ASSESSING THE INFLUENCE OF POLICY FACTORS ON ALTERNATIVE FUEL VEHICLE ADOPTION IN GEORGIA

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LIST OF SYMBOLS AND ABBREVIATIONS

AEVDC	Atlanta Electric Vehicle Development Coalition
AFDC	Alternative Fuels Data Center
AFV	Alternative Fuel Vehicle
AMFA	Alternative Motor Fuels Act
ARRA	American Recovery and Reinvestment Act of 2009
B20	Biodiesel Fuel with 20% Biodiesel and 80% Petroleum Diesel
BEV	Battery Electric Vehicle
CAA	Clean Air Act
CAFE	Corporate Average Fuel Economy
CFV	Conventional Fuel Vehicle
CNG	Compressed Natural Gas
DCFC	Direct Current Fast Charger
DOE	Department of Energy
E85	Ethanol Fuel with 85% Ethanol and 15% Gasoline
EPAct	Energy Policy Act
EREV	Extended-Range Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FAST	Fixing America’s Surface Transportation Act
FCEV	Fuel Cell Electric Vehicle
FHWA	Federal Highway Administration
HDV	Heavy-Duty Vehicle

HEV	Hybrid Electric Vehicle
HOV	High-Occupancy Vehicle (lane)
ISTEA	Intermodal Surface Transportation Efficiency Act
LEV	Low-Emission Vehicle
MDV	Medium-Duty Vehicle
MPGe	Miles per Gallon (of gasoline) Equivalent
NAAQS	National Ambient Air Quality Standards
NGV	Natural Gas Vehicle
PEV	Plug-In Electric Vehicle
PHEV	Plug-In Hybrid Electric Vehicle
TIS	Technological Innovation System
ZEV	Zero-Emission Vehicle

SUMMARY

To make a compelling case for government incentives as a stimulus for alternative fuel vehicle adoption, this thesis assesses the preliminary impacts associated with the elimination of Georgia's income tax credits for low-emission and zero-emission vehicle purchases. The thesis identifies policy factors that appear to impact alternative fuel vehicle (AFV) adoption in the United States, with a focus on government incentives. Specific policy factors are discussed in the context of state and federal laws. For Georgia, motor vehicle registrations were collected to track AFV adoption rates before and after the change in law. Electric and hybrid vehicle registrations in Georgia have plummeted since the income tax credits were eliminated on June 30, 2015. Income tax credit data were collected to chart the significant increase in zero-emission and low-emission vehicle purchases and leases since electric vehicles started flooding the market.

The primary outcome of this research is a set of distinct, measurable policy factors that influence AFV adoption in the United States. The factors identified include: 1) reward amount to income ratio, 2) ease of policy comprehension, 3) consumer awareness, 4) fuel/vehicle coverage of incentives, 5) incentive user groups, 6) forms of incentives (grants, income tax credits, etc.), 7) number of incentives available, and 8) dollar values of incentives. The conclusion presents factors for use in choice model estimation. These factors should be useful by policymakers who are trying to understand the true value of government incentives for alternative fuel vehicles.

CHAPTER 1
INTRODUCTION

Vehicles powered by alternatives forms of energy are entering the market at a high rate as car manufacturers (initially motivated by higher EPA fuel economy standards) realize the immense consumer demand for vehicles that release fewer emissions and have lower maintenance costs. In the U.S., the combined market share of BEVs (battery electric vehicles) and PHEVs (plug-in hybrid electric vehicles) went from 0.00174% in 2010 to 0.84% in 2015 (IHS, 2016). Battery capacity and vehicle ranges are increasing and electric vehicles in particular are becoming a more energy efficient, cost effective, and environmentally friendly option for consumers.

In 2014, Georgia had a BEV market share of 1.60%, beating out Washington, California, and Hawaii as the state with the highest BEV market share (Cole, 2014). Until recently, Georgia offered a $5,000 (maximum) income tax credit for consumers who purchased or leased a zero-emission vehicle (ZEV) and a $2,500 (maximum) income tax credit for those who purchased or leased a low-emission vehicle (LEV). This incentive was on top of the federal tax incentive of $7,500 (maximum). On June 30, 2015, the Georgia tax credits were repealed, and an electric vehicle registration fee of $200/year was added, presumably to compensate for lost gas tax revenues from electric vehicles. Many electric vehicle enthusiasts have questioned the motives of lawmakers and demanded that Georgia reinstate the incentives to improve air quality and decrease gasoline dependency in the state. Opponents of the incentives say that the income tax credits are causing the state to lose millions of dollars a year in tax revenues.

To assess the role of government incentives as a stimulus for alternative fuel vehicle adoption in Georgia, this thesis attempts to pinpoint the factors influencing electric vehicle purchase decisions, with a focus on the elimination of the state's LEV and ZEV income tax credits. This thesis also attempts to identify policy factors that may affect alternative fuel vehicle (AFV) adoption across the United States, with a focus on government incentives.

The term 'alternative fuel vehicle' is used throughout this paper because many of the incentives available address multiple fuel types. Although plug-in hybrid electric vehicles (PHEVs), hybrid electric vehicles (HEVs), and plug-in electric vehicles (PEVs) are some of the most well-known AFVs, many state and federal laws also apply to natural gas, biodiesel, ethanol, and other alternative fuels.

Identified policy factors will be discussed in the context of state and federal laws. The factors to be discussed include: 1) reward amount to income ratio, 2) ease of policy comprehension, 3) consumer awareness, 4) fuel/vehicle coverage of incentives, 5) incentive user groups, 6) forms of incentives (grants, income tax credits, etc.), 7) number of incentives available, and 8) dollar values of incentives. For Georgia, motor vehicle registrations have been collected to track AFV adoption rates before and after the elimination of the tax credits and imposition of the new annual registration fee. Income tax credit data have been assessed to chart the significant increase in zero-emission and low-emission vehicle purchases and leases since electric vehicles started entering the market. These analyses make a convincing case for reinstating the tax credits and removing/replacing the new $200 AFV registration fee, if the region desires to continue to increase the fleet penetration rate of electric vehicles from an energy and air quality perspective.

The primary outcome of this thesis is a set of distinct, measurable policy factors that influence AFV adoption in the United States. The conclusions are presented as a set of factors that can be used in choice model development. The hope is that these factors can be used in future research to identify more complex, statistically significant relationships. Additionally, this thesis may be useful for policymakers who are trying to understand the implications of government AFV incentives.

CHAPTER 2
LITERATURE REVIEW

The following chapter summarizes a variety of academic sources that were considered when conducting the research for this thesis. While there are many resources for general information about alternative fuel vehicles and electric vehicles, few discuss Georgia in particular. Many of the articles were written for a particular fuel type or vehicle type, and do not consider policy specifics. While these articles are diverse, much of the data available about policy and fuels come from a few sources. For instance, IHS Automotive (acquired R. L. Polk & Co. in July 2013) is one of the most cited sources for vehicle registration data. Likewise, the U.S. Department of Energy's Alternative Fuels Data Center collects and provides most of the information about incentives, EV charging stations, and fuels (Alternative Fuel Incentives and Laws, 2016). While many of the sources pinpoint specific factors that influence AFV adoption rates, few are able to quantify the outcomes of policy change and provide adequate information to decision makers about the benefits of AFV incentives. The following literature review provides summaries for sources that were deemed to be relevant to this discussion. The benefit of many of these articles comes in the determination of AFV driver characteristics, a factor that was not tackled explicitly in this thesis analysis. These resources largely serve to fill gaps in personal research, guide the direction of this thesis, and address factors that were too time-consuming to study. The most recent articles are discussed first, and the publication dates range from 2012 to 2016. Publication details are included in the reference section. These sources do not include online and personally collected data. The following is a list of source titles that were considered in this literature review:

Plug-In Electric Vehicle Multi-State Market and Charging Survey (2016)

Overcoming Barriers to Deployment of Plug-in Electric Vehicles (2015)

Integrating Plug-In Electric Vehicles into the Grid: Policy Entrepreneurship in California (2015)

Comparison of plug-in electric vehicle adoption in the United States: A state by state approach (2015)

Understanding Variations in U.S. Plug-In Electric Vehicle Markets (2014)

Plug-In Electric Vehicles: A Case Study of Seven Markets (2014)

Non-Cost Barriers to Consumer Adoption of New Light-Duty Vehicle Technologies (2013)

Identifying the early adopters of alternative fuel vehicles: a case study of Birmingham, United Kingdom (2012)

Effects of Federal Tax Credits for the Purchase of Electric Vehicles (2012)

A socio-technical analysis of widespread electric vehicle adoption (2012)

A New Approach to Modeling Large-Scale Alternative Fuel and Vehicle Transitions (2012)

Transitions to Alternative Transportation Technologies – Plug-In Hybrid Electric Vehicles (2010)

Plug-in Hybrid and Battery Electric Vehicles (Market penetration scenarios of electric drive vehicles) (2010)

Multi-agent simulation of adoption of alternative fuels (2010)

Plug-in Hybrid Electric Vehicle Market Penetration Scenarios (2008)

Giving Green to Get Green: Incentives and Consumer Adoption of Hybrid Vehicle Technology (2008)

Plug-In Electric Vehicle Multi-State Market and Charging Survey

The "Plug-In Electric Vehicle Multi-State Market and Charging Survey (EPRI, 2016)" was published by the Electric Power Research Institute and generated more than 4,000 PEV owner surveys in order to understand the PEV market and the potential role of utility companies in supplying electricity for charging and ramping up the market. Drivers were surveyed in 11 states and the District of Columbia. The primary purpose of the survey was to find potential impacts of utilities on ownership experience, including purchasing decisions, charging behavior, travel behavior, and household socio-demographics. This report is included in this literature review because of its results regarding attitudes, beliefs, and perceptions of PEV owners (EPRI, 2016).

Socioeconomic characteristics of the surveyed population were provided in the form of **Figure 1**, which shows reported yearly household income. The median yearly household income for the surveyed population (U.S.), according to this data, was $150,000 per household per year. These data were also organized by state and vehicle. For Georgia, the average household yearly income for Tesla Model S owners was around $370,000, while the average household yearly income for Ford Fusion Energi owners was around $120,000. Other vehicles included in this analysis were the Toyota Prius Plug-In, the Ford C-Max Energi, the Chevrolet Volt, and the Nissan LEAF (EPRI, 2016).

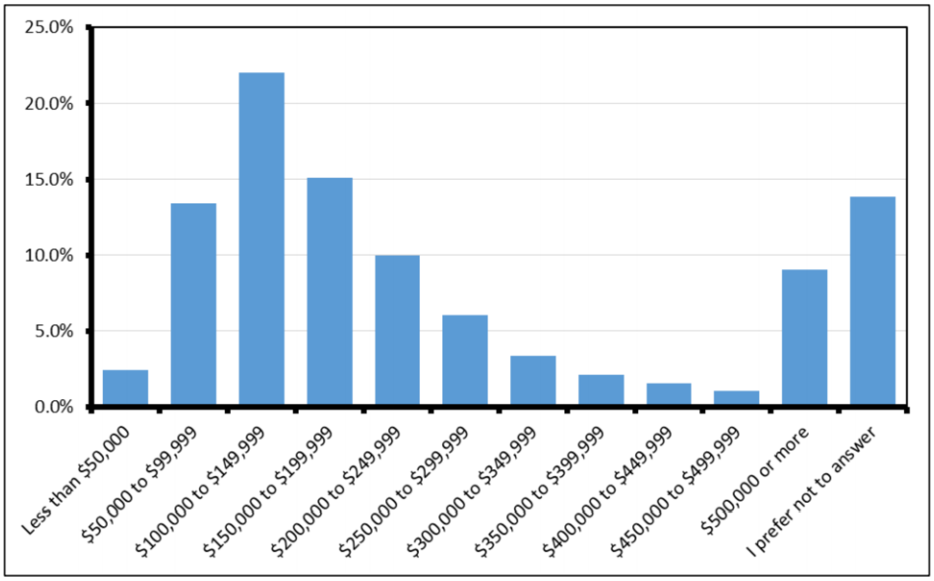

Figure 1: Household Reported Yearly Income (EPRI, 2016)

Furthermore, EPRI found that 50% (much higher than national average) of the survey takers had masters, doctorate, or professional degrees, while 29% (close to national average) were college graduates. An analysis of the necessity of incentives by vehicle type was completed for the previously mentioned vehicles. These data are shown in **Table 1**. As expected, the owners of the more expensive vehicles answered that many of the incentives were less necessary. The federal tax incentives were, by far, the most necessary incentives for the survey takers, while local rebates, HOV access, and EVSE subsidies were seen as being much less necessary (EPRI, 2016).

Table 1: Necessity of Incentives by Vehicle Type (EPRI, 2016)

	Federal tax	State rebate	Local rebate	Workplace charger	Dedicated Parking	HOV	EVSE subsidy
TOYOTA PRIUS PLUG-IN							
Necessary	51%	11%	8%	15%	11%	11%	7%
Not Necessary	26%	10%	8%	17%	20%	17%	10%
Not Applicable	23%	79%	84%	68%	68%	72%	83%
FORD C-MAX ENERGI							
Necessary	58%	12%	6%	13%	7%	9%	11%
Not Necessary	26%	14%	7%	23%	26%	18%	16%
Not Applicable	16%	74%	87%	64%	66%	73%	73%
FORD FUSION ENERGI							
Necessary	52%	9%	8%	17%	6%	11%	9%
Not Necessary	22%	14%	7%	25%	32%	20%	15%
Not Applicable	26%	77%	85%	58%	62%	69%	76%
CHEVROLET VOLT							
Necessary	67%	16%	4%	15%	7%	7%	14%
Not Necessary	18%	12%	8%	32%	31%	23%	25%
Not Applicable	15%	72%	88%	54%	62%	70%	62%
NISSAN LEAF							
Necessary	71%	33%	3%	19%	7%	8%	17%
Not Necessary	16%	15%	8%	31%	39%	32%	28%
Not Applicable	13%	52%	89%	49%	55%	61%	55%
TESLA MODEL S							
Necessary	49%	15%	2%	7%	7%	8%	5%
Not Necessary	47%	21%	8%	32%	36%	31%	17%
Not Applicable	4%	64%	90%	61%	57%	60%	77%

Moreover, one of the more interesting analyses was associated with driving behavior and percentage of mileage used for commuting. The Tesla Model S actually had a lower percentage for commutes than the Ford Fusion Energi, the Chevrolet Volt, and the Nisan LEAF, which are known to have lower battery capacities (EPRI, 2016).

Overcoming Barriers to Deployment of Plug-In Electric Vehicles

The National Research Council of the National Academies published a report in 2015 called “Overcoming Barriers to Deployment of Plug-In Electric Vehicles (Transportation Research Board and National Research Council, 2015)”. This article first discusses the state of plug-in electric vehicle and PEV charging station technologies. A short review of the market-development process is provided, which goes over consumer demographics and attitudes towards PEVs. An analysis of incentives is given in order to evaluate the outcomes of encouraging PEV adoption. One of the admitted gaps in this report is the need for research on the effectiveness of incentives to encourage PEV adoption (Transportation Research Board and National Research Council, 2015).

The section of this report from which this thesis will draw information is called “The Mainstream Consumer and Possible Barriers to Their Adoption of Plug-In Electric Vehicles”. Consumer opinions of AFVs often differ among regions of the country. Without consumer and dealership surveys (which this thesis does not provide), it is hard to measure the critical influence of general consumer purchasing habits. The dichotomy of AFV purchasing habits can be seen when comparing the west coast states to Midwestern states. For example, residents of California are often known for their more progressive lifestyles, and are more likely to be early adopters of AFVs, while residents of Montana (a more rural state) seem to stick with conventional fuels (Transportation Research Board and National Research Council, 2015).

According to the NRC report, there are five factors that typically affect the rates of adoption and diffusion for innovative products: 1) relative advantage, 2) complexity,

3) compatibility, 4) trial-ability, and 5) observability (Transportation Research Board and National Research Council, 2015).

- Relative advantage deals with cost-benefit considerations of consumers who weigh the price and nonmonetary costs against the perceived benefits of AFVs.
- Complexity relates to the difficulty of using the AFV technology. Many older consumers are wary about adopting technologies that add confusion to their lives without making them significantly better.
- Compatibility deals with AFVs fitting into the consumer's existing lifestyle. One of the major concerns with electric vehicles, for instance, is the battery life. If drivers commute two hours to work every day, this becomes a major concern.
- Trial-ability is all about testing the vehicle before buying it. Consumers who choose to test drive their AFVs at the dealership get a good sense of the acceleration speeds and comfortability, but get no real sense of the re-fueling process or range.
- Observability is similar to relative advantage in that consumers weigh costs and benefits. Observability is more focused on the observed, rather than perceived, benefits of owning an AFV. One of the most readily observable benefits of EVs is the immediate fuel cost savings.

It is difficult to quantify relative advantage, complexity, compatibility, trial-ability, and observability, but a few observations stand out as being significant drivers of AFV adoption. The NRC report discusses consumer "confidence" in new technologies.

Confidence in technology is often related to age, and consumer age is often defined by the type of living environment, whether rural, suburban, or urban. “Confidence” could help explain why EV purchases and leases are often concentrated in urban areas. This report also notes that consumer decisions are often based on their perceptions rather than factual data. According to this report, 75 percent of people in 21 of the largest U.S. cities are unaware of cost savings and reductions in maintenance costs of PEVs. Among the previously discussed factors, this report identifies a few other barriers to PEV adoption: limited variety/availability of PEVs, misunderstandings of PEV range, difficulties in understanding electricity consumption, fuel cost calculations, quantifying charging station infrastructure needs, complexities of installing home charging stations, difficulties in determining environmental benefits, lack of information about incentives, and lack of knowledge of PEV benefits. Each of these barriers is discussed in-depth (Transportation Research Board and National Research Council, 2015).

One of the most notable barriers that may help clarify the difference in adoption rates between California, Georgia and other states, is the ‘greenness’ of AFVs. The personality types of people who adopt AFVs early in the technology’s life are generally aware of environmental issues and care about reducing emissions. It is a lofty assumption to say that people in California are more environmentally aware, but the state’s environmental policies (not only with alternative fuels) are some of the most comprehensive in the U.S. And the people who choose to live in California generally accept this fact, which shows in their lifestyles (Transportation Research Board and National Research Council, 2015).

Comparison of Plug-In Electric Vehicle Adoption in the United States: A State by State Approach

"Comparison of Plug-In Electric Vehicle Adoption in the United States: A State by State Approach", by the University of California, Davis, Institute of Transportation Studies attempts to identify correlations between social, economic, geographic, and policy factors and plug-in electric vehicle adoption rates across different states in the U.S. The authors also question how these factors vary between BEV and PHEV markets. The authors gathered vehicle registration data and then conducted a series of statistical tests to assess the relationship between the factors and BEV and PHEV adoption. Registration data were obtained from IHS Automotive for calendar year 2013 and used to calculate the dependent variables, and BEV and PHEV market share by state (Vergis & Chen, 2015).

The explanatory variables used in their analysis are detailed in **Table 2**. For most variables, 2013 was used as the time period. The report contains more detailed information about how these variables were determined and measured (Vergis & Chen, 2015). A backwards stepwise regression method was used to exclude the variables that did not contribute to the explanatory power of the model. The equations below (**Figure 2**) were used for final model specifications, where *i* represents each state and *e* is the error term. Access to HOV lanes, income, manufacturing related to electric components and battery manufacturing, community readiness funding, and past HEV market share variables were excluded (Vergis & Chen, 2015).

