment from firms that develop EV technology and turn the region into an EV development hub, then short to medium term financial incentives would be important. However, if the goal is more general energy intensity reduction, then there are other longer-term routes.

Medium term

Firstly, clear vocal support of EV's with a clear action plan was quoted as a high priority if EV's are to become widely adopted. This could include support of MBTA EVs, which were clearly advertised, government fleet EVs, also clearly advertised, or as Ally Automotive suggested, school buses that are electric or hybrid based. There was consensus that a clear action plan would be very beneficial for the adoption of EVs in Massachusetts.

[21] ECOtality. http://www.ecotality.com. Accessed April 2011.

Long term

In the longer term, there are many non-financial incentives that could help EV adoption. As noted in the McKinsey Quarterly February 2011 edition, education could be far more effective than financial incentives when it comes to adoption of EVs.[23] This view was confirmed by Ally Automotive who said that early adopters are likely to be well-off families anyway, and so informing them about how EVs work would quell fears about 'running out of battery on the highway'. This finding was supported by the view that residences of Massachusetts are generally richer than other most other States (ranking 7th with a median household income of 62,365, making financial incentives less critical).

As Stated above, this information could take the form of practical advertising on electric busses or government fleets. Zipcar's adoption of hybrid EV's is also a great advertisement for the reliability of EVs, and State encouragement for more EVs could help improve the impression of reliability in range of EV's. Other initiatives such as letting EVs use designated traffic lanes would also incentivize as well as raise awareness of EVs.

As Ally Automotive pointed out, one of the attractive features of Massachusetts is its universities. MIT for example already has an active EV group, which has programs in EV building etc. It was suggested that by harnessing the enthusiasm and expertise of such student initiatives greater public awareness could be increased.

Finally, while Azure Dynamic pointed out that public charging infrastructure would not be a great incentive for private fleets, and the McKinsey Quarterly suggested that public charging was not critical for public adoption, there are benefits of having a few highly visible charging stations, as pointed out by Optimal Energy. This would serve both to inform the public of the possibility of driving electric, as well as allay fears of being stranded.

Policy Recommendations

From the discussions with stakeholders, we draw the following conclusions:

Policy Recommendation: In the short term, financial incentives were seen as the most promising way to encourage both private and commercial EV adoption.

Policy Recommendation: In the medium to long term, a clear State vision of EV adoption was identified as the most important aspect. Such an action plan would include public awareness campaigns, private-public partnerships, and designated lanes for EVs.

[23] Russell Hensley, Stefan M. Knupfer and Axel Krieger. McKinsey. "The fast lane to the adoption of electric cars." February 2011.

CONCLUSIONS

This report has attempted to survey the literature, data, and human resources available to provide information to inform MA's implementation of EV policy. The limited amount of data provides uncertain results. The following conclusions attempt to strike the appropriate balance between utility and certainty:

Widespread opportunities throughout the State

The demographic analysis and survey of interest from a variety of stakeholders throughout the State suggest that there are opportunities for deployment of both personal EVs and fleets of EVs throughout the State, not just the Boston area. The Oregon case study suggests that engaging a variety of stakeholders can be effective in developing a unified rollout across the State.

Demand for State leadership

While many of the people interviewed suggested that direct financial incentives would be helpful in the short term, there was even stronger demand for long-term leadership from the State government. Commercial interests want information and stability in regulation in order to ensure long-term incentives for their companies.

ANNEX

Contacted Municipalities

Belmont:	Peter Castanino, Director of Department of Public Works
Boston:	Rachel Szakmary, Transportation Planner
Boston:	Jim McGonagle, Director of Central Fleet Maintenance
Cambridge:	Jon Bolduc, Environmental Planner
Framingham:	Fred Davies, Director of Fleet, Facilities and Communication
Northampton:	Bill LeTendre, Director of Parking
Northampton:	Chris Mason, Energy Officer

Contacted Companies

Ally Automotive:	RaduGogoana, technician, current MIT student
Azure Dynamics:	Beth Silverman, Sales at Azure Dynamics
Ally Automotive:	CEO Dan Bogard
Chevrolet Boston	
Nissan Boston	
Optimal Energy:	Jaco Van Loggerenberg, Media & Events Manager
Toyota Boston	
Zipcar Boston	