Table 2: Potential Explanatory Variables (Vergis & Chen, 2015)

Potential explanatory variables	HEV	PEV	BEV	PHEV
Charging infrastructure		✓	✓	✓
PEV Model availability	✓			
Manufacturing presence		✓		
Energy prices or savings	✓	✓	✓	✓
Direct Financial Incentives	✓	✓	✓	
HOV access	✓	✓		✓
Awareness			✓	✓
Environmentalism	✓	✓		
Annual VMT		✓		
Population density			✓	
GDP or Income	✓		✓	✓
Education		✓		
Codes and Standards		✓		
Weather		✓		
HEV shares		✓		

$$\text{BEV Market Share}_i = \alpha + \beta_1\text{Electricity}_i + \beta_2\text{Charging infrastructure}_i + \beta_3\text{Gasoline}_i + \beta_4\text{Awareness}_i + \beta_5\text{Education}_i + \beta_6\text{Weather}_i + \beta_7\text{Population}_i + e_i$$

$$\text{PHEV Market Share}_i = \alpha + \beta_1\text{VMT}_i + \beta_2\text{Number of PHEV Vehicle Models}_i + \beta_3\text{Presence of PHEV Purchase Incentive}_i + \beta_4\text{Number of Other Supportive Incentives/Policies}_i + \beta_5\text{Environmentalism}_i + \beta_6\text{Weather}_i + e_i$$

Figure 2: Final Model Specifications for BEV and PHEV Market Shares (Vergis & Chen, 2015)

For the BEV model, the following variables were positively correlated: 1) publicly available charging infrastructure, 2) gasoline prices, 3) awareness of electric vehicles, 4) education levels, 5) electricity prices, 6) winter temperature, and 7) population density. For the PHEV market share model, the following variables were positively correlated with an increase in PHEV market share: 1) increase in the number of PHEV models available for purchase, 2) the presence of PHEV purchase incentives, 3) the number of other supportive incentives and policies available in each state, and 4) average winter temperatures (Vergis & Chen, 2015).

Plug-In Electric Vehicles: A Case Study of Seven Markets

"Plug-In Electric Vehicles: A Case Study of Seven Markets (Turrentine, Vergis, Fulton, & Fulton, 2014)" was published in October 2014 through the University of California, Davis, Institute of Transportation Studies. The analyses within this report attempt to provide insights into the developing PEV markets in Norway, Netherlands, California, United States, France, Japan, and Germany. A Technological Innovation System (TIS) approach was applied to systematically identify the potential roles of different factors in promulgating new markets. This report is included in the literature review because it is one of the few reports that consider international markets and U.S. markets (Turrentine, Vergis, Fulton, & Fulton, 2014).

Figure 3 shows the market penetration rate of PEVs by region. Norway has a much higher purchase percentage than the other regions being studied. It is important to point out that California has been given its own category because of its higher than average adoption rates, indicating that there are likely additional factors in the California population that need to be controlled for in the model. An individual analysis of the Netherlands showed that the number of PHEV and PEV units sold (by month) did not decrease significantly after incentives were taken away. The Netherlands PHEV incentives expired in December 2013, a month in which sales skyrocketed. Sales then plummeted in January 2014, but stabilized within a few months (Turrentine, Vergis, Fulton, & Fulton, 2014).

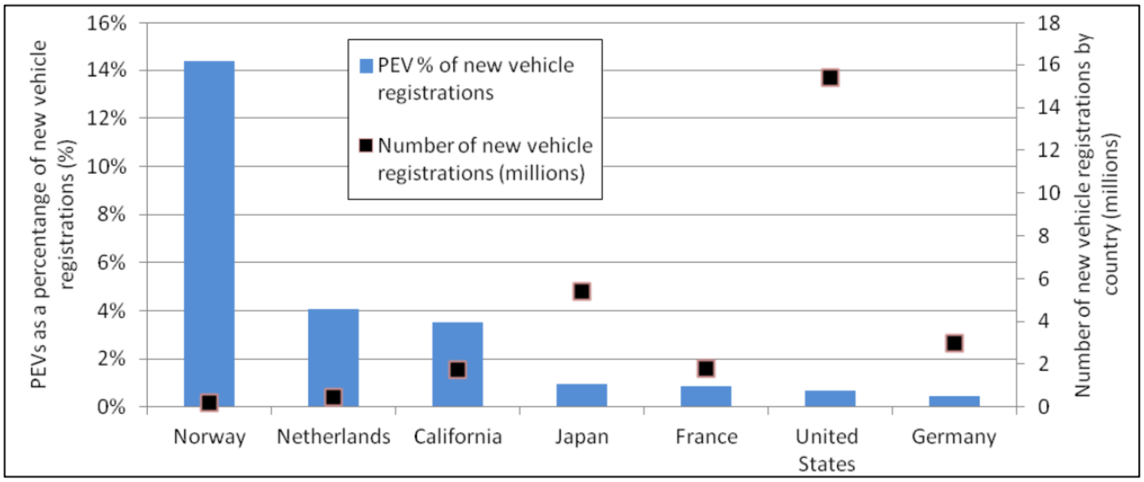

Figure 3: Market Penetration Rate of PEVs by Region (Turrentine, Vergis, Fulton, & Fulton, 2014)

Japan has been introducing PEV incentives since 1978, including subsidies, sales tax waivers and incentives, and leasing incentive programs. Japan has also historically been the leader in lithium ion battery manufacturing. In 2009, Japan represented 57% of the global lithium-ion manufacture market share. Hence, it seems appropriate that the Japanese BEV market represented 20% of the global market sales in 2012 (Turrentine, Vergis, Fulton, & Fulton, 2014).

A Technological Innovation System (TIS) table was ultimately created that ranks these different regions by each category. **Table 3** shows the final table, with ‘PEV market share ranking’ governing the order of the regions. Legitimation is defined as actions that help to increase social acceptance of PEV technologies in the region. Interestingly, France was ranked first in the legitimation category, even though they were ranked fifth in the PEV market share category (Turrentine, Vergis, Fulton, & Fulton, 2014). France was ranked highly because of their goal of having 2 million PEVs sold by 2020. Germany was ranked first in the resource mobilization category because of its large dedication of funds for PEV agencies and research. To conclude, this paper asserts that market formation, legitimation, and positive externalities are likely contributors to higher shares of PEV market shares (Turrentine, Vergis, Fulton, & Fulton, 2014).

Table 3: Rankings of Case Study Regions Across Studied TIS Factors (Turrentine, Vergis, Fulton, & Fulton, 2014)

Region	PEV market share ranking	Market Formation (F4)	Legitimation (F5)	Resource mobilization (F6)	Positive externalities (F7)
Norway	1	2	3	5	1
Netherlands	2	1	2	7	2
California	3	3	3	3	7
Japan	4	6	3	4	5
France	5	5	1	2	3
United States	6	4	2	6	6
Germany	7	3	3	1	4

Identifying the Early Adopters of Alternative Fuel Vehicles: A Case Study of Birmingham, United Kingdom

“Identifying the Early Adopters of Alternative Fuel Vehicles: A Case Study of Birmingham, United Kingdom (Campbell, Ryley, & Thring, 2012)” was written at Loughborough University in the UK in 2012. The goal of this paper was to pinpoint the geographic distribution of early adopters of AFVs in metropolitan areas. The authors used a technique known as hierarchical cluster analysis. In particular, this paper focused on a city called Birmingham in the UK. Through the mapping exercise, the clusters of early adopters in relation to the city center were made apparent. The analysis proved useful for finding charging stations for drivers who didn’t have chargers at their homes. It was also beneficial for vehicle manufacturers who could use the data for identifying market segments. Ultimately, the findings of the mapping exercise were used to make policy recommendations. This type of mapping exercise can identify different ways in which policies can affect AFV adoption and vice versa (Campbell, Ryley, & Thring, 2012).

The independent variables used in this paper's geographical model included: 1) locations, 2) car ownership, 3) education, 4) home-ownership, 5) age, 6) socio-economic status, and 7) journey (mode) to work. These variables were used to describe an anticipated alternative fuel vehicle driver. A set of characteristics were identified for typical AFV early adopters, and these variables were employed in hierarchal cluster analysis. Seven waves of adopters were identified: early adopters, early majority first wave, early majority second wave, late majority first wave, late majority second wave, laggards, and unlikely adopters, with the latter waves representing those who adopted later. **Table 4** was taken from the paper and shows the output of the cluster analysis with the seven waves compared to the determined variables. As shown in the table, the early adopters cluster has the highest mean values across the six variables. These data represent 9% of the population of the Birmingham County Council area. Interestingly, all of the means except the "% of age 16-59" decrease with the waves. Perhaps this analysis would have shown more significant results if a smaller age group was chosen (Campbell, Ryley, & Thring, 2012).

Table 4: Output for Cluster Run of Seven in Order of Likely Adoption (Campbell, Ryley, & Thring, 2012)

Ward Method			% of age 16-59	% of owner occupiers	combined % of detached and semi detached homes	% of those travel to work by car	% of households with 2+ cars	% of professional employees or managers within ward
Early adopters	N	Valid	259	259	259	259	259	259
	Mean		64%	94%	93%	67%	52%	39%
	Std. Deviation		4%	4%	7%	5%	10%	7%
	Minimum		54%	76%	72%	53%	33%	22%
	Maximum		77%	100%	100%	82%	83%	68%
Early majority first wave	N	Valid	493	493	493	493	493	493
	Mean		62%	87%	87%	58%	29%	25%
	Std. Deviation		5%	9%	10%	5%	7%	6%
	Minimum		33%	46%	57%	35%	6%	7%
	Maximum		76%	100%	100%	72%	57%	52%
Early majority second wave	N	Valid	473	473	473	473	473	473
	Mean		61%	75%	55%	57%	26%	29%
	Std. Deviation		6%	12%	11%	8%	9%	12%
	Minimum		43%	47%	16%	37%	10%	8%
	Maximum		76%	100%	76%	83%	55%	66%
Late majority first wave	N	Valid	454	454	454	454	454	454
	Mean		57%	70%	23%	49%	16%	23%
	Std. Deviation		9%	10%	11%	8%	7%	14%
	Minimum		32%	28%	0%	28%	0%	4%
	Maximum		79%	91%	52%	77%	39%	67%
Late majority second wave	N	Valid	618	618	618	618	618	618
	Mean		54%	47%	43%	47%	13%	15%
	Std. Deviation		5%	12%	11%	7%	5%	6%
	Minimum		36%	3%	17%	25%	3%	3%
	Maximum		71%	80%	88%	71%	37%	51%
Laggards	N	Valid	531	531	531	531	531	531
	Mean		54%	40%	21%	42%	9%	15%
	Std. Deviation		8%	10%	8%	6%	4%	9%
	Minimum		38%	9%	3%	22%	0%	2%
	Maximum		78%	62%	45%	63%	28%	56%
Unlikely adopters	N	Valid	298	298	298	298	298	298
	Mean		50%	17%	13%	32%	6%	11%
	Std. Deviation		14%	10%	9%	8%	6%	5%
	Minimum		5%	0%	0%	15%	0%	0%
	Maximum		84%	42%	39%	67%	33%	31%

The results of the cluster analysis are useful for identifying characteristics of AFV early adopters. In the case of Birmingham, UK, a cluster of areas in the north part of the city were identified as having the highest percentage of adopters. A high percentage of the population in these areas could be classified as home owners that live in detached or semi-detached homes. Half of the surveyed population owned more than one vehicle. 40% of the early adopter population was made up of higher income individuals (defined in this analysis as managers and professionals). 'Unlikely adopters' were identified as living closer to the urban core and having better access to public transportation (Campbell, Ryley, & Thring, 2012).

The Birmingham paper suggests that policies should be implemented that promote incentives in areas with high concentrations of potential alternative fuel vehicle owners, as discussed above. Increasing the visibility and availability of AFV refueling stations may also increase AFV ownership (Campbell, Ryley, & Thring, 2012).

Effects of Federal Tax Credits for the Purchase of Electric Vehicles

The Congress of the United States Congressional Budget Office (CBO) published a report summarizing the impacts of federal tax credits on the purchase of electric vehicles in September of 2012 (Gecan, 2012). The CBO report focuses solely on federal government incentives that have influenced PHEV and BEV adoption and a reduction in gasoline consumption and emissions. The CBO report begins by giving an overview of the federal tax credits, stating that tax credits' direct effect on gasoline consumption ranges from $3 to $7 per gallon saved when consumers purchase a similarly equipped (in terms of fuel economy, size, etc.) electric vehicle. The CBO report also states that the cost per metric ton of carbon dioxide equivalent (CO_2e) emissions reduced can vary from $230 to $4,400 for electric vehicles that are comparable to average-fuel-economy conventional vehicles because the costs also depend on the emissions released in generating the electricity for EV battery charging (Gecan, 2012).

The CBO report discusses the cost-competitiveness of PHEVs and BEVs when they are subsidized to match prices of conventional vehicles. According to CBO's analysis, the federal credits in 2012 were large enough for some EVs to be cost-competitive with conventional vehicles, but PHEVs with large batteries needed credits that were two or three times larger to make them cost-competitive. In other words, as the battery range of the vehicle increases, the price of the vehicle increases disproportionately. The CBO report provides the caveat that purchase price is not always the most important factor to early adopter drivers (Gecan, 2012).

The report goes on to provide a series of succinct findings. The report points to the fact that tax credits in 2012 may not have been large enough to make EVs cost competitive with conventional vehicles, but prices of EVs were decreasing and eventually would be more competitive. This is generally what happened over the next few years. **Figure 4** is taken from the report and shows the tax credits that would be necessary for EVs to be cost-competitive with conventional vehicles. This analysis is based on battery size being a determining factor of vehicle price. As the figure shows, as battery capacity increases, the tax credits required becomes very large. The fuel economy of the conventional vehicles does not seem to significantly affect the tax credits required. This analysis was also completed for predicted 2020 vehicle costs (Gecan, 2012).

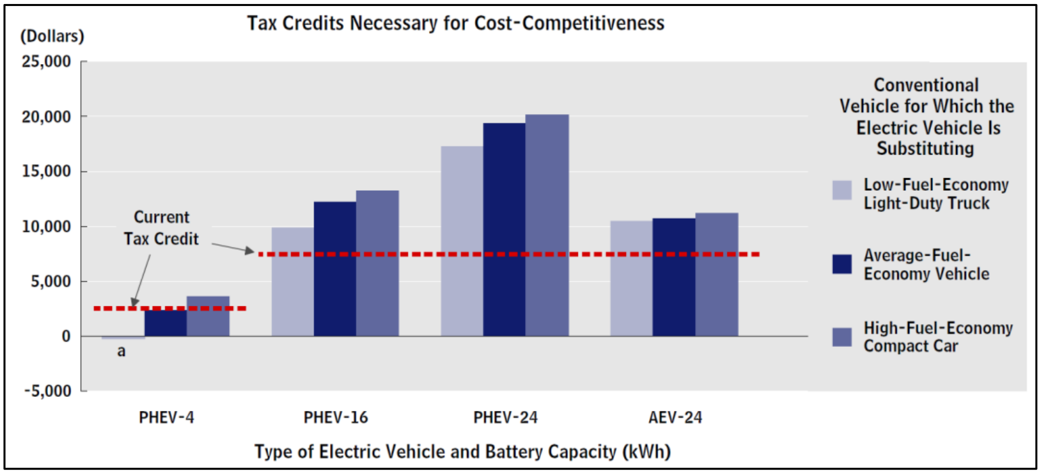

Figure 4: Tax Credits Necessary for Cost-Competitiveness (Gecan, 2012)

The CBO report goes on to address energy and environmental effects of the tax credits. The first conclusion was that, in the short term, the tax credits are likely to have little or no impact on total gasoline consumption and emissions. The second conclusion was that, in the long term, the credits might decrease gasoline use and emissions, but the cost-effectiveness the subsidies is unknown (Gecan, 2012).

Multiple recommendations for future tax credit laws were provided by the CBO report. Firstly, the size of the tax credits will need to be reconsidered as time passes. As vehicles become cheaper, the demand for incentives may not be as high. Next, the number (vehicle cap per incentive) of tax credits available will need to be reassessed as EVs become more ubiquitous. Furthermore, tax credits should be equalized for those who are not able to take full advantage of the incentives because of their income. That is, lower income households may not fully benefit from a federal tax credit if their tax burden is low. This balance could be achieved by providing refunds on top of income tax credits or replacing the tax credits completely with a refund program (Gecan, 2012).

A New Approach to Modeling Large-Scale Alternative Fuel and Vehicle Transitions

"A New Approach to Modeling Large-Scale Alternative Fuel and Vehicle Transitions" was published through UC Davis and the Lawrence Berkeley National Laboratory. The authors of this paper created a simulation game as a tool for improving AFV transition policies. Simulation games are often used to explore problems that feature high degrees of uncertainty. This particular game simulates a three-sided market of vehicle producers, fuel producers, and consumers. The game prompts users to make decisions about managing their businesses and vehicle purchases. Ultimately, the game provides insights into likely dynamics and outcomes that diverge unpredictably from input assumptions. The primary challenge with AFVs is getting the different parties to quickly and effectively transition from conventional vehicles (Bremson, Meir, Lawell, & Ogden, 2013).

The game is called Autopia, taking place over ten turns, each of which is a four year period. Inputs include, but are not limited to, fuel prices, fleet attrition, and consumer income. The result of the game is narrative data about prospective market reactions to various scenarios (Bremson, Meir, Lawell, & Ogden, 2013).

"A New Approach to Modeling Large-Scale Alternative Fuel and Vehicle Transitions" presents two primary findings of the game simulation that rely heavily on initial assumptions about consumer choice. First, a counter-intuitive effect of increasing gasoline prices was identified. Those with lower incomes are not likely to adopt a more efficient technology if they cannot afford it, and high fuel prices can make AFVs unaffordable for many consumers by depleting their financial reserves. This does not apply to higher income individuals. This finding points to the fact that increasing gasoline prices do not always coincide with increased AFV adoption. Secondly, the idea of a 'feature gap' is presented. Feature gaps are the distances between comparable features of AFVs and CFVs. For example, a Chevy Volt (in 2012) cost $40,000 and the Chevy Cruze Eco cost around $20,000. The main difference between these vehicles is substantially improved gasoline mileage. However, many consumers may not be willing to pay twice the purchase cost for this singular improved feature. The authors suggest that this type of feature gap might be closed by forcing all new vehicles to be hybrid vehicles (Bremson, Meir, Lawell, & Ogden, 2013).

"A New Approach to Modeling Large-Scale Alternative Fuel and Vehicle Transitions" is included in the literature review because of its unique method of factor determination. As the amount of research on the effects of policy on AFV adoption increases, this type of simulation game may be useful for determining statistically significant variables (Bremson, Meir, Lawell, & Ogden, 2013).

Literature Review Findings

Through this literature review, the following factors were identified as possible influencers of AFV adoption rates: 1) gasoline prices, 2) cost competitiveness of AFVs, 3) electricity prices, 4) primary mode of travel, 5) primary owner age, 6) education of vehicle owner, 7) income of owner, 8) consumer understanding of technology benefits, 9) technology complexity, 10) technology compatibility, 11) technology trial-ability, 12) community type (rural, urban, etc.), 13) weather, 14) environmental awareness, 15) commute distances, 16) charging infrastructure availability and price, 17) vehicle availability, and 18) availability and magnitude of incentives. Many of these sources also hint at possible policies or strategies that can be implemented to incentivize EV adoption. Most notably, incentives and laws should probably change as AFV market penetration increases. There is an apparent gap in research regarding the effects of policy on AFV adoption. The literature review sources do not describe, in detail, the specific characteristics of policies that may help encourage AFV adoption. This thesis attempts to fill gaps in this research by investigating policy specifics and comparing policies across states.

CHAPTER 3

STAKEHOLDER ANALYSIS

A variety of public entities, private entities, and individuals are vested in AFVs, AFV infrastructure, and AFV policy decisions. A diverse set of players constantly interact with each other and influence policy decisions and consumer perception. Charging station manufacturers, electric vehicle enthusiasts, and statewide energy agencies are a few of the stakeholders who are influenced by AFV policy daily. It is crucial for these stakeholders to monitor and assess Georgia General Assembly Bills and assess them for provisions that may hurt or help them.

In the case of Georgia's electric vehicle income tax credits, the consumer is the primary stakeholder. Consumers don't often have the power that is required to convince lawmakers to change the content of a bill. However, numerous electric vehicle advocacy groups, made up of electric vehicle enthusiasts who care about EV policy in Georgia, meet frequently and discuss new policies and technologies. Although unsuccessful, a few of these groups were responsible for writing versions of the income tax credit language that was included in HB 220, an alternate bill to HB 170 (see policy section for more details). This language was not adopted, but it was important for EV advocates to voice their opinion in this way. The following stakeholder analysis identifies these stakeholders and details their role in Georgia's AFV policy decisions.

Electric Vehicle Charging Station Manufacturers and Distributors

The ChargePoint, Blink, SemaCharge, Tesla, EVgo, GE WattStation, and Greenlots EV charging station networks are the most popular in Georgia. These companies rely on a large population of EV drivers to stay viable and make a profit on their products. As of January, 2016, there were over 100 Level 1 charging ports, over 980 Level 2 charging stations, and over 135 direct current (DC) fast charging stations in Georgia. **Figure 5** shows EV charging station location counts in Georgia by provider as of March, 2016. This information does not factor in multiple ports at one location. These data are provided by the U.S. Department of Energy's Alternative Fuels Data Center and are updated on a monthly basis or when resources are available. Because resources are sometimes limited, the counts may not be recent, but should represent a general distribution of charging station networks (Data Downloads - Alternative fuel stations, 2016)

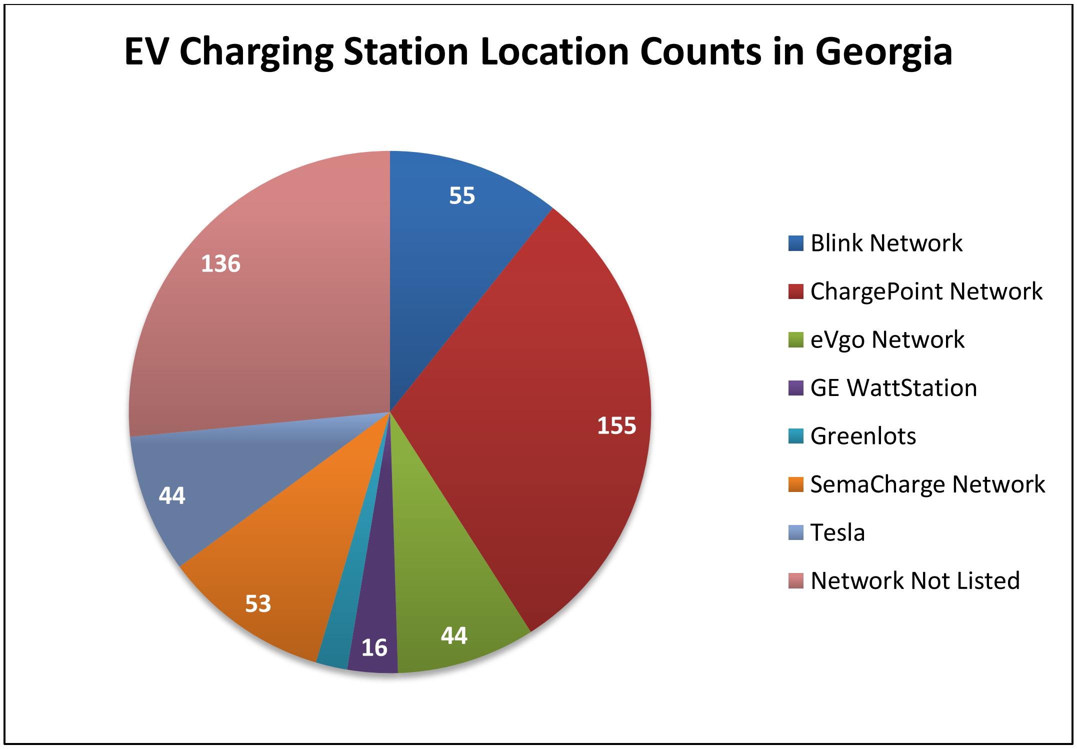

Figure 5: EV Charging Station Location Counts in Georgia by Provider (does not factor in multiple ports at one location) (Data Downloads - Alternative fuel stations, 2016)

ChargePoint has the most charging station locations in Georgia and claims to be the world's largest and most open EV charging network with more than 26,200 charging spots throughout the world. ChargePoint, formerly known as Coulomb Technologies, is solely an EV infrastructure company based in Campbell, California. ChargePoint's first EV charging stations were installed in downtown San Jose, California in 2009. ChargePoint maintains a unique mobile application that allows users to start, stop, track, and manage charging activities from a smart phone. They also offer home EV charging stations through their ChargePoint Home product line (Who We Are, 2016).

Blink is the second largest EV charging station installer in Georgia. Just as with many of the EV charging station manufacturers and distributors, Blink was originally founded when the federal government created The EV Project. The EV Project collected and analyzed data from charging units in 20 cities throughout the U.S. The data collection phase ran from January 1, 2011 through December 31, 2013 and captured almost 125 million miles of driving and 4 million charging events. Overall, the EV Project partnered with city, regional, and state governments, utilities, and other organizations to deploy aver 12,500 public and residential charging stations. The project was funded by the U.S. Department of Energy through a federal stimulus grant of $144.7 million, made possible by the American Recovery and Reinvestment Act (ARRA). The grants were matched by private investment, bringing the total value of the project to approximately $230 million (The EV Project, 2016). Blink was purchased by Car Charging Group (OTCQB: CCGI) in October 2013. The company has recently starting selling Blink residential chargers to EV owners (Car Charging Group, Inc., 2016).

These EV charging station companies have grown as EVs have become more common. They rely on the EV market to flourish to keep growing. HB 170 certainly did not help these entities with demand: as income tax credits disappear and EV sales start to slow, EV charging stations will be needed less. These companies cannot afford to lose this type of business, especially in Georgia where the EV market is significant. In order to combat the recent legislation, EV charging station companies should join a lobbyist consortium, as was attempted in 2015.

Alternative Fuel Vehicle Dealerships and Manufacturers

Towards the end of 2013, Atlanta became the premiere city for Nissan LEAF buyers and leasers. There are 38 Nissan dealerships in Georgia, many of them concentrated around the metro Atlanta area. The number of Nissan LEAFs registered in

Georgia went from 94 in 2011 to 9201 in 2014 (IHS, 2016). Much of the Nissan LEAF's success in Georgia can likely be attributed to the zero-emission vehicle (ZEV) income tax credit offered (until June 30, 2015) by Georgia. Across all U.S. states, Georgia has the 8th highest number of Nissan dealerships, with California, Texas, New York, Florida, Pennsylvania, North Carolina, and Illinois ranking higher (Nissan USA - Locations, 2016).

The Tesla Model S had the second highest registrations in Georgia in 2014. There are three Tesla showrooms/stores in Georgia, all of which are in the metro Atlanta area: Marietta, Buckhead, and Decatur (Tesla Motors - Locations, 2016). The Tesla Model S is a fully electric vehicle and also qualified for the ZEV tax credit. It is generally assumed that a different set of consumers buy Tesla vehicles because of their high price tag. While the lower tier 2016 Nissan LEAF retails at around $30,000 (2016 Nissan LEAF, 2016), the lower tier 2016 Tesla Model S costs around $70,000 (Tesla - Design, 2016). The Tesla Model S, however has a much longer battery range and more of a mainstream physical design. While the ZEV tax credit certainly helps higher income consumers afford this vehicle, it does not make it completely affordable for the average buyer. As the policy section of this thesis will suggest, higher income buyers should not always benefit from the same incentives as low income buyers.

Chevrolet, Ford, and BMW also compete with Nissan and Tesla. In 2015, BMW's i3 doubled its sales form 2014 and represented a higher percentage of PEV registrations than all except the LEAF and Model S (IHS, 2016). As the income tax credit dilemma continues to play out, car manufacturers should have an active role in a lobbyist consortium and help consumers urge legislators to reinstate the credit for low-emission and zero-emission vehicles.

The U.S. Department of Energy's Alternative Fuels Data Center maintains a database of all available alternative fuel vehicles in the U.S. This list includes all vehicles that are available to purchase new from car manufacturers, but does not include older models that are no longer in production. A separate database for older vehicles is available on the U.S. DOE website. Currently, there are over 350 light duty AFVs on the market for the average consumer, and over 170 heavy duty AFVs available for public and private fleets (Alternative Fuels and Advanced Vehicles, 2016). It is crucial to consider AFV availability when forming policy goals. More and more AFVs are becoming available as technology improves and becomes more affordable. It is the duty of federal, state, and local governments to encourage AFV adoption and promote AFVs as tangible, affordable, and practical alternatives to gasoline powered vehicles (Alternative Fuels and Advanced Vehicles, 2016).

Table 5 shows a breakdown of the number of models and fuel types per each manufacturer in the U.S. The table only shows those vehicles classified as light-duty vehicles by the U.S. DOE. Ford, Chevrolet, and GMC are among the top AFV manufacturers. The data are broken down into nine different fuel types: Ethanol (E85), Hybrid Electric, Plug-In Hybrid Electric, Biodiesel, Compressed Natural Gas (CNG), Electric, Propane, CNG Bi-Fuel, and Hydrogen Fuel Cell. Ethanol (E85) is the most popular alternative fuel. There are over twice as many E85 vehicles on the market than the next alternative fuel, hybrid electric. Under Georgia's HB 170, "alternative fuel" is defined as electricity, natural gas, and propane. There is no mention of hydrogen fuel cell technology or E85, although HB 170 does include bi-fuels and dual fuels in its definition (Alternative Fuels and Advanced Vehicles, 2016).

Table 5: Breakdown of Models and Fuel Types by Manufacturer (includes available 2015 and 2016 models) (Alternative Fuels and Advanced Vehicles, 2016)

Manufacturer	Total Number of AFVs on Market	Fuel Type								
		Ethanol (E85)	Hybrid Electric	Plug-In Hybrid Electric	Biodiesel	Compressed Natural Gas	Electric	Propane	Compressed Natural Gas Bi - Fuel	Hydrogen Fuel Cell
Acura	1		1							
Audi	14	10	2	2						
Bentley Motors	3	3								
BMW	11		4	5			2			
Buick	5	5								
Cadillac	3	1		2						
Chevrolet	57	33	1	2	9	6	2	1	3	
Chrysler	10	10								
Dodge	11	11								
Fiat	2						2			
Ford	65	24	4	4	5	13	2	13		
GMC	32	20			6	4		1	1	
Honda	7		4	1		1				1
Hyundai	5		2	1						2
Infiniti	8		8							
Jaguar	5	5								
Jeep	6	4			2					
Kia	4		3				1			
Land Rover	3	3								
Lexus	14		14							
Lincoln	2		2							
McLaren	2			2						
Mercedes-Benz	16	9	1	3			2			1
Mitsibishi	2						2			
Nissan	9	4	2		1		2			
Porsche	5			5						
Ram	12	4			6	1			1	
Smart	2						2			
Subaru	2		2							
Tesla	5						5			
Toyota	21	4	13	2				1		1
Volkswagen	5		3				2			
Volvo	1			1						
TOTAL	350	150	66	30	29	25	24	16	5	5

As seen in the above table, Ford manufactures 65 different AFV models. 24 of these vehicles utilize E85, while only 10 of their cars use electricity in some way (Alternative Fuels and Advanced Vehicles, 2016).

It is also important to consider the number of vehicles available over time. **Figure 6** shows the rise in AFV vehicles that have been available throughout model years. This table includes all available heavy-duty and light-duty vehicles. The "All AFVs" category includes biodiesel (B20), CNG bi-fuel, CNG, EV, ethanol (E85), HEV, hydrogen fuel cell, methanol, PHEV, propane, and propane bi-fuel. The overall AFV count is shown next to the count for EVs, HEVs, and PHEVs. A large spike in available AFVs is apparent in 2011, when the count went from 57 vehicles to 117 vehicles. This trend coincides heavily with the increase in AFV purchases and leases in 2011 (Data Downloads - Alternative fuel stations, 2016). Future research on AFVs should include information about changes in manufacturer's suggested retail price (MSRP) throughout the model years. The MSRP for EVs in particular, are very dependent on battery costs. This type of analysis would reveal trends in affordability and could be compared to median household incomes.

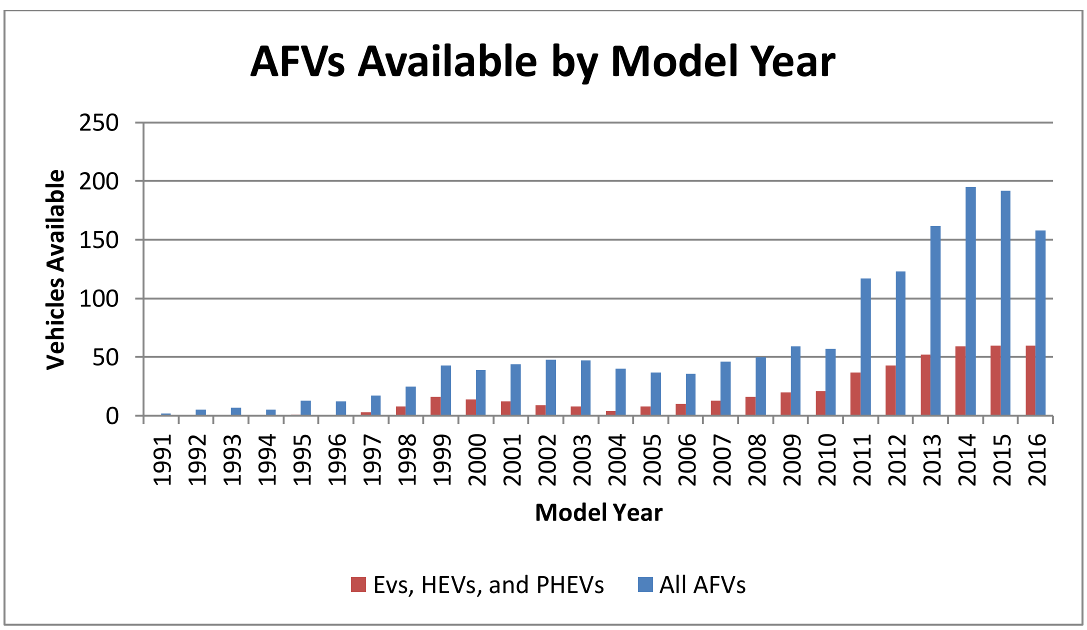

Figure 6: AFVs Available by Model Year (2016 data included up to February) (Data Downloads - Alternative fuel stations, 2016)

Battery Manufacturers and Retailers

Battery costs make up a large bulk of the overall cost of EVs. By some estimates, batteries account for around 25% of the total vehicle cost (Nykvist & Nilsson, 2015). Therefore, it is generally sufficient to assume that the overall cost of an EV is directly related to the battery cost. Lithium-ion battery pack prices have been decreasing significantly since EVs flooded the market. A 2014 study showed that industry-wide cost estimates declined by approximately 14% annually between 2007 and 2014. **Figure 7** shows a chart taken from this study that shows the decline in price of lithium-ion battery packs. The creators of this chart took data from multiples sources and traced both reported cost for industry and costs for market-leading manufactures. The black line is the log fit of all estimates. As shown in the figure, the log fit of all estimates went from around $1300 per kWh in 2006 to around $400 per kWh in 2014 (Nykvist & Nilsson, 2015).

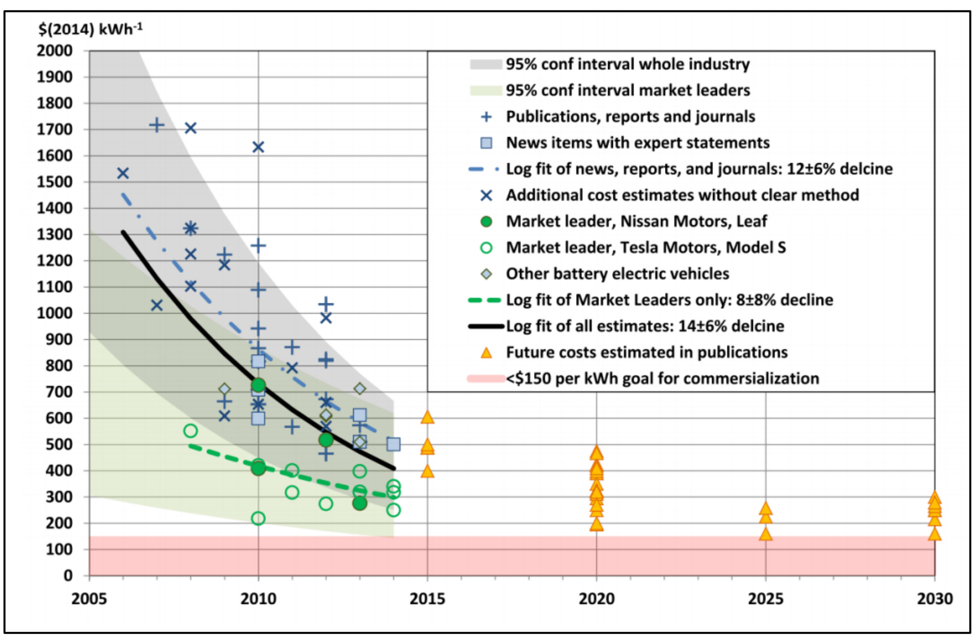

Figure 7: Cost of Lithium-ion Battery Packs in BEVs (Nykvist & Nilsson, 2015)

Battery manufacturers have been one of the largest beneficiaries of the rise of BEV popularity. As of quarter one of 2015, Panasonic was first in sales for light-duty EV battery manufacturers. Panasonic supplies batteries for both Tesla and Volkswagen. Following Panasonic are AESC (supplies batteries for Nissan Motors), BYD, Mitsubishi/GS Yuasa, LG Chem, and Samsung. These rankings are similar for 2014 (Ayre, 2015). As BEV sales increase, these companies should see tremendous growth.

City of Atlanta, Office of Sustainability

Atlanta's Office of Sustainability recently launched a citywide sustainability initiative called *Power to Change* which "aspires to present a clear path forward for us all in these endeavors: marrying national best practices with local context, leveraging the work of countless individuals and organizations (public and private) across many impact areas, and giving us all a sense of common purpose and accomplishment." As electric vehicle registrations have skyrocketed, the City of Atlanta has streamlined its permitting process for residential electric vehicle supply equipment. Through the Office of Buildings, the city has created three categories for permitting electric vehicle supply equipment (EVSE): single-family residential, multi-family residential, and commercial. A resolution was also authorized to create a task force through the Office of Sustainability to explore the city's EV infrastructure readiness. This task force recognized that embracing AFV technologies had the power to boost the local economy, reduce fuel costs for commuters, and release fewer pollutants into the air. Unfortunately, this task ultimately disappeared. In 2012, the city received a grant award from the U.S. DOE's Clean Cities Advanced Vehicle Development Program of $58,000 that went towards funding Atlanta's EV readiness planning efforts. With help from the city, the U.S. DOE ultimately created the *Southeast Regional EV Readiness Workbook* in 2013 (City of Atlanta, 2016).

Clean Cities – Georgia

The Clean Cities Program is an initiative of the U.S. Department of Energy (DOE) and focuses on strategies to reduce petroleum consumption in transportation. There are around 100 Clean Cities Coalitions throughout the U.S. Clean Cities-Georgia was the first coalition and was officially designated in 1993. Clean Cities-Georgia is the central coordinating point for AFV activities in the state of Georgia. Their mission is to advance the energy, economic, and environmental security of the U.S. by supporting local actions to reduce petroleum use in transportation. Clean Cities - Georgia has three primary strategies to achieve this mission: replace petroleum products with alternative fuel, reduce petroleum use by promoting smarter driving habits, fuel-efficient vehicles, idle reduction, and advanced technologies, and eliminate petroleum use by encouraging mass transit usage, trip elimination and congestion mitigation. In 2014, Clean Cities-Georgia became involved in the EcoCAR program, the latest advanced vehicle technology completion series that challenged 16 university teams to redesign the Chevrolet Camaro to reduce its environmental impact. The design period runs for four years (2014 to 2018). Georgia Tech was Georgia's only university to enter the competition and constantly interacted with Clean Cities-Georgia. Georgia Tech's team was comprised of four managers, 23 students, and three professors. This competition is just one way in which Clean Cities-Georgia is helping shape Georgia's AFV future (Clean Cities - Georgia, 2015).

Georgia Regional Transportation Authority (GRTA)

In 1999, under the leadership of Governor Roy Barnes, the state of Georgia created the Georgia Regional Transportation Authority (GRTA). This agency was created in response to Atlanta being in the "serious" category of emissions violations. At that time, Atlanta was at risk of losing federal funds for highway projects if it did not improve air quality. Atlanta was ultimately being tasked with getting down to 215 tons of nitrogen oxide by 2005. The creation of GRTA was controversial at the time because it was completely altering Atlanta's traffic mitigation strategies (Greenblatt, 1999). GRTA primarily uses Motor Coach Industries (MCI) buses that use diesel fuel. A few of these buses run on CNG fuel (Pendered, 2014). Although GRTA already focuses on using lower octane fuels, as AFV technology becomes more efficient and affordable, they have to consider switching from gasoline and diesel vehicles to cleaner-burning fuels. Currently, electric buses are not common. As technology improves, bus manufacturers should consider electricity as a viable option to fuel their buses.

Electric Vehicle Advocacy Groups

There are a number of EV advocacy groups in Georgia that meet regularly and discuss recent topics regarding EVs. These groups represent the voice of average consumers. They are important as vessels for discussion and consumer-led movements. In 2015, a few of these groups were responsible for putting together alternate forms of policy in the form of HB 220, a bill meant to replace HB 170 (see policy section for more details). The EV Club of the South is a group of electric vehicle enthusiasts and drivers that meets once a month and shares stories, real world experiences, and recent news about electric vehicles. This group's purpose is to promote the successful growth of EVs in Atlanta and the Southeast, while acting as a network for information both to and from the manufacturers and retailers of EVs and EV infrastructure. Michael Beinenson, a tax credit expert, is the president of this club. Beinenson helped lead the club's efforts to advance HB 220. Don Francis, Executive Director of Partnership for Clean Transportation, Inc. and Coordinator for Clean Cities-Georgia sits as one of the committee chairs. Francis co-led the effort to develop and advance HB 220 and to martial data to counter the $200 Road Use Fee imposed through the passage of HB 170 (Electric Vehicle Club of the South, 2015).

The Atlanta Electric Vehicle Development Coalition (AEVDC) is a blog-based advocacy group used to foster partnerships to help advance electric vehicle infrastructure and ownership in the 11-county metro Atlanta area. Their website provides up-to-date information about EV legislation, deals for EV buyers/leasers, and new EV technologies (Cohen, About AEVDC, 2016). Jeff Cohen founded the AEVDC and subsequently became National Sales Manager for Current Powered by GE Electric Vehicle Charging Infrastructure. The blog gained its highest readership during the 2015 Georgia General Assembly when all eyes were fixed on Georgia. Cohen reports that the blog attracted readers from over 80 countries during the 2014 40-day legislative session (Cohen, About AEVDC, 2016).

Electrify Atlanta is a comprehensive website for EV buyers and leasers in Atlanta and Georgia. Chris Campbell runs this website and is an electrical engineer who follows EV news as a hobby. Campbell owned the first Chevrolet VOLT sold in Georgia and used his experience to advance knowledge about EVs. His website has information about tax credits, technology, individual vehicles on the market, infrastructure, solar power, and more. Campbell is also the leader of EV Club of the South and is responsible for maintaining and reporting Georgia EVSE infrastructure (Campbell C. , 2016).

Georgia Department of Natural Resources, Environmental Protection Division

The Air Protection Branch at the Georgia Environmental Protection Division reviews and completes certification forms and supporting documents for the LEV/ZEV tax credits in Georgia. Through the EPD website, LEV/ZEV buyers and leasers can download one of the following forms: LEV/ZEV, Medium-Duty Vehicle/Heavy Duty Vehicle (MDV/HDV), Vehicle Conversion or Electric Vehicle Charger Certification Form. These forms must be completed and sent with a copy of the bill of sale or lease agreement, permanent tag registration, and (in the case of converted vehicles) purchase invoices for conversion kits. Georgia EPD reviews the completed certification forms and supporting documents. Once all of the requirements have been met, the EPD signs the form and sends it back to the applicant. For the LEV/ZEV credits, drivers then attach the approved certification form to their Georgia income tax return before it is sent to the Georgia Department of Revenue, which approves the form and issues the actual tax credit. This process is slightly different for the MDV/HDV tax credits (Alternative Fuels and Tax Credits, 2016). From the 2011 to 2015, the number of LEV/ZEV certificates issued went from 4 to 8469 (IHS, 2016). The EPD was suddenly responsible for processing over 8,000 applications. As alternative fuel vehicles become more popular, Georgia must rethink how they handle these types of tax credits.

Georgia Power

Georgia Power currently has an Electric Vehicle Charger Rebate Program which offers incentive programs to help offset some of the costs associated with residential EV charger installations. Georgia Power residential customers may qualify for a $250 rebate for each new residential charger purchased and installed. Georgia Power also has a Business EV Charger Program, which may award up to $500 for each new Level 2 charger purchased and installed. To be eligible, businesses must be Georgia Power customers, each charger must have a dedicated circuit, and the business can't be a third-party vendor or EV charging business. Georgia Power also offers up to $10,000 for properties that include PEV charging infrastructure in their projects. To qualify, businesses must have at least 100 employees/residents, and the property must install five charging stations and plan infrastructure for ten charging stations. Additionally, Georgia Power has partnered with Nissan North America, Inc. on the Nissan EV Advantage Program. Existing Georgia Power business customers who qualify for Georgia Power's EV charger rebate may also qualify for an additional $500 rebate for each Level 2 EV charger installed. The most recent program ran through March 21, 2016. Nissan benefits from this because they are then allowed to host a Ride and Drive event at the company to showcase their vehicles (Get Current, Drive Electric, 2016).

Furthermore, Georgia Power offers two special PEV electricity rates: a nights and weekends rate, and a PEV rate. These rates are broken down into three different time periods: super off peak (11:00 a.m. until 7:00 a.m.), off-peak, and on-peak. Off-peak is priced higher than super off-peak, but much lower than on-peak. This incentive helps equalize charging throughout the day, reducing the peak demand on the grid. The nights and weekends rate is considered an off-peak rate, and does not have a super off-peak period. Georgia Power also maintains a Community Charging Network. Each of their charging locations has a Level 2 and DC Fast Charging station (Get Current, Drive Electric, 2016).

Each of these incentives has the potential to increase Georgia Power's revenue. By encouraging off-peak electricity use, Georgia Power is able to more effectively balance electricity demand throughout the day. By incentivizing EV charging stations, Georgia Power is increasing electricity use in the state and collecting more revenue. Ideally, these charging stations will have a high utilization rate that will exceed capital costs.

Consumers

Everyday consumers are ultimately the most important stakeholder in this analysis. It is up to consumers to stop purchasing gasoline vehicles and start driving zero and low-emission vehicles that can considerably improve air quality in cities. More and more consumers are choosing to switch to AFVs every day. Sometime in the next few decades, electric vehicles will likely replace gasoline vehicles as the most popular vehicle type (McMahon, 2016). As consumers are offered cheaper, longer-ranging EVs, the choice between gasoline and electricity will become clearer.

It is crucial to compare states when discussing consumer vehicle choices. Georgia started to become noticed as a state with surprisingly high EV adoption rates in 2014. **Table 6** shows EV sales (as of June 2014) for the top ten states as a percentage of all new vehicle sales. Georgia's percentage went from 0.94% in 2013 to 1.60% in June, 2014. Georgia passed Washington, California, and Hawaii within that time and continued to compete with California for the top position throughout 2015 (Cole, 2014).

Table 6: EV Sales as a Percentage of All New Vehicle Sales (Cole, 2014)

	EV % Total as of June 2014
Georgia	**1.60%**
California	**1.41%**
Washington	**1.13%**
Hawaii	**1.04%**
Oregon	**0.67%**
Utah	**0.31%**
Colorado	**0.27%**
Arizona	**0.20%**
Tennessee	**0.19%**
Connecticut	**0.19%**
All States	**0.32%**

Gasoline Companies, Providers, and Lobbyists

Gasoline sales will inevitably be affected as AFV sales increase. As gasoline prices decrease, consumers are led away from AFVs because of overall costs. This relationship has been seen over the past five years as EVs have flooded the market. From mid-2014 to early-2016, gas prices have experienced a dramatic drop. In April, 2014, the average gallon of gas in the U.S. cost around $3.70. In February, 2016, the average price of a gallon of gas in the U.S. was at 6-year low of $1.69. Gas prices have risen since February, 2016, but they are not up to post-recession levels (Gas Buddy, 2016). Few studies have been published regarding the effect of gasoline prices on AFV adoption, but the aforementioned relationship is generally believed to be true.

It will be interesting to see how gasoline companies, providers and lobbyists react to decreasing demand for oil. Undoubtedly, Middle Eastern countries like Saudi Arabia, Iran, Iraq, Kuwait, and the United Arab Emirates are destined to lose profits in the future as AFV adoption rates increase. Around 70% of all oil consumed in the U.S. is used for transportation (American Fuels, 2013). The shift from oil to electricity will be gradual, but it will be extremely difficult for oil companies to maintain dominance in the energy sector.

CHAPTER 4

POLICY ANALYSIS

It is important to consider various state and federal alternative fuel vehicle incentives and laws from jurisdictions throughout the U.S. Although Georgia's AFV incentives may have helped to increase the amount of AFVs on the road in the past six years, they were not the only, and certainly not the first, laws of their kind. Every state in the U.S. has its own unique set of incentives that encourage AFV adoption. Most of the state incentives were a product of federal policy development in the 1980's and 1990's, so it is crucial to first consider relevant federal laws and initiatives.

Federal Policy

The Clean Air Act (CAA) of 1970 was the first major federal effort to promote AFVs and clean energy. This piece of legislation also authorized the establishment of the National Ambient Air Quality Standards (NAAQS) which designated six criteria pollutants that were detrimental to the public in large quantities. The CAA also created requirements for motor vehicle emissions and State Implementation Plans to achieve the air quality standards. The Energy Policy and Conservation Act of 1975 established Corporate Average Fuel Economy (CAFE) standards. CAFE standards strive to increase fuel economy of vehicles and thereby decrease emissions (U.S. Department of Energy, 2016). The Alternative Motor Fuels Act of 1988 provided Corporate Average Fuel Economy (CAFE) incentives for manufacturers of vehicles that used (in whole or in part) ethanol, methanol, or natural gas fuels (Summaries for the Alternative Motor Fuels Act of

1988, 2016). The 1990 Clean Air Act Amendments authorized the U.S. Environmental Protection Agency (EPA) to restrict Federal Highway Administration (FHWA) HOV lane funds to states federally authorized to reduce air pollution and allowed these states to include HOV lanes in their state implementation plans (Alternative Fuel Vehicles and High Occupancy Vehicle Lanes, 2016). These implementation plans could then specify AFVs as having special permission to use HOV lanes.

Apart from these initial federal policy introductions, other initial laws were very focused on requiring federal, state, and private fleets to have a set amount of AFVs without much incentive. These fleets could earn credits toward their annual AFV-acquisition requirements that could be used toward compliance or banked once the fleet achieved compliance for investments in alternative fuel infrastructure, mobile non-road equipment, and emerging technologies associated with certain electric drive vehicle technologies. One program that came out of the Alternative Motor Fuels Act (AMFA) of 1988 and the 1990 Clean Air Act was the U.S. Department of Energy's Clean Cities. Clean Cities is a federal program that was created with the Alternative Fuels Data Center (AFDC) in 1991. The AFDC's mission was to collect, analyze, and distribute data used to evaluate alternative fuels and vehicles. In 1992, the enactment of the Energy Policy Act of 1992 (EPAct) required certain vehicle fleets to acquire AFVs. Subsequently, the U.S. Department of Energy then created Clean Cities in 1993 to provide informational, technical, and financial resources to EPAct-regulated fleets and voluntary adopters of AFVs (About Clean Cities, 2016). The Energy Independence and Security Act of 2007 functioned to increase the supply of renewable energy sources and advance CAFE standards.

A series of surface transportation policies were introduced beginning in 1991 in the form of the Intermodal Surface Transportation Efficiency Act (ISTEA). This legislation led to new standards for highway construction and safety programs. Subsequent laws were passed over the next two decades, with the most recent being enacted in 2015 in the form of the Fixing America's Surface Transportation (FAST) Act. The FAST Act included provisions for AFVs and AFV infrastructure (U.S. Department of Energy, 2016).

One of the first major efforts to provide tax credits came from the Energy Improvement and Extension Act of 2008. Within this act were provisions for tax credits and exemptions for alternative fuels and technologies. This trend continued with the American Recovery and Reinvestment Act of 2009, which allocated almost $800 billion to energy independence investments and renewable energy, among other things. This act led to the Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010, which extended and reinstated several AFV tax credits. Many of these credits were focused towards ethanol and biodiesel. The American Taxpayer Relief Act of 2012 and the Tax Increase Prevention Act of 2014 followed this piece of legislation with further AFV credit extensions. Most recently, the Consolidated Appropriations Act of 2016 reinstated several of these tax incentives, including the excise tax credits for alternative fuels, the tax credit for second generation biofuel production, the income and excise tax credit for biodiesel, and, among others, the fuel cell motor vehicle tax credit (U.S. Department of Energy, 2016).

Individual states eventually embraced the aforementioned requirements and started forming stricter policies and more rewarding incentive programs. These programs will be discussed in the following sections.

State Policy

Many states have had incentive programs in their laws for over two decades, but most have not seen tangible results until recently. These incentives were underutilized before electric vehicles flooded the market, but appear to have encouraged manufacturers to start creating new technologies. One of the first state laws relating to AFVs was enacted in Rhode Island in 1993. The law stated that vehicles powered exclusively by electricity were exempt from state emissions control inspections. Many other states followed suit in exempting emission inspections for electric vehicles. One of the first true incentives came out of Hawaii in 1997 and allowed drivers of plug-in electric vehicles to use HOV lanes and park for free in state, county, or public parking spaces (All Laws and Incentives Sorted by Type, 2016). Currently, many states in the U.S. allow AFVs to drive in the HOV lane without penalty.

The following analysis attempts to summarize current state laws that incentivize AFVs. This analysis will primarily focus on laws for individuals, but will also touch on fleet laws. These laws are constantly being amended in the face of increased adoption rates. As more people buy and lease AFVs, the existing incentives become more utilized and governments are forced to pull back in the face of oppositionists. States were partially chosen based on the extensiveness of their AFV incentives and laws. States were also included in the analysis if they had high AFV adoption rates or sales. The goal of this analysis is to discover possible alternative policies for Georgia.

California

California is the home of many emerging electric vehicle manufacturers like Tesla Motors. California did not implement its most recent, major purchase incentive program until March of 2010, when the state created the Clean Vehicle Rebate Program. This program offered rebates, as opposed to tax credits, for the purchase or lease of qualified vehicles. The rebates were up to $5,000 for zero emission and plug-in hybrid light-duty vehicles (All Laws and Incentives Sorted by Type, 2016). California soon became the biggest market for alternative fuel vehicles, even though the state's policy lagged behind some other states. Halfway through 2015, California began introduction of the Plus-Up Project, as part of the Enhanced Fleet Modernization Program (EFMP) that aimed to make it easier for lower income individuals to purchase electric vehicles (Making the Cleanest Cars Affordable, 2015). For the first phase, low-cost EVs will be available to those who live in either the South Coast Air Quality Management District (Greater Los Angeles) or the San Joaquin Valley Air Pollution Control District. The program requires participants to replace their old car with one of the listed options: hybrid, plug-in hybrid, or pure electric vehicles. **Table 7** shows the predicted payouts for different income levels**.**

Table 7: California's EFMP Plus-Up Pilot Program (Making the Cleanest Cars Affordable, 2015)

	Hybrid (20 MPG+)	**Hybrid** (35 MPG+)	**Plug-In Hybrid**	**EV**
Low Income (<=225% of the federal poverty level)	**$6,500**	**$7,000**	**$9,500 + $1,500***	**$9,500 + $2,500***
Moderate Income (226%-300% of federal poverty level)		**$5,000**	**$7,500 + $1,500***	**$7,500 + $2,500***
Above Moderate Income (301% - 400% of federal poverty level)			**$5,500 + $1,500***	**$5,500 + $2,500***
*Clean Vehicle Rebate Project for new vehicle purchases				

The Enhanced Fleet Modernization Program will cover cars that are less than eight years old. The extra $1,500 and $2,500 rewards will be for new vehicles. The program also offers money for those who choose to scrap their old car and permanently ride public transit. Depending on the person's income, they will receive between $2,500 and $4,500 for a public transit pass (Halvorson, 2015). This type of legislation is appropriate for the changing market for a number of reasons. Higher income citizens will not be able to easily take advantage of cheap alternative fuel vehicles. Instead of awarding income tax credits to the higher income individuals, tax money will be used to help those with lower incomes to purchase a green vehicle that would otherwise be much too expensive. This legislation does not prevent higher income buyers from purchasing AFVs, but it functions to decrease the gap between different income levels and promote cleaner burning vehicles.

Washington

As might be expected, the state of Washington has also developed a set of AFV incentives available to consumers and commercial fleets. In 2005, Washington adopted the California motor vehicle emission standards, with the exception of California's zero emission vehicle program. This means that Washington's standards have grown with California's standards and regulations. These laws and regulations reflect the consistently progressive policy initiatives that have characterized west coast legislation (Washington Laws and Incentives, 2016).

Washington implemented a state motor vehicle sales and use tax emption for new passenger cars, light-duty trucks, and medium-duty passenger vehicles. To qualify, the fair market value of these vehicles must be less than $35,000. This tax exemption was enacted in 2005 and is currently set to expire in 2019. There are also tax breaks for public lands used for installing, maintaining, and operating EV infrastructure. If these properties qualify, they are exempt from leasehold excise taxes until January 1, 2020. Under this same law, the state sales and use taxes does not apply to PEV batteries , labor and services for installing, repairing, altering, or improving PEV batteries and EV infrastructure, and the sale of property used for EV infrastructure (Washington Laws and Incentives, 2016).

Washington also has tax credits available for businesses that purchase new commercial AFVs. Qualified commercial vehicles are required to be powered only by natural gas, propone, hydrogen, dimethyl ether, or electricity. Tax credit amounts vary based on gross vehicle weight (GVWR) and are up to 50% of the incremental cost, with maximum credit values being $20,000 for GVWRs. This tax credit program was created in 2015 and runs through January 1, 2021 (Washington Laws and Incentives, 2016).

A PEV fee for all EV operators is set to begin on July 1, 2016. This fee is similar to Georgia's new fee. It is $100 and will only sunset if the state starts imposing a vehicle miles traveled fee or tax in the state. Starting on July 1, 2016, PHEVs with an all-electric range of at least 30 miles will be subject to the registration renewal fee. PEVs able to travel at least 30 miles using only battery power will be subject to an additional $50 registration renewal fee. Just as Colorado, Nebraska, Virginia, and North Carolina, Georgia, Wyoming, Idaho, and Michigan have attempted to do, Washington has tried to make up for lost gas tax revenue from AFVs by instituting this new fee. As AFVs become more common than gasoline vehicles, the entire transportation revenue structure will need to be reconsidered (Washington Laws and Incentives, 2016).

Maryland

Maryland has a variety of incentives for AFV purchasers and leasers. Purchasers of qualified PEVs can apply for a tax credit against Maryland's imposed excise tax. Individuals can use the tax credits for one vehicle and businesses can use it for 10 vehicles. Qualified vehicles must have a gross vehicle weight of 8,500 pounds or less, be able to travel at 55 miles per hour, have more than one wheel, and primarily use an electric motor. If new vehicles are purchased between July 1, 2014 and July 1, 2017, owners are eligible for up to $3,000 in tax credits, calculated as $125 per kWh of battery capacity. Through this system, the credit is returned to the taxpayer in the form of a check from the state (Maryland Laws and Incentives, 2016).

The Maryland Energy Administration (MEA) offers an income tax credit up to 20% of the cost of a charging station. The credit may not exceed the lesser of $400 or the state income tax imposed for that tax year. Credits can be applied to one personal EVSE or 30 businesses EVSEs. Through 2016, there is $600,000 available for this tax credit (Maryland Laws and Incentives, 2016).

The MEA also offers an EVSE rebate program available to an individual, business or state or local government entities for the costs of acquiring and installing qualified EVSE. Between July 1, 2014, and June 30, 2016, rebate amounts are equal to up to 50% of $900 for individuals, $5,000 for businesses or state or local governments, and $7,500 for retail service station dealers. The rebate is limited to one EVSE per individual and total funding for each fiscal year shall not exceed $600,000 (Maryland Laws and Incentives, 2016).

The MEA also manages the Maryland Freedom Fleet Voucher (FFV) program. This program provides vouchers for new and converted AFVs. This voucher program covers many different fuels: natural gas, propane, HEV, PEV, and hydraulic hybrid vehicles. The maximum award amount is 50% of the vehicle's incremental cost, except for PEVs which do not have a cap (Maryland Laws and Incentives, 2016).

Oregon

Oregon is another state that has consistently high AFV adoption rates. Oregon offers a variety of incentives for AFVs, including rewards for vehicles that use biodiesel. Oregon has a unique loan program that provides loans to public agencies, private entities, and tribes for the incremental cost of AFVs and AFV conversions. Through the Oregon

Department of Energy (ODOE) AFV Revolving Fund, priority is given to converting petroleum-powered vehicles to AFVs. The loan recipient is usually responsible for a fee of 0.1% of the loan, up to $2,500. Vehicles fueled by electricity, biofuel, gasoline and alcohol blends, hydrogen, natural gas, propane, or other approved fuels are eligible (Oregon Laws and Incentives, 2016).

Oregon also maintains a Residential Energy Tax Credit program, through which individuals can receive a tax credit of 50% of the vehicle cost, up to $750. Vehicles fueled by electricity, natural gas, gasoline blended with at least 85% ethanol (E85), propane, and other approved fuels are eligible. Construction companies are eligible to claim the credit if they install the infrastructure during construction. This credit is available in Oregon through December 31, 2017 (Oregon Laws and Incentives, 2016).

If business owners choose to install AFV infrastructure, they may be eligible for a tax credit of 35%. This tax credit also applies for the conversion or incremental cost of two or more AFVs. Facilities for mixing, storing, compressing, or dispensing fuels for vehicles operating on the alternative fuels noted above are eligible. Non-profit organizations and public entities that do not have an Oregon tax liability may receive the credit for an eligible project but must transfer their project eligibility to a pass-through partner in exchange a cash payment. This credit is available in Oregon through December 31, 2018 (Oregon Laws and Incentives, 2016).

Oregon also has a State Energy Loan Program (SELP) which offers low-interest loans to companies who are working on qualified AFV projects. These projects include fuel production facilities, dedicated feedstock production, fueling infrastructure, and fleet vehicles (Oregon Laws and Incentives, 2016).

Colorado

Colorado has over 10 different incentives for AFV and AFV infrastructure. One of Colorado's most notable incentives comes in the form of the Innovative Motor Vehicle Credit. Eligible technologies include all alternative fuels, diesel hybrid electric vehicles and PHEVs. Idle reduction technologies, aerodynamic technologies, and clean fuel trailers may also qualify for the tax credit. **Table 8** shows the percentage available for each technology. Credit amounts vary for each category, vehicle weight, and tax year. Taxpayers must subtract credits, grants, or rebates provided by the federal government before applying the percentage calculations. Each technology type and vehicle weight class has an annual credit cap. (Colorado Laws and Incentives, 2016).

Table 8: Credits Offered from Colorado's Innovative Motor Vehicle Credit Program (Colorado Laws and Incentives, 2016)

Category	2014-2016	2017-2018	2019	2020	2021
1 - Original equipment manufacturer (OEM) light-duty EV or PHEV	Equal to the actual cost incurred to purchase or lease the vehicle, multiplied by battery capacity, and divided by 100. This amount is then multiplied by a factor for each year: 1 for 2014-2018, 0.75 for 2019, 0.50 for 2020, and 0.25 for 2021.				
1A - Conversion of a light-duty motor vehicle to a EV or PHEV	75%	75%	56.25%	37.5%	18.75%
2 - Light-duty diesel-electric hybrid passenger vehicle with a minimum fuel economy of 70 miles per gallon (mpg)	15%	15%	11.25%	7.5%	3.75%
3 - Light-duty passenger vehicle, light-duty truck, or medium-duty diesel-electric truck conversion that increases original fuel economy by at least 40%	25%	25%	18.75%	12.5%	6.25%
4 - Dedicated or bi-fuel OEM vehicle powered by compressed natural gas (CNG) or liquefied petroleum gas (LPG or propane)	18%	15%	11.25%	7.5%	3.75%
4A - Dedicated or bi-fuel vehicle converted to use CNG or propane	55%	45%	33.75%	22.5%	11.25%
4B - Dedicated or bi-fuel OEM truck powered by liquefied natural gas (LNG) or hydrogen	18%	15%	11.25%	7.5%	3.75%
4C - Dedicated or bi-fuel truck converted to use LNG or hydrogen	55%	45%	33.75%	22.5%	11.25%
5 - Idle reduction technologies	25%	25%	25%	25%	25%
6 - Aerodynamic technologies	25%	25%	25%	25%	25%
7 - OEM EV truck or PHEV truck	18%	15%	11.25%	7.5%	3.75%
7A - Conversion to an EV truck or PHEV truck	55%	45%	33.75%	22.5%	11.25%
8 - Clean fuel refrigerated trailer (purchased after July 1, 2014)	18%	15%	11.25%	7.5%	3.75%
8A - Conversion to a clean fuel refrigerated trailer (after July 1, 2014)	55%	45%	33.75%	22.5%	11.25%
9 - Hydraulic hybrid trailer	55%	45%	33.75%	22.5%	11.25%

Colorado also has a low emission vehicle sales tax exemption. Vehicles, vehicle power sources, or parts used for converting a vehicle power source to reduce emissions are exempt from state sales tax. This exemption applies to vehicles that were sold on or before June 30, 2014, are certified to federal LEV standards, and have a gross vehicle weight rating (GVWR) of over 10,000 pounds. If a vehicle was sold after July 1, 2014, the exemption applies to vehicles certified to federal LEV standards that have a GVWR of over 26,000 pounds (Colorado Laws and Incentives, 2016).

Additionally, Colorado maintains the Charge Ahead Colorado program that supports PEV and EVSE adoption by individuals and fleets. Multiple grants exist in this program. These grants will fund 80% of the cost of a charging station up to $3,260 for single port Level 2 stations, $6,260 for single port DC fast charging stations, $13,000 for multiple port Level 2 stations, and $16,000 for multiple port DC fast charging stations. One of the grants in this program also provides funding for 80% of the incremental cost of a qualified PEV, up to $8,260.

Illinois

Just like Colorado, Illinois has an abundance of AFV incentives for its citizens. Until 2015, The Illinois Alternate Fuels Rebate Program provided a rebate for 80%, up to $4,000, of the incremental cost of purchasing an AFV, the cost of converting a conventional vehicle to an AFV, and the incremental cost of purchasing alternative fuels. E85, fuel blends containing at least 20% biodiesel (B20), natural gas, propane, electricity, and hydrogen are eligible for this program. The E85 fuel rebate was up to $450 per year (depending on vehicle miles traveled) for up to three years for each flexible fuel vehicle that used E85 at least half the time. The biodiesel fuel rebate was for 80% of the incremental cost of the fuel. These rebates were part of the Illinois Green Fleets Program and were available to all qualified Illinois residents, businesses, local government units, and organizations (Illinois Laws and Incentives, 2016).

Illinois offered an EVSE rebate until 2015, when the state's budget crisis suspended the rebates indefinitely. The Illinois Department of Commerce and Economic Opportunity Department provided the rebates for EVSE equipment with qualified connectors. Rebates covered 50% of the cost of equipment and installation up to $3,750 per networked single station, $3,000 per non-networked single station, $7,500 per networked dual station, $6,000 per non-networked dual station, $15,000 per networked DC fast charge (DCFC) station, and $12,500 per non-networked DCFC station. The maximum total rebate awarded was $50,000. Eligible applicants included government entities, private businesses, educational institutions, non-profit organizations, and individual residents of Illinois. Illinois also has a variety of incentives for biofuels, ethanol, diesel, propane, and natural gas (Illinois Laws and Incentives, 2016).

District of Columbia

There are currently four incentives for consumers and fleets in the District of Columbia. In D.C., businesses and individuals are eligible for an income tax credit of 50% of the incremental or conversion cost for qualified AFVs, up to $19,000 per vehicle. There is also a tax credit available for 50% of the equipment and labor costs for the purchase and installation of alternative fuel infrastructure. The maximum credit is $1,000 per residential electric vehicle charging station, and $10,000 per publicly accessible AFV fueling station. Ethanol blends of at least 85%, compressed natural gas, liquefied natural gas, propane, biodiesel, electricity, and hydrogen are qualified for these incentives. This incentive expires December 31, 2026 (District of Columbia Laws and Incentives, 2016).

AFVs and motor vehicles with an estimated average city fuel economy of at least 40 MPG are exempt from the excise tax imposed on an original certificate of title in D.C. The original purchaser and subsequent purchasers of the vehicle are eligible for this exemption. Moreover, certified clean fuel vehicles are exempt from time-of-day and day-of-week restrictions and commercial vehicle bans, if these vehicles are part of a fleet that operates at least 10 clean fuel vehicles in D.C. In most cases, this exemption does not permit unrestricted access to HOV lanes (District of Columbia Laws and Incentives, 2016).

Hawaii

The state of Hawaii only has three incentives for consumers. The first incentive provides ethanol producers with an income tax credit equal to 30% of production facility nameplate capacity between 500,000 and 15 million gallons per year. The second AFV incentive allows qualified PEVS to use HOV lanes and park for free in state and county facilities. Hawaii also has a charging rate incentive for residential and commercial customers.

Hawaii's high adoption rates can probably attributed to buyer demographics. As previously discussed in the literature review, general awareness and mindsets differ throughout the country, and Hawaii often attracts people with alternative lifestyles.

Louisiana

Louisiana currently has a generous income tax credit for AFVs that serves as the state's primary incentive. Louisiana offers an income tax credit of 36% of the cost of converting a vehicle to operate on an alternative fuel, the incremental cost of purchasing an AFV, and the cost of AFV fueling equipment. Consumers can also choose to take a tax credit of 7.2% of the cost of the AFV (up to $1,500) (Louisiana Laws and Incentives, 2016). Prior to 2016, the 36% tax credit was 50%, and the 7.2% tax credit was 10% (Alternative Fuel Incentives and Laws, 2016). Just as in many other states, certain Louisiana lawmakers are starting to view the income tax credits as severe drains on tax money. Additionally, Louisiana has an extensive propane vehicle conversion and purchasing reward program. Up to $1,500 is available for new propane vehicles, and up to $800 is available for vehicle conversions (Louisiana Laws and Incentives, 2016).

Pennsylvania

In addition to providing financial assistance for qualified AFV projects, Pennsylvania's Alternative Fuels Incentive Grant offers rebates to assist eligible residents with the incremental cost of purchasing new AFVs. Eligible vehicles include EVS, PHEVS, hydrogen or fuel cell electric vehicles (FCEVs), natural gas vehicles (NGVs) and propane vehicles for which $2,000 is available for EVs and PHEVs. Rebates of $1,000 are available for FCEVS, NGVs, and propane vehicles (Pennsylvania Laws and Incentives, 2016).

Prior to 2015, deployment and manufacturing projects in Pennsylvania were eligible for grants up to $1,000,000 from the Pennsylvania Energy Development Authority. These projects included biomass, fuel cells, and clean and alternative fuels for transportation (Pennsylvania Laws and Incentives, 2016).

South Carolina

South Carolina has consistently maintained high AFV adoption rates. In South Carolina, an income tax credit is available for the purchase or lease of a new PHEV. Credits are equal to $667, plus $111 if the vehicle has at least five kWh of battery capacity, plus $111 for each additional kWh. The maximum credit is $2,000 per vehicle. Individuals can use this income tax credit for multiple vehicles, as long as the amount does not exceed $200,000 (South Carolina Laws and Incentives, 2016).

South Carolina also has an AFV Revolving Loan Program for both public entities and private entities. **Table 9** shows the amount of loan and grant, if applicable.

Table 9: South Carolina Revolving Loan Programs for Private and Public Entities (South Carolina Laws and Incentives, 2016)

State agencies and educational institutions	Private non-profit organizations, and local governments	Businesses, industries, utilities, and non-profits
70% of each project's funding as a loan, and 30% as a grant	Up to 100% of eligible project costs ranging from $25,000 to $500,000 per fiscal year	Up to 100% of the project costs, ranging from $50,000 to $1,000,000

In addition to these incentives, South Carolina also has a few incentives for biofuels, hydrogen and fuel cell technologies. South Carolina also has an infrastructure financing program (South Carolina Laws and Incentives, 2016).

Utah

A 35% income tax credit is available for the purchase or lease of new electric, natural gas, and propane vehicles. This income tax credit has a maximum award amount of $1,500. A $1,000 tax credit is available for purchased or leased PHEVS. Converted vehicles are eligible for a $2,500 tax credit (up to 50% of the conversion cost) (Utah Laws and Incentives, 2016).

In Utah, propane, natural gas, electricity, and hydrogen are exempt from state fuel taxes when used to operate a motor vehicle. Instead of this normal state fuel tax, these fuels are taxed at a rate of three-nineteenths of the original tax amount (Utah Laws and Incentives, 2016).

The Utah Clean Fuels and Vehicle Technology Grant and Loan Program provides grants and loans to assist businesses and government entities with the cost of converting vehicles, the incremental cost of purchasing vehicles, the cost of retrofitting diesel vehicles, and the cost of fueling equipment (Utah Laws and Incentives, 2016). The 2014 and 2015 award amount was $500,000 for grants and $200,000 for loans (Clean Fuels Program, 2016). Utah also has a natural gas vehicle tax credit which covers heavy duty vehicles and provides up to $25,000 (Utah Laws and Incentives, 2016).

Georgia AFV Policy, History, and Specifics

The Zero Emission Vehicle (ZEV), Low-Emission Vehicle (LEV), and the Electric Vehicle Charger (EVC) tax credits were adopted by Georgia in 1998 in response to Atlanta's history as a violator of the National Ambient Air Quality Standards (NAAQS) for ozone (O'Connor, 1998). During May of 1998, for instance, ozone warnings were issued for five out of thirty-one days. Along with the burgeoning mass production of hybrid vehicles in the new millennia, Atlanta in particular saw this legislation as an opportunity to improve its air quality and become a landing pad for electric vehicle dealerships.

The first piece of legislation to enter the Georgia House of Representatives came in the form of HB 1161 in 1998, “Income tax credit; certain low-emission vehicles”, which was written to amend Article 2 of Chapter 7 of Title 48 of the Official Code of Georgia Annotated. Title 48 related to the “imposition, rate, and computation of income taxes, so as to provide for income tax credits for the purchase or lease of a new low-emission vehicle or the conversion of a conventionally fueled vehicle; and for other purposes.” In addition to Governor Zell Miller, this bill was headed by Larry Walker, a democratic representative from House District 141 (near Macon, GA) (HB 1661, 1998).

Through this piece of legislation, the first income tax credit for AFV’s in Georgia was set at $1,500 and applicable to all taxable years beginning on or after January 1, 1998 (HB 1661, 1998). The intent of this original bill was not to provide Georgia taxpayers with a gratuity for buying a new motor vehicle. The legislation was meant to provide an incentive to taxpayers who incurred additional costs when they switched to motor vehicles that used alternative fuels. The bill went through an amendment process because the phrase “clean fuel” was too broad. Instead, lawmakers decided to use “alternative fuel” because it didn’t include denatured ethanol, reformulated gasoline, and propane which were predicted to be used by car manufacturers in the years to follow (O'Connor, 1998).

After two years, legislators decided to increase the credit to $2500 for hybrids and other low emission vehicles. In 2001, provisions for the $5,000 tax credit for zero-emission vehicles were created, along with free access to HOV lanes. This came in the form of HB 261 of the 2001-2002 Regular Session. Even though the law went into effect on April 4, 2001, it wasn't until almost 10 years later that it started being utilized to its full potential. Tesla and Nissan started introducing fully electric vehicles between 2008 and 2010, and residents of Georgia slowly realized that they could buy and lease these cars for a cheaper price. In particular, Nissan dealers began to market the impact of the $5,000 ZEV income tax credit for the Nissan LEAF. Prior to the widespread availability of electric vehicle options, having an "alternative fuel vehicle" usually meant converting the vehicle yourself. Once the Nissan LEAF and Tesla Model S hit the market, that limitation was gone and the original intent of the legislation was put into question (O'Connor, 1998).

In 2015, the Transportation Funding Act (House Bill 170) was introduced in the Georgia House of Representatives. HB 170 addressed many of the pertinent issues facing Georgia's transportation system. The bill tackled the minimum $1 billion funding shortfall for modernization and maintenance of roads and bridges. It also reduced the state's maintenance backlog and 50 year repair and improvement cycle. The bill ensured that funding intended for transportation went towards transportation. Among other provisions, the bill also addressed sales tax vs. excise tax, hotel-motel tax, aviation fuel tax, the Transportation Investment Act of 2010, the mandatory 10-Year Strategic Plan, and the alternative fuel vehicle tax incentives. The tax credits were ultimately overshadowed by more deliberated issues, and HB 170 passed the House, 129 to 41 and the Senate, 42 to 12. The low-emission and zero-emission income tax credits were reduced to zero (the original laws were not repealed). In their place, a $200 fee for personal electric vehicles and $300 fee for commercial vehicles was put in place to make up for lost motor fuel taxes. Beginning July 1, 2015 vehicles eligible for the alternative fuel vehicle license plate included those vehicles fueled solely by electricity, natural gas, propane, bi-fuel, or dual fuel. Alternative fuel vehicle license plates are now subject to a one-time manufacturing fee of $25 and are annually subject to a $20 registration fee and a $35 special tag fee. Such fees are in addition to the alternative fuel vehicle fee and, if applicable, any taxes (Alternative Fuel Vehicle License Plates FAQ, 2016). As stated above, these new fees went into effect on July 1, 2015. Drivers who purchased or leased their vehicles before that time could still apply for the income tax credits (Georgia Transportation Alliance, 2015).

Judging by the number of supporters in the Georgia House of Representatives, and local news articles, the Transportation Funding Act was well received. There are two sides of the story, however, when it comes to the AFV tax credits. Republican representative Chuck Martin (R-Alpharetta) was one of the primary proponents of eliminating the tax credits. He introduced legislation in hopes of eliminating the credits entirely. He argued that the "peculiar" credit would cost the state approximately $50 million in 2015, which translated to over $1 billion over the next 20 years. He also contended that only 18,000 to 20,000 people were benefitting from the loss in state money. On the other hand, electric vehicle enthusiasts like Tim Echols, an elected official serving on the Georgia Public Service Commission, saw a value of keeping the credits and encouraging future AFV growth in Georgia. In an Atlanta Journal Constitution article, he outlined the benefits of keeping the credits and represented the thoughts of many Georgians who were utilizing the credits responsibly. Firstly, pure electric vehicles leave money in the state by utilizing an alternative form of energy generated in Georgia.

Next, the $5,000 tax credit is usually spent in Georgia, and put back into our economy. Finally, air quality in the metro Atlanta area (where a large portion of Georgia's population resides) is improved. These two opposing views represent the current status of this legislation. The law only recently went into effect, and many are still fighting to reverse its influence before people stop purchasing and leasing electric vehicles in Georgia (Sabulis, 2015).

The most active proponents of bringing back the AFV tax credits are electric vehicle enthusiasts who lead advocacy groups, serve as elected officials, or are advocates for clean energy in Georgia. Clean Cities-Georgia, the Atlanta Electric Vehicle Development Coalition (AEVDC), and Electrify Atlanta are a few of the most passionate groups which have actively tried to persuade legislators to change their minds. The functions of these groups are summarized in the stakeholder analysis.

Two new House Bills were introduced in Georgia's 2016 Legislative Session. No action was taken on either bill, but at least an attempt was made in restructuring Georgia's AFV policies. House Bill 877 and House Bill 878 represented attempts to reconcile the current law that eliminates the income tax credits and introduces a new $200 fee. HB 877 was sponsored by Representative Margaret Kaiser. HB 877 was a reintroduction of the 2015 legislation to restructure the tax credit for buying and leasing an electric car. Under HB 877, tax credits would have been reinstated from July 1, 2017 to December 31, 2019. The tax credit levels would have changed at the 18 month mark, and the annual tax credit cap would be set at $30 million. Tax credits for EVs with battery sizes of 4.0 to 10.0 kWh would have been reduced from $2,000 to $1,000 on January 1, 2018. Tax credits would have been available for businesses who installed EV charging stations at 10% of the charger cost ($2,500 cap). Credits would also be expanded to PHEVs like the Volt. This bill was ultimately a comprehensive compromise that was worked out with the involvement of many parties. HB 877 reflected the letter and spirit of 2015's HB 220. Through this bill, income tax credit amounts would have been somewhere in between the nonexistent credits and the previous credits (Cohen, Georgia EV Tax Credit Revived?, 2016). HB 878 was sponsored by Representative Scott Holcomb. Through HB 878, the EV road use fee would have been reduced from $200 to $75 (HB 878, 2016). As discussed in the gasoline tax analysis, this fee is more accurate for typical vehicles. It is possible that an EV study committee may be formed by the Georgia State Senate sometime in the near future to reconcile the tax credit issue and form a more comprehensive solution (Cohen, Georgia EV Tax Credit Revived?, 2016).

CHAPTER 5

INTEGRATING MEASURABLE POLICY FACTORS INTO A COMPREHENSIVE CHOICE MODEL

Policy Factors Analysis

The following chapter provides a detailed summary of policy factors that may influence AFV adoption. These factors were identified by studying previous literature, and collecting data that describes different aspects of AFV policies. Each of the subsections presented herein represent a factor that may be significant in predicting AFV adoption rates in different U.S. states. The factors that were considered in previous sections are as follows: 1) gasoline prices, 2) cost competitiveness of AFVs, 3) electricity prices, 4) primary mode of travel, 5) primary owner age, 6) education of vehicle owner, 7) income of owner, 8) consumer understanding of technology benefits, 9) technology complexity, 10) technology compatibility, 11) technology trial-ability, 12) community type (rural, urban, etc.), 13) weather, 14) environmental awareness, 15) commute distances, 16) charging infrastructure availability and price, 17) vehicle availability, and 18) availability and magnitude of incentives. This analysis attempts to fill the gaps in this research by delving deeper into specific policy factors.

Reward Amount to Income Ratio

One of the major issues with electric vehicles is affordability. Generally, the capital costs of buying electric vehicles are higher than those associated with gasoline vehicles. In the long run, there are many savings associated with refueling and maintenance. However, incomes and costs of living estimates vary greatly between states, cities, and regions. A $2,500 incentive in Georgia may be more influential than a comparable incentive in California where the cost of living is higher. Each state should consider its incentive amounts separately from other states.

Ease of Policy Comprehension

Incentives are often perceived and marketed in different ways. Prior to the elimination of Georgia's incentives, the income tax credits were seen, by many, as a simple lump sum of cash. Even though many buyers did not qualify for the full income tax incentive of $5,000 or $2,500, they purchased vehicles knowing that they would receive some form of monetary compensation. Many other states' laws and incentives are much more complicated than Georgia's. For instance, many states have incentives that vary based on vehicle type, battery capacity, and model year. With Colorado's Innovative Motor Vehicle Credit, amounts vary for each category, vehicle weight, and tax year. Taxpayers must subtract credits, grants, or rebates provided by the federal government before applying the percentage calculations. Each technology type and vehicle weight class has an annual credit cap. This type of incentive introduces an element of complexity that many consumers may not want to deal with. Although this type of incentive may help balance out market conditions, states should weigh the benefits of more appropriate incentives with the costs of more complex laws.

Consumer Awareness

Consumer awareness is an important factor when analyzing alternative fuel vehicle policy. Georgia's incentives have been in the news for many years, most likely because of the state's high adoption rates. Positive publicity has made Georgia's incentives extremely popular among AFV buyers and leasers. To gauge consumer awareness, surveys should be completed in a region or state. Surveys can reveal gaps in consumer information and allow the state to market incentives to appropriate audiences.

Fuel/Vehicle Type

All 50 states in the U.S. have provided incentives for alternative fuel vehicles (Alternative Fuels and Tax Credits, 2016). Ultimately, AFV sales should be reflective of the amount of incentives available for each fuel type. **Figure 8** shows a breakdown of state and federal incentives by fuel/vehicle type. These data were taken from the Alternative Fuels Data Center and reorganized to show counts for each fuel/vehicle (All Laws and Incentives Sorted by Type, 2016). The categories shown are: electric, natural gas, biodiesel, ethanol, liquefied petroleum gas (propane), hybrid electric vehicles/plug-in electric vehicles, hydrogen/fuel cell, idle reduction, aftermarket conversion, fuel economy/efficiency, neighborhood electric vehicles, and other. Most incentives fit into more than one of these categories, so this does not reflect the overall number of incentives. Georgia's incentives generally follow this distribution, with four incentives covering electricity, and two incentives (respectively) covering natural gas vehicles, propane vehicles, HEVs/PEVs, hydrogen fuel cell vehicles, and idle reduction technologies. The appendix shows a breakdown of these incentives by state.

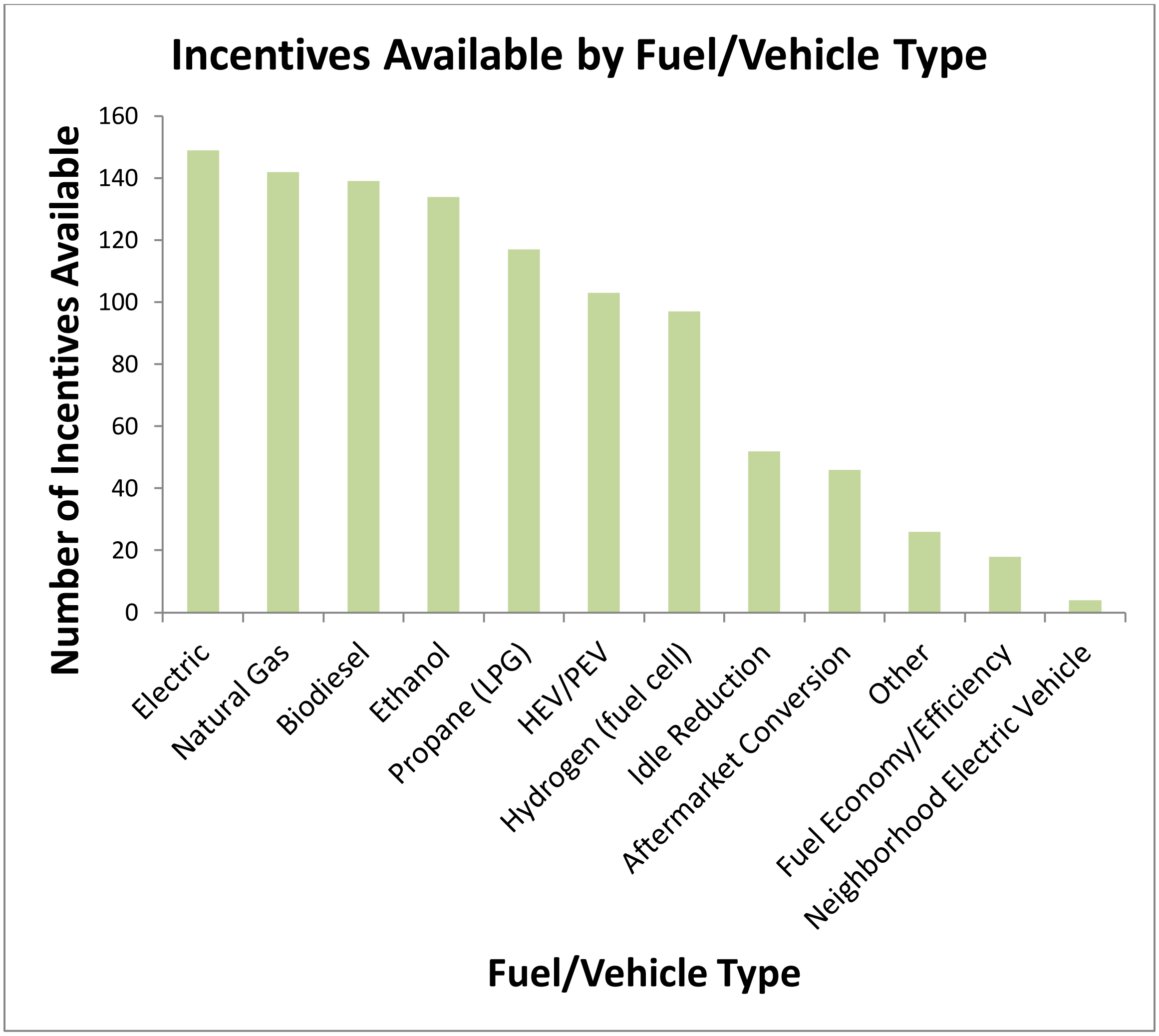

Figure 8: Alternative Fuel Vehicle Incentives by Fuel Type (Includes all State and Federal Incentives) (All Laws and Incentives Sorted by Type, 2016)

The electricity category includes all-electric vehicles and plug-in hybrid electric vehicles, while the hybrid electric vehicle category includes those vehicles that run partially on electricity and partially on another fuel.

Natural gas is a fuel that is already available through utility infrastructure throughout much of the United States. There are 300,000 miles of transmission pipes, and 1.9 million miles of distribution pipes that transport natural gas within the United States.

Natural gas must be compressed (CNG) or liquefied (LNG) to be compatible with vehicles (Natural Gas Fuel Basics, 2016).

Biodiesel is a domestically produced, renewal fuel that is often manufactured from vegetable oils, animal fats, or recycled food grease. Biodiesel is similar to petroleum diesel, but it is cleaner burning. The primary benefit of biodiesel fuel is that it reduces emissions when compared to traditional diesel fuel (Biodiesel Fuel Basics, 2016).

Ethanol is a renewable fuel made from corn and other plant material and its use is very widespread throughout the U.S. E85 contains 51%-83% ethanol and is generally used by flex-fuel vehicles that have special modifications to their engines. E15 is another type of ethanol-based fuel that contains 10%-15% ethanol and 85%-90% gasoline. E15 is the most ubiquitous type of ethanol-based fuel in the U.S. and can be found at most gas stations. It can generally be used in vehicles that were manufactured after 2001 (Ethanol Fuel Basics, 2016).

Propane, or liquefied petroleum gas (LPG) is a type of fuel that has been used across the world for many decades. It is very high-energy, clean burning, and cheap. LPG is the world's third most common transportation fuel. Propane generally costs less than gasoline and offers a comparable driving range to conventional fuel. Vehicles that use propane also incur less maintenance costs because it is a low oil-contamination fuel (Propane Fuel Basics, 2016).

Hydrogen is an emissions-free alternative fuel when used in a fuel cell. It can be produced from a range of domestic energy sources. Once in a fuel cell, hydrogen vehicles only produce water vapor and warm air. Fuel cell vehicles and hydrogen infrastructure are currently not widely available in the U.S., but are increasing in popularity (Fuel Cell Electric Vehicles, 2016).

Neighborhood electric vehicles (NEV) are smaller battery electric vehicles, such as golf carts, that are legally limited to lower speeds and certain roads. NEVs are more common on college campuses and in certain towns and cities that have a wide and interconnected path system, such as Peachtree City, Georgia (Abuelsamid, 2009).

The idle reduction category refers to technologies and practices that reduce the amount of time that engines idle unnecessarily. Reducing idle time in fleets is especially important when considering emissions. More than 6 billion gallons of diesel fuel and gasoline are consumed every year while vehicles are idling (Idle Reduction, 2016).

This analysis is important because there hasn't been significant growth in natural gas, biodiesel, and propane vehicles on the road. Electric vehicle adoption rates have increased significantly, but policy makers should also contemplate the possibility of encouraging other alternative fuels. Policies and incentives should ultimately coincide with adoption rates for each fuel type.

User Category

The number of available incentives may also influence purchase decisions for various types of users. **Figure 9** shows the distribution of incentives based on user categories: alternative fuel producer, alternative fuel dealer/seller, fleet purchaser/seller, vehicle owner/driver, AFV manufacturer/retrofitter, other, alternative fuel purchaser, and fueling/TSE infrastructure owner. Many of the incentives have multiple user categories, so this does not reflect the number of incentives available. A total of 244 of the incentives apply to fleets, while 210 incentives apply to individuals. This is in line with many of the federal policies that encourage fleets to choose alternative fuels. Fleets also have the most opportunity to positively affect emissions levels. Georgia has seven incentives that cover fleets and six incentives that cover individual vehicle owners/drivers. California, Delaware, Illinois, and Indiana have many incentives for fleets. Although many of the personal incentives are well known, policymakers should consider more elaborate and effective laws to encourage fleets to adopt AFVs. The appendix shows a more detailed breakdown of these incentive user categories by state.

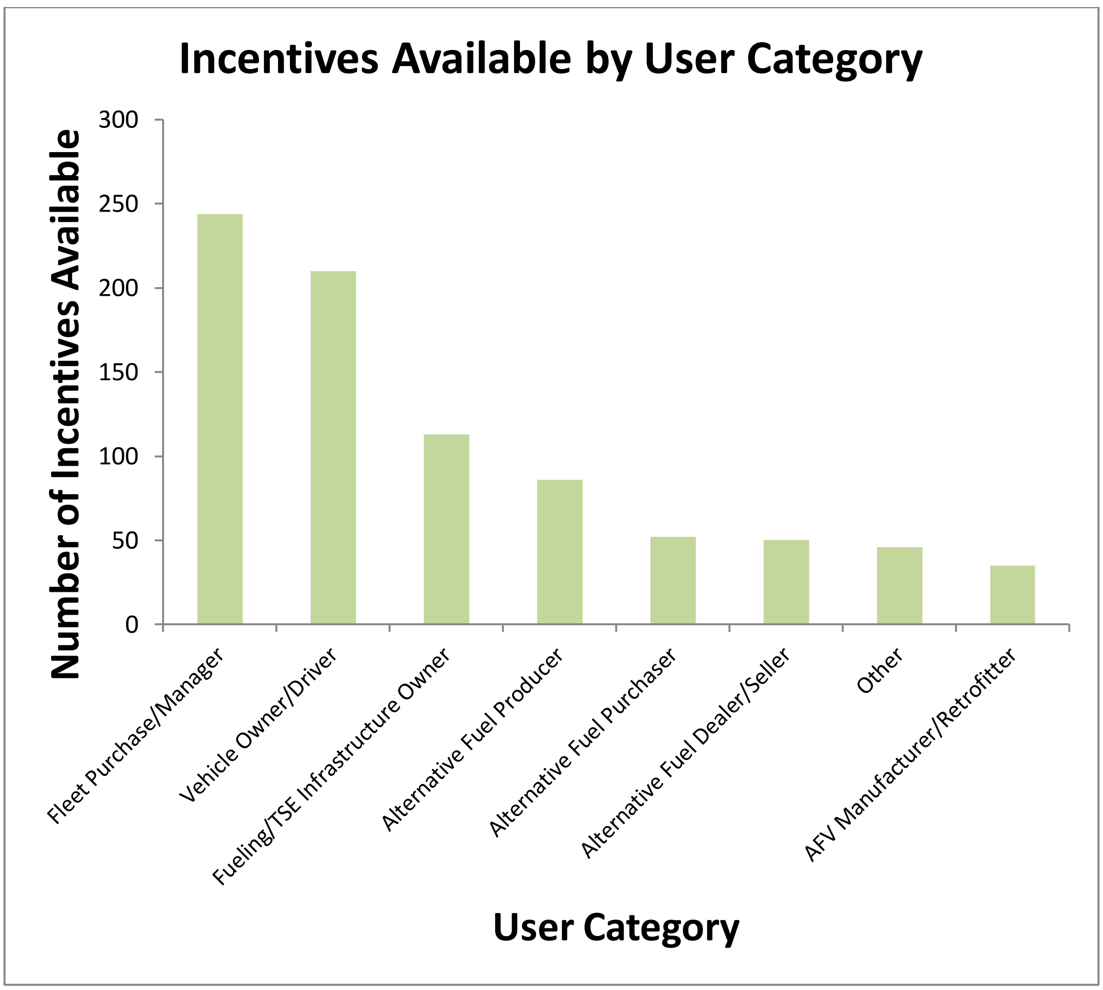

Figure 9: Alternative Fuel Vehicle Incentives Available by User Category (Includes all State and Federal Incentives) (All Laws and Incentives Sorted by Type, 2016)

Incentive Category

One of the most important metrics for incentives is the form that the incentives take. The Alternative Fuels Data Center classifies types of incentives in the following way: tax incentives, exemptions, grants, rebates, loans and leases, and other. **Figure 10** shows the distribution of these incentive types. Tax incentives and exemptions represent a large portion of the incentives. The appendix shows a breakdown of these incentives by state. Georgia has incentives primarily in the form of tax incentives, exemptions, rebates, loans, and "other". Conversely, California's primary mode of incentive delivery is through grants. The state has 14 available grants, and only two tax incentives.

It is important for policymakers to compare the effectiveness of each of these incentive types. In particular, income tax credits should be compared with grants and rebates. While exemptions are technically incentives, they do not provide anything in addition to existing resources; generally, they only create convenience.

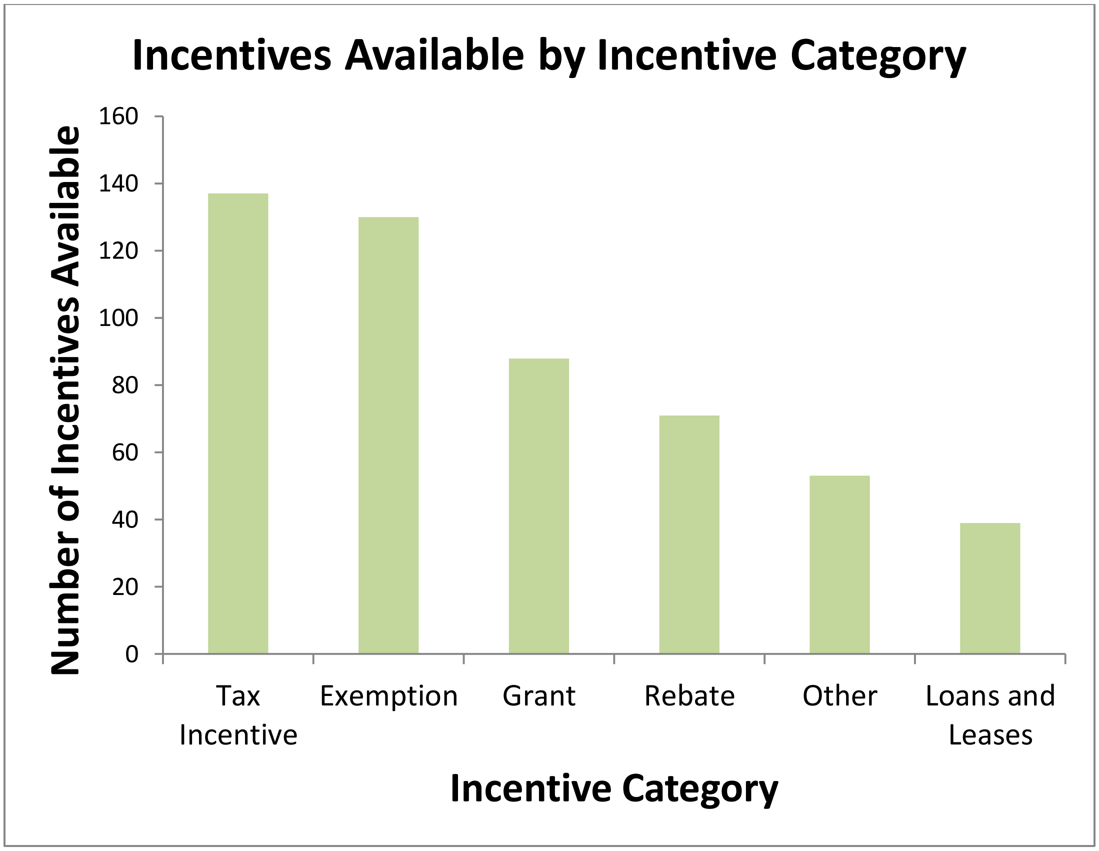

Figure 10: Alternative Fuel Vehicle Incentives Available by Incentive Category (Includes all State and Federal Incentives) (All Laws and Incentives Sorted by Type, 2016)

Number of Available Incentives

Figure 11 shows the distribution of incentives among states, with the darker states having more incentives. The only incentives included are those that are classified by the U.S. Department of Energy as "state incentives" and "utility/private incentives". Hawaii and Alaska (not shown on map) have three and one incentives, respectively. There is an apparent lack of state incentives in the southern part of the U.S. Arkansas, Louisiana, and Mississippi have three, two, and two incentives respectively. The more rural western states such as Wyoming and Idaho also have very few incentives. The most surprising states are New Hampshire, and Vermont, which have three and two incentives respectively. Vermont does not have incentives for individual consumers, but does have tax credits available to businesses that develop AFV technology. With this map reflecting the deletion of the income tax credits, it also shows the surprising lack of incentives in Georgia. The number of incentives may not be directly related to the amount of AFV adoptions; the relation may be with the magnitude of those incentives.

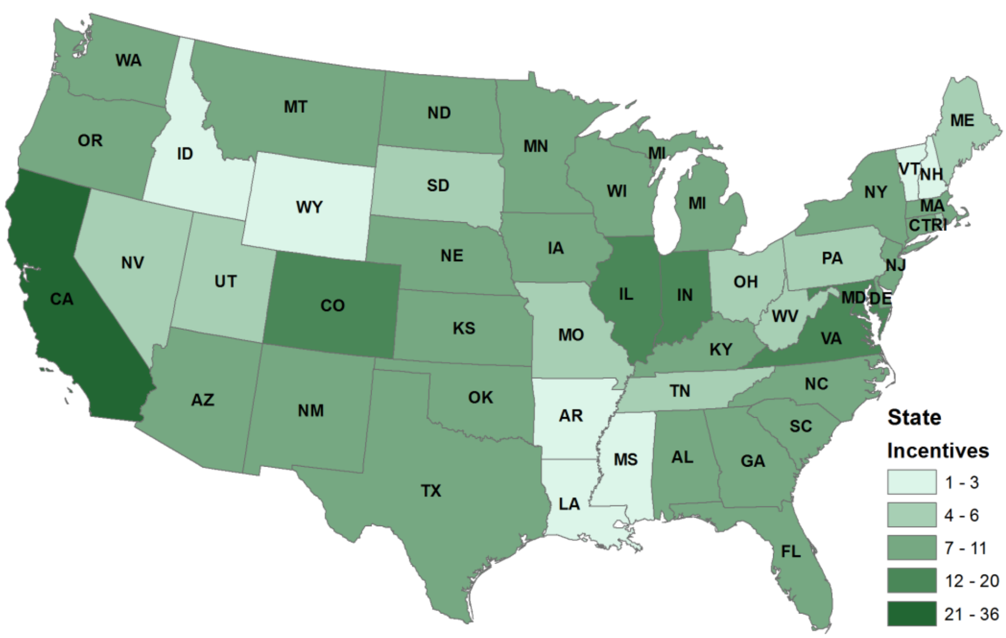

Figure 11: Amount of Incentives by State as of March, 2016 (All Laws and Incentives Sorted by Type, 2016)

Dollar Values of Incentives

One of the most important factors to consumers is the dollar amount of incentives. Reward amounts vary based on many different criteria, but consumers generally perceive incentives the way they are presented. In Georgia, incentives have been presented in the form of a lump sum, even though amounts vary and come in the form of income tax credits. Georgia's reward amounts are some of the highest in the country. Future research on government incentives should attempt to discern comparable dollar amounts (benefits) across states. This analysis would require numerous percentage conversions and data collection. If effective, this analysis could provide incentive amounts in a universal unit that could be useful for state comparisons.

Measurable Effects of Policy Factors on AFV Adoption Rates in Georgia

The primary dependent variables in this discussion are vehicle registrations and ZEV and LEV income tax credit certificate filings. Because the primary purpose of this research is to identify possible policy factors that may influence vehicle registrations and income tax credit certificate filings in Georgia, data for both registrations and certificate filings have been collected. A gasoline tax analysis is also provided to compare the new road use fee with typical gasoline taxes for other vehicles.

Vehicle Registrations

One of the best ways to assess whether a specific policy is truly influencing real world variables is to reverse that policy. By taking away the income tax credits, Georgia happened to do exactly that. **Figure 12** shows PHEV, HEV, and BEV vehicle registrations in the U.S. from 2010 to 2015 for top selling vehicles. **Figure 13** shows PHEV, HEV, and BEV registrations in Georgia from 2010 to 2015 for top selling vehicles. Obvious growth can be seen between each consecutive year. Between 2013 and 2014, PHEV, HEV, and BEV registrations in Georgia rose by almost 300%. Because of the extreme nature of the Nissan LEAF adoption rates in Georgia, **Figure 14** shows

LEAF registrations separately. **Figure 15** shows Nissan LEAF registrations by month in order to show the contrast between the latter part of 2014 and the latter part of 2015. In Georgia, a dramatic rise in LEAF registrations can be seen in May and June of 2015. This is likely attributed to consumers purposefully purchasing or leasing their vehicles before the income tax credits ended. After June, a severe decline in LEAF registrations was observed. From August to December, 2015, there were fewer than 100 LEAF registrations each month in Georgia (IHS, 2016). These data were collected by IHS Automotive, driven by Polk (acquired R.L. Polk & Co. in July 2013) and organized by Southern Company. Data were received directly from Don Francis, Executive Director of Partnership for Clean Transportation, Inc. and Coordinator for Clean Cities-Georgia. IHS Automotive generally releases data about 90 days after the end of the last month in which data are shown. Registrations are broken down by vehicle make and model. Tables with more details about these figures are provided in the appendix.

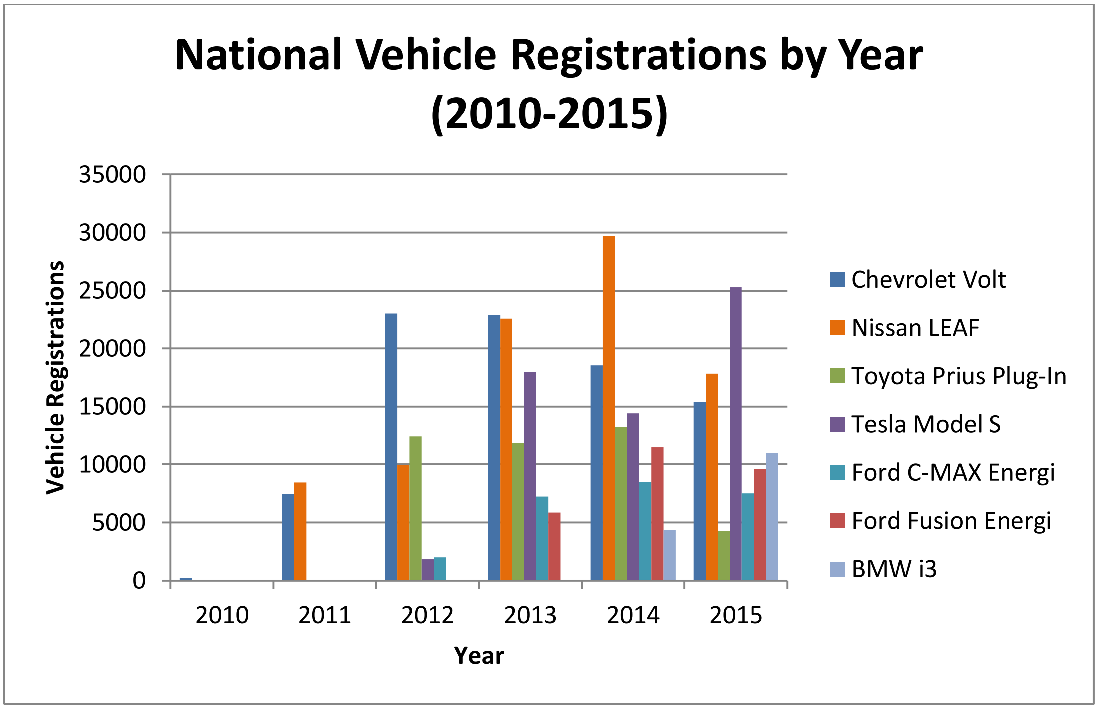

Figure 12: National Vehicle Registrations by Year (IHS, 2016)

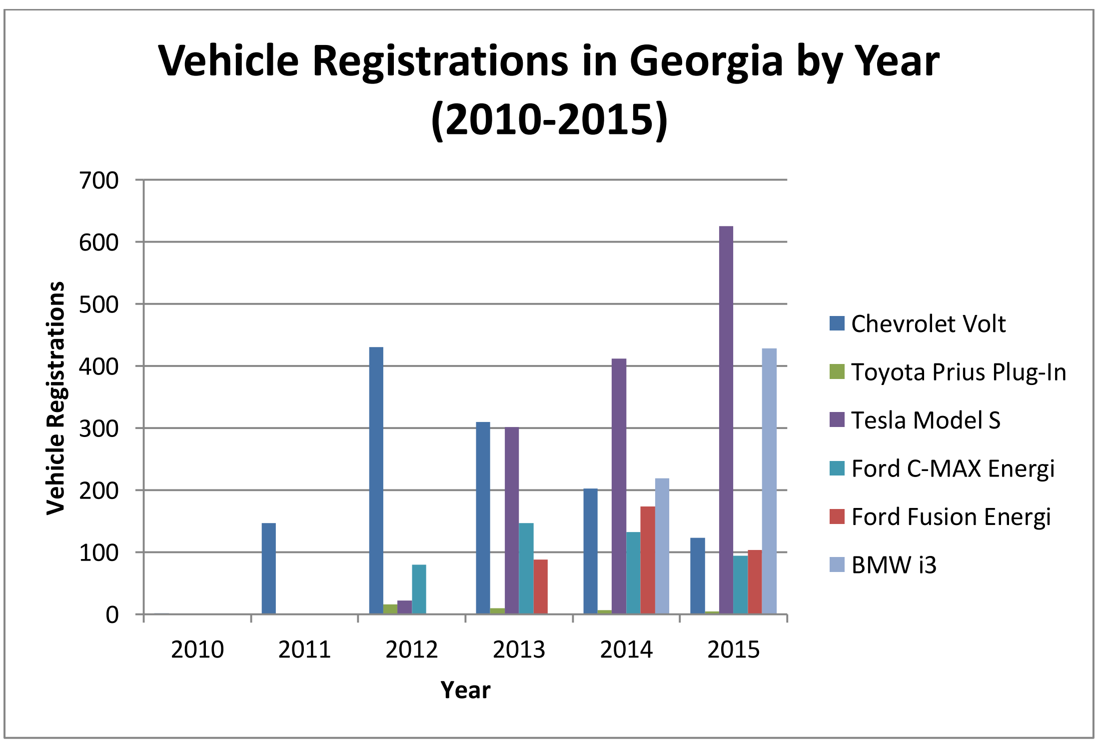

Figure 13: Vehicle Registrations in Georgia by Year (IHS, 2016)

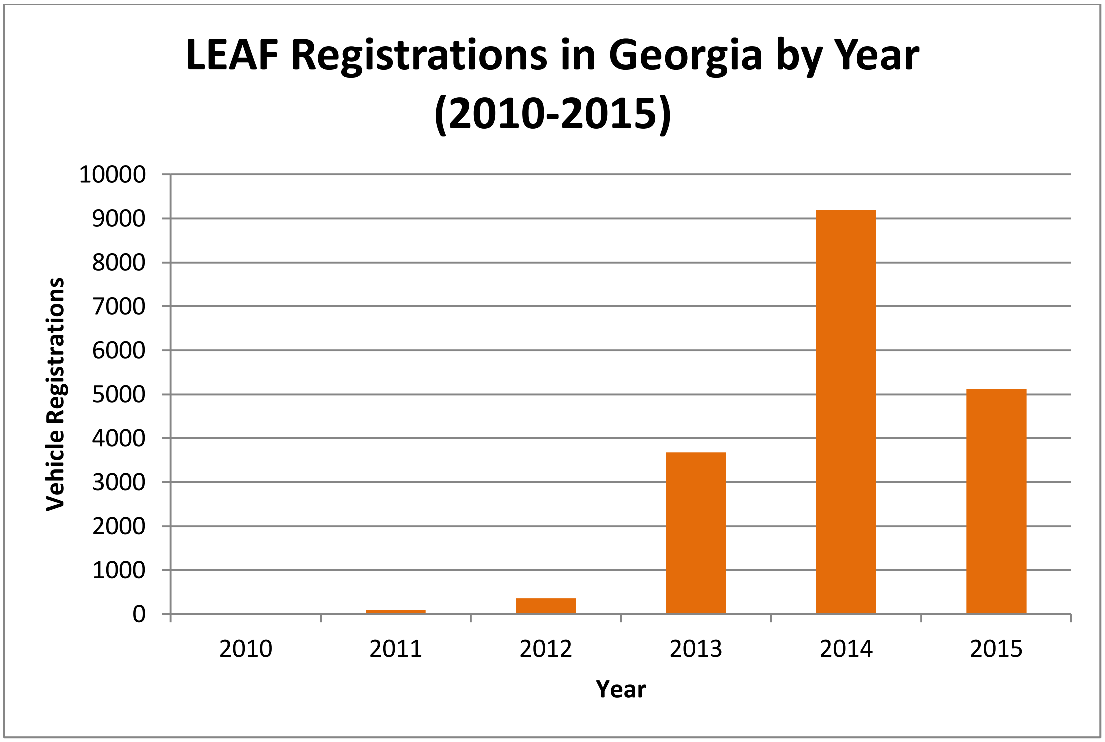

Figure 14: LEAF Registrations in Georgia by Year (IHS, 2016)

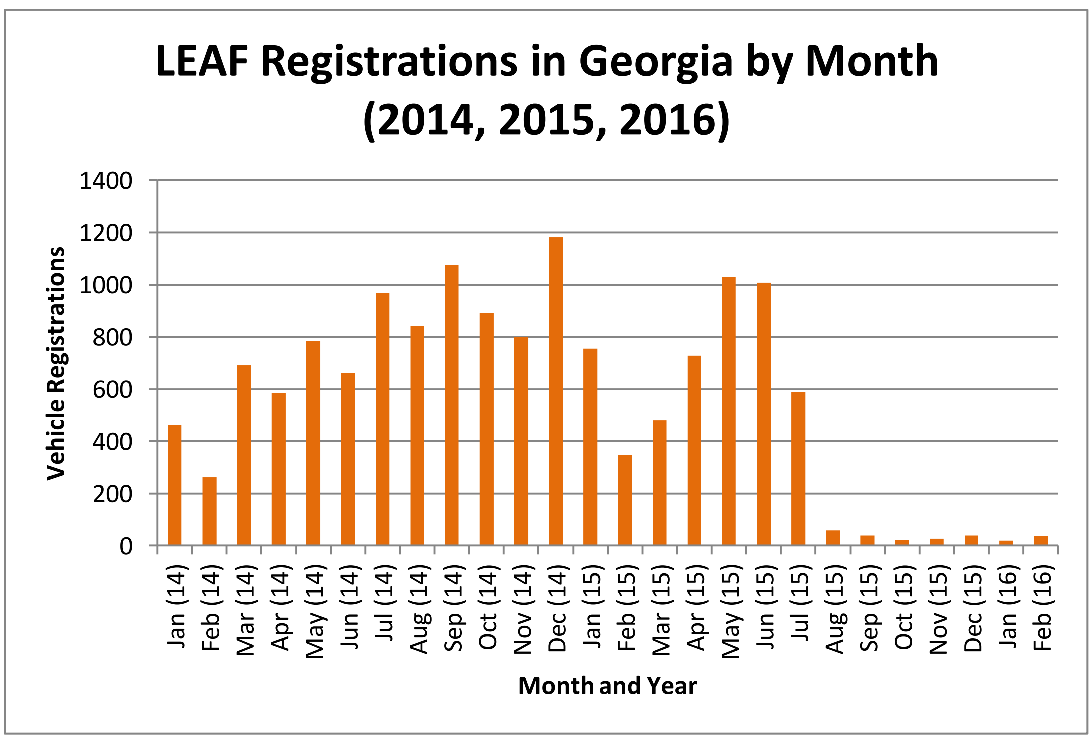

Figure 15: LEAF Registrations in Georgia by Month (IHS, 2016)

Income Tax Credit Certificates

The income tax credit certificates are the only way of tracking the incentive utilization rates in Georgia. The available data for income tax credit certificates begin in 2000 and are provided by the Georgia Department of Natural Resources. These data are split between low-emission vehicle (LEV) tax credit certificates and zero-emission vehicle (ZEV) tax credit certificates. **Figure 16** shows a breakdown of ZEV certificate utilization from 2000 to 2015. Beginning in 2012, certificate utilization began to skyrocket. Just as PHEV and HEV registrations increased dramatically in 2012, so did certificate filing. LEV and ZEV certificate utilization did not grow equally within the 15 year study period as ZEV rates increased much faster. More detailed data, which includes LEV certificate filings and data from 2016, can be found in the appendix (Georgia Department of Natural Resources, 2016).

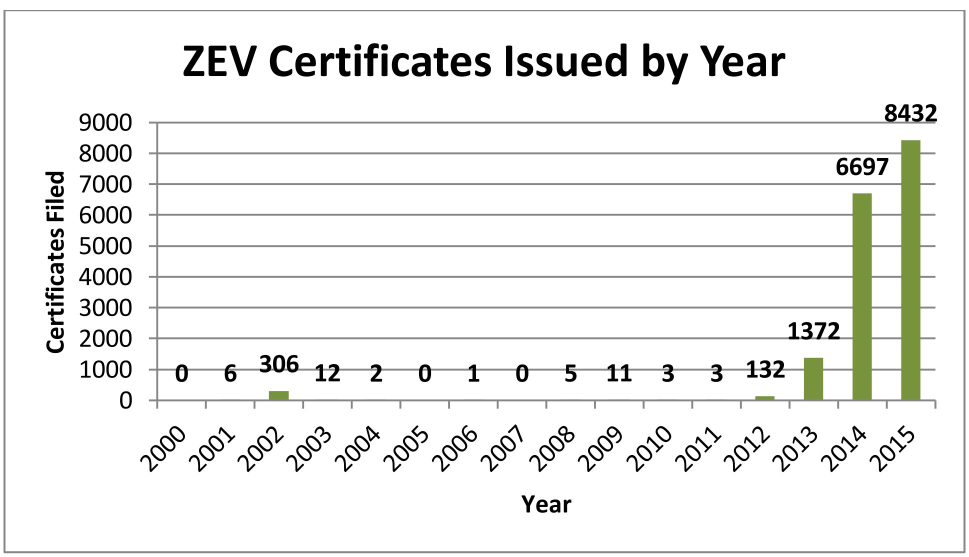

Figure 16: ZEV Certificates Issued by Year in Georgia (Georgia Department of Natural Resources, 2016)

It is also possible to track certificate filings throughout 2015 by month. **Figure 17** shows LEV and ZEV income tax credit certificate filings in 2015 by month. June was the last month in which consumers could purchase or lease LEVs or ZEVs and still be eligible for the income tax credit. This explains why there are data for the certificates after June; some consumers decided to wait and file their certificates well after they purchased or leased their vehicles. The number of people who still want to utilize the income tax credit is dwindling, but there is no way to track how many are left. Impacts of the law change, however, can be seen beginning in May, when the number of utilized certificates began decreasing significantly (Georgia Department of Natural Resources, 2016).

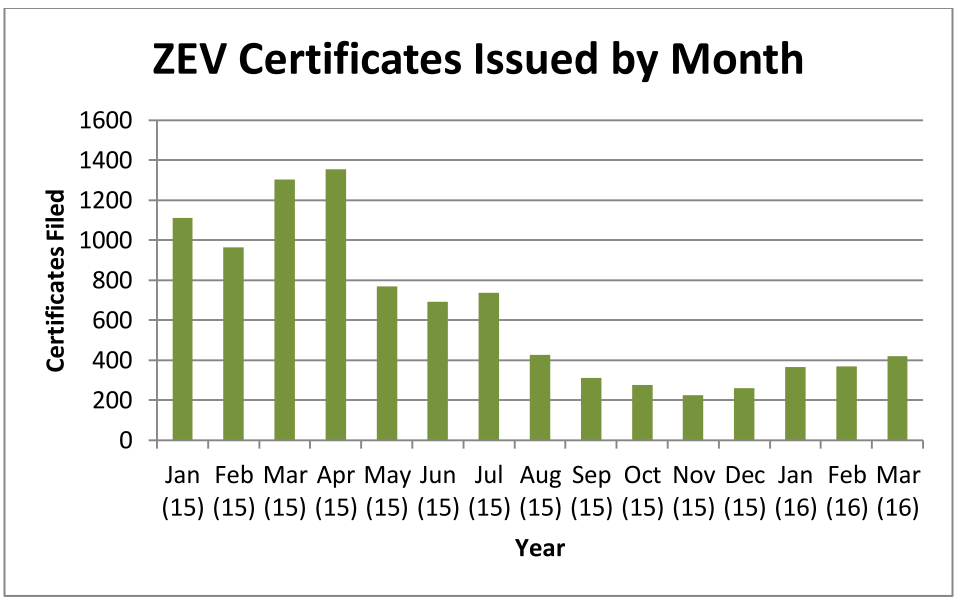

Figure 17: ZEV Certificates Issued by Month in Georgia (Georgia Department of Natural Resources, 2016)

The income tax credit certificate data does not say anything about how many individual consumers utilized the certificates. It only says how many certificates were utilized in total (during the respective period). This means that those consumers who purchased or leased more than one vehicle are not represented. Data have been collected regarding the number of taxpayers who utilized the certificates to solve this problem. **Table 10** and **Table 11** show the number of taxpayers (consumers) who utilized the LEV and ZEV certificates vs. the amount of money rewarded to those taxpayers (IHS, 2016). The average LEV and ZEV credit per taxpayer are shown. Data for 2015 are not included, but the ZEV credit dollars utilized should follow the same trend as the income tax credit certificate filings (Georgia Department of Revenue, 2014).

Table 10: LEV Income Tax Credit Certificate Filings by Taxpayer (Georgia Department of Revenue, 2014)

	LEV Credit		
Tax Year	Taxpayers	Utilized	Average per Taxpayer
2011	70	$116,319	$1,661.70
2012	63	$228,756	$3,631.05
2013	294	$1,219,737	$4,148.77
2014	214	$813,320	$3,800.56

Table 11: ZEV Income Tax Credit Certificate Filings by Taxpayer (Georgia Department of Revenue, 2014)

	ZEV Credit		
Tax Year	Taxpayers	Utilized	Average per Taxpayer
2011	54	$194,008	$3,592.74
2012	256	$1,109,805	$4,335.18
2013	3444	$14,761,545	$4,286.16
2014	9565	$38,295,970	$4,003.76

Gasoline Tax Analysis

It is important to consider gasoline tax when discussing the low-emission and zero-emission vehicle income tax credits. The proponents of HB 170 are convinced that plug-in hybrid electric and battery electric vehicle drivers should pay their fair share of taxes; hence, the additional $200 fee that is now required for PHEV and BEV drivers. This new $200 annual fee for PHEV and BEV was no based upon a detailed analysis of current taxes paid by average drivers in Georgia, which is only $114.58 per year (Francis, 2016).

Table 12 shows a breakdown of gasoline taxes paid by drivers of different types of vehicles in Georgia: SUVs, light trucks, standard cars, compact cars, hybrids, Priuses, PHEVs, and BEVs.

Table 12: Gasoline Tax and Equivalents for Vehicle Types in Georgia with Addition of $200 Road Use Fee (Francis, 2016)

Vehicle Type	MPG	Gallons/Year	Gasoline Taxes	AFV Registration Fee and Special Tag Fee	Electricity Sales Tax	Total
SUV	15	684.50	$177.98	-	-	**$177.98**
Light Truck	17.10	600.50	$156.12	-	-	**$156.12**
Standard Car	23.30	440.70	$114.58	-	-	**$114.58**
Compact	30	342.30	$88.99	-	-	**$88.99**
Sub Compact	35	293.40	$76.28	-	-	**$76.28**
Hybrid	40	256.70	$66.74	-	-	**$66.74**
Prius	50	205.40	$53.39	-	-	**$53.39**
PHEV (without AFV license plate)	37	84.10	$21.87	-	$22.79	**$44.66**
PHEV (with AFV license plate)	37	84.10	$21.87	$235	$22.79	**$279.66**
BEV	-	-	-	$235	$22.79	**$257.79**

This analysis uses a number of assumptions. The average mileage for Nissan LEAF drivers in Georgia from 2011 to 2014 was 10,268 miles/year according to Nissan North America (Fuel Economy, 2015). The miles per kWh are assumed to be 3.5, while the kWh per year are assumed to be 2,934. The cost per kWh is assumed to be $0.11, and sales tax is assumed to be 7%. Miles per gallon (MPG) values were taken from the U.S. Department of Transportation Statistics tables for average fuel efficiency of light duty vehicles (Bureau of Transportation Statistics, 2015). The Chevrolet Volt's combined fuel economy was used for the PHEV values and is estimated by the U.S. Environmental Protection Agency at 60 MPG equivalent (MPGE), with 95 MPGE in electric-only mode and 37 MPGE while running primarily on gasoline. According to data from the U.S. DOE's EV Project, Volts are driven 12,238 miles per year on average with 9,112 electric miles and 3,126 gasoline miles (The EV Project, 2015). This analysis was provided by Don Francis, Executive Director of Partnership for Clean Transportation, Inc. and Coordinator for Clean Cities-Georgia.

Through the current AFV license plate fee system, PHEVs and BEVs are paying more than SUVs, the least efficient vehicle type in the list. Policymakers should build on previous proposals for the fee and equalize it with other vehicles. At most, the fee should match what a standard car might pay (i.e. $114.58).

Summary

The following factors were identified as possible contributors to differentiation in AFV adoption among U.S. states: 1) reward amount to income ratio, 2) ease of policy comprehension, 3) consumer awareness, 4) fuel/vehicle coverage of incentives, 5) incentive user groups, 6) forms of incentives (grants, income tax credits, etc.), 7) number of incentives available, and 8) dollar values of incentives. After the elimination of the AFV income tax credits in Georgia on June 30, 2015, Nissan LEAF sales in Georgia dropped dramatically. This drop in EV sales may help policymakers and researchers better understand the effect of incentive availability on AFV adoption.

CHAPTER 6

CONCLUSIONS, RECOMMENDATIONS, AND FUTURE RESEARCH

Recommendations

As shown in the state policy analysis, there are many alternative policies implemented in other states that could be implemented effectively in Georgia. These policies could likely please both sceptics and advocates of AFV incentives. The following section attempts to provide succinct recommendations for moving forward with AFV policy development in Georgia.

Reconsidering Elimination of Income Tax Credits

The adoption and subsequent elimination of electric vehicle purchase incentives in Georgia clearly indicates that incentives are an effective way to encourage EV adoption. As soon as the LEV and ZEV income tax credits were eliminated, the decrease in EV adoption was dramatic. House Bills 877 and 878 represent a great attempt at reconciling these issues by lowering the maximum incentive award amount and decreasing the annual AFV fee to a more appropriate level. Until EVs become the primary vehicle type and emissions have been reduced to healthier levels, the incentives appear to be needed to encourage future AFV adoption. Reinstating the incentives, perhaps with smaller caps, will assist in this transition.

Policies may be Transferable Between Jurisdictions

It is important that policymakers in each state review and consider policies developed and implemented in other U.S. states. Georgia should consider the possibility of providing incentives through a more complex system. One of the major trends in AFV policy to award income tax credits, grants, and rebates based off of income. California is a great example of a state that has attempted to provide incentives that will encourage lower income drivers to purchase EVs. However, policies implemented in other states may need to be tailored to Georgia drivers. Policymakers must always consider the driving habits of Georgia citizens and should not automatically conclude that policies are completely transferrable from other states.

Surveys

Surveys are an important step in assessing the effectiveness of any decision-making process. Policymakers should consider surveys as a method for gauging consumer demand and the influence of incentives on purchase decisions. For instance, many consumers in Georgia may be satisfied with an incentive that is somewhere in between the previous amount and no incentive at all. Surveys should be distributed and organized by market region. For instance, the Atlanta Metropolitan area should be considered separately from the rest of Georgia. There are also standard public policy research tools for gauging public awareness that should be undertaken. As noted earlier, continued incentive will likely be necessary to support a transition to an electric vehicle future (McMahon, 2016).

Set Adoption Goals and Decrease Incentives Accordingly

As AFVs (EVs in particular) penetrate the market and become a larger portion of the world's fleet, incentive amounts should be adjusted. Countries, states, regions, and cities should set adoption goals and decrease incentives as consumers switch from gasoline to electricity (or some other cleaner burning fuel). Ultimately, incentives will likely be eliminated. Once electric cars become the primary vehicle type, there will be no need for incentives.

Ensuring Justified Motivations for Policy Decisions

Policymakers may also want to consider the implications of encouraging alternative forms of energy. In the U.S., AFV incentives exist because the federal government decided to step in and start tackling climate change and air quality. To remain true to these ideals, state policymakers may want to look at environmental impacts of legislation, in particular the effects that emissions have on air quality and respiratory health. Furthermore, gasoline is not a sustainable form of energy. With the correct infrastructure and planning, electricity can be produced indefinitely. It is also important to consider reducing foreign oil dependency. Electricity can be produced through renewable sources such as biomass, geothermal, solar, and wind energy.

Moreover, policy decisions may be justified based on local economic conditions. In Georgia, electric vehicle sales represent a large part of the economy. The automobile market is trending towards electric vehicles, so policymakers may want to consider the influence of government incentives on AFV adoption. AFV sales have declined significantly since the income tax credits were eliminated in Georgia. In the long run, this may affect vehicle dealership profits.

EVs as the Primary Vehicle Type

As EV market penetration increases, it is inevitable that gasoline vehicles will be replaced. Policymakers should consider a future where EVs are the primary vehicle type. While the new $200 fee in Georgia begins to tackle this issue by addressing the lack of taxes collected from EV drivers, this solution runs counter to incentivizing this future market. As previously stated, AFV incentives may eventually become unnecessary to prime the market as EVs gain market share. At this point in time, however, policymakers should consider setting up a taxation system (similar to gasoline tax) that more equitably taxes drivers as a function of road consumption.

By the end of this century, the term “alternative fuel vehicle” may have a completely different definition. Gasoline vehicles may have been phased out, new types of energies may have been implemented, and electric vehicles may be considered normal. Tesla’s recent Model 3 announcement makes this future more tangible; Tesla received around 200,000 orders for its Model 3 within 24 hours of accepting down payments (Isidore, 2016). This represents a huge movement towards electric vehicles and hints at a dramatic change in EV market penetration.

Conclusions

Many states are beginning to form innovative laws that tackle changing vehicle markets. States have demonstrated that laws, regulations, and incentives can be effective in increasing adoption rates, can be matched with local markets, and can vary based on factors such as income, vehicle type, and battery capacity. Based upon the decline in electric vehicle purchases in Georgia after the elimination of the $5,000 tax credit and imposition of the $200/year registration fee, it seems clear that some kind of incentives are likely to be necessary to encourage electric vehicle adoption. Such incentives may need to be presented in a manner that consumers can better understand. Consumer awareness and comprehension is an extremely important factor in influencing adoption rates.

Vehicle manufacturers and consumers are not the only parties who are affected by the changing vehicle market. Gasoline companies, battery manufacturers, local governments, advocacy groups, and federal entities all have a stake in AFV policies.

This thesis has attempted to identify measurable policy factors in the literature that appear to affect AFV adoption rates and ultimately affect the vehicle market. Through the literature review, the following factors are most likely responsible for differentiation in AFV adoption rates: 1) gasoline prices, 2) cost competitiveness of AFVs, 3) electricity prices, 4) primary mode of travel, 5) primary owner age, 6) education of vehicle owner, 7) income of owner, 8) consumer understanding of technology benefits, 9) technology complexity, 10) technology compatibility, 11) technology trial-ability, 12) community type (rural, urban, etc.), 13) weather, 14) environmental awareness, 15) commute distances, 16) charging infrastructure availability and price, 17) vehicle availability, and 18) availability and magnitude of incentives. In particular, this thesis has found that the following factors may contribute to fluctuating adoption rates between states: 1) reward amount to income ratio, 2) ease of policy comprehension, 3) consumer awareness, 4) fuel/vehicle coverage of incentives, 5) incentive user groups, 6) forms of incentives (grants, income tax credits, etc.), 7) number of incentives available, and 8) dollar values of incentives. In Georgia, a dramatic decrease in EV adoption occurred with the elimination of the LEV and ZEV income tax credits. The number of available AFV options, the amount of EV infrastructure, and EV battery ranges are all increasing, while the costs of AFVS are decreasing. There is likely no other explanation for Georgia's decreasing EV adoption rate other than the elimination of the income tax credits. A full statistical analysis of purchase decisions is recommended based on previously identified factors and adoption rates in different markets.

Although electric vehicle adoption rates have increased throughout the world and more consumers are purchasing EVs every day, the significant decline in purchases after the incentives were eliminated indicates that there is still likely a need for incentives that encourage alternative fuels in Georgia. A compromise could be reached between lawmakers who oppose and support AFV incentives. As EVs slowly replace gasoline vehicles as the primary vehicle type, laws should be reconsidered and readjusted accordingly.

Future Research

Future research should focus on forming choice models that can pinpoint statistically significant factors and variables. In order to complete this analysis, sales figures (collected separately for each market) should be compared to changes in policy variables that may influence AFV adoption. Through factor analysis and regression, these factors can be proven and made conclusive. Primarily, reward amounts of incentives between different U.S. states should be compared through a common unit (i.e. percentage of lifetime vehicle costs). This type of analysis should also factor in cost of living and household median income in order to accurately compare incentives between markets. Research may also be expanded to every U.S. state and countries throughout the world. The AFV market is constantly changing, and research should frequently be reworked.

Additionally, future research may include information about increasing availability and affordability of AFVs as compared to availability of incentives. For example, manufacturer's suggested retail price (MSRP) throughout the model years should be collected to assess the decreasing barriers to AFV adoption. The MSRP for EVs in particular, are very dependent on battery costs.

A cost-benefit analysis of incentives may also be useful. This would require estimation of the costs to the economy of the incentives (increasing taxes elsewhere to compensate) and the benefits of moving to EVs, which includes quantifying environmental benefits, health benefits, energy security benefits, etc. A full resource economics analysis for the state of GA should be conducted.

Methods from the literature review may be useful for a detailed market analysis that includes the aforementioned policy factors. Ideally, a choice model should initially include all likely variables. These variables can then be combined into factors that more accurately capture independent variables. A detailed factor analysis should be used in this case.

APPENDIX A

Table 13: Alternative Fuel Vehicle Incentives by Fuel Type (Includes All State and Federal Incentives) (All Laws and Incentives Sorted by Type, 2016)

	ELEC	NG	BIOD	ETH	LPG	HEV	HY	IR	AFTMKTCONV	OTHER	EFFEC	NEVS	**TOTAL**
AK								1					**1**
AL		2	2	1	2			3	2				**12**
AR		2			1			1	1				**5**
AZ	6	5			5	5	4	1					**26**
CA	17	11	4	3	7	14	10	2	4	8	2	1	**83**
CO	6	8	2	2	5	5	3	2	3	1			**37**
CT	5	1	1	1	1	5	2	1		1			**18**
DC	3	3	2	2	3	2	3		1		2		**21**
DE	5	3	1	1	3	2	2	1	1	1			**20**
FL	2	1	3	3	1	1	1	1	1				**14**
GA	4	2	1	1	2	2	2	2	1	1			**18**
HI	1			1		1						1	**4**
IA	1	2	5	6	1		3						**18**
ID	1	1	2		1	1	1						**7**
IL	8	4	6	7	4	5	3	3	2		1		**43**
IN	5	10	8	6	7	3	3	1	5	1	2		**51**
KS		2	5	7	2			1	1				**18**
KY		1	4	4	2								**11**
LA	1	1	1	1	1				1				**6**
MA	5	1		1	1	5		2	1				**16**
MD	6	2	2	3	2	4	1	2	1	1	1		**25**
ME	1		2	1				1				1	**6**
MI	2	3	1	1	2	1	1						**11**
MN				3				2					**5**
MO	2	2	2	2	2	1	2	1					**14**
MS	1	1	1	1	2	1			1				**8**
MT		1	5	4	1		1		1				**13**
NC	6	4	6	6	4	3	4	2	1				**36**
ND		1	7	5									**13**
NE	1	5	1	3	4		3	1	1				**19**
NH	1					1		2	1	1	1		**7**
NJ	3				1	3				1	1		**9**
NM	2	2	6	4	2	1	4	1	1				**23**
NV	2	2			2	2	2						**10**
NY	5	4	2	3	1	6	3	1	1	2	2		**30**
OH	2	4	2	2	3		1	2					**16**
OK	2	3	3	5	3	1	3	1	1				**22**
OR	5	5	5	5	4	2	3	2	3		1		**35**
PA	2	1	2	2	2	1	2	2			1		**15**
RI	3		1			2	1			1			**8**
SC	2	3	4	4	3	4	4	1					**25**
SD			2	2	1					1			**6**
TN	2	1	1	1		2		1					**8**
TX	4	4	4	3	4	2	4	2	3	1	1		**32**
US	8	9	15	15	7	5	7	1	2	3	2	1	**75**
UT	4	5			3	1	1		1		1		**16**
VA	4	7	9	7	5	3	7	1	1	2			**46**
VT	1	1	2	1	1	1	1						**8**
WA	6	4	1		3	4	2	1	1				**22**
WI	2	2	3	2	2	1	3	2					**17**
WV		6	3	2	4			1	2				**18**
TOTAL	**149**	**142**	**139**	**134**	**117**	**103**	**97**	**52**	**46**	**26**	**18**	**4**	**1,027**

Table 14: Alternative Fuel Vehicle Incentives Available by User Category (Includes All State and Federal Incentives) (All Laws and Incentives Sorted by Type, 2016)

	FLEET	IND	STATION	AFP	PURCH	AFS	OTHER	MAN	TOTAL
AK	1	1							**2**
AL	5	3	4	1	1	1	1		**16**
AR	3	1	1						**5**
AZ	5	8							**13**
CA	26	22	11		7		6	5	**77**
CO	9	7	5	1	1	1		2	**26**
CT	5	5	1	1			1		**13**
DC	2	3	1						**6**
DE	10	6	5		2	1	1		**25**
FL	5	3	3	4		1	3	2	**21**
GA	7	6	3		1		2	1	**20**
HI	2	2		1					**5**
IA	1		5	4		3	1		**14**
ID	1	1		1	1		1		**5**
IL	11	7	5	2	3	2	1	1	**32**
IN	14	9	3	4	5	1	2	2	**40**
KS	3	3	2	5		2			**15**
KY	1	1	2	4	2	2	2		**14**
LA	2	1	1					1	**5**
MA	4	5	4	1	1	1	1		**17**
MD	8	8	3	1			2		**22**
ME	2	2		2					**6**
MI	3	6	3	1			2		**15**
MN	3	4	2	1			1	2	**13**
MO	3	2	1	2					**8**
MS	1				1	1			**3**
MT	1	1	2	5	1	3	1		**14**
NC	6	3	3	2	3	2		1	**20**
ND			2	5		3	1		**11**
NE	5	6	2	1	2	3	1	1	**21**
NH	2	1	1					1	**5**
NJ	5	6	1		1				**13**
NM	2	1	1	3	2	3	1	1	**14**
NV	3	4							**7**
NY	7	7	2	2	1	2		1	**22**
OH	3	2	2		1		1	3	**12**
OK	6	7	5	2	1	1			**22**
OR	6	5	4	2	1	1		1	**20**
PA	4	4	1	1	1			1	**12**
RI	2	3		1	1	1			**8**
SC	5	2	1	2		1	1	1	**13**
SD	1	1	1	3	2	2			**10**
TN	5	6	2	1		1			**15**
TX	7	8	2		1	1	1		**20**
US	11	6	4	9	1	4	5	1	**41**
UT	5	5	1		1				**12**
VA	6	6	3	7	2	1	4	2	**31**
VT	1						1	2	**4**
WA	6	4	6	4	2	2	1	2	**27**
WI	4	4			1	1	1	1	**12**
WV	4	2	2		2	2			**12**
TOTAL	**244**	**210**	**113**	**86**	**52**	**50**	**46**	**35**	**836**

Table 15: Alternative Fuel Vehicle Incentives Available by Incentive Category (Includes All State and Federal Incentives) (All Laws and Incentives Sorted by Type, 2016)

	TAX	EXEM	GNT	RBATE	OTHER	LOANS	TOTAL
AK		1					**1**
AL	1	1	1	1	2	2	**8**
AR			1	1		2	**4**
AZ	3	5	1		1		**10**
CA	2	2	14	13	12	4	**47**
CO	3	7	4		1		**15**
CT		2	3	2	1		**8**
DC	2	3					**5**
DE	1	2	2	4	2		**11**
FL	2	3	1	4	1	1	**12**
GA	4	2		1	1	1	**9**
HI	1	1			1		**3**
IA	6		2		1		**9**
ID	1	3					**4**
IL	2	7	5	5	2	2	**23**
IN	8	4	4	4	4		**24**
KS	5	3		2		2	**12**
KY	4	1	3		1		**9**
LA	1		1				**2**
MA	1	3	3	2			**9**
MD	4	2	2	2	3		**13**
ME	2	3					**5**
MI	1	3		3	4		**11**
MN	1	2	1	2	1	1	**8**
MO	1	2	2	1			**6**
MS			1			1	**2**
MT	8	2					**10**
NC	2	5	3				**10**
ND	4		2			3	**9**
NE	3	2		4		1	**10**
NH		1	1	1			**3**
NJ	2	4		1		2	**9**
NM	6	2	1				**9**
NV		3			1		**4**
NY	3	6	1	1	2	1	**14**
OH		2	3		1	1	**7**
OK	5	3		1	1	3	**13**
OR	4	4				2	**10**
PA		1	3	2			**6**
RI	2	3		1			**6**
SC	5	2			1	3	**11**
SD	4	1	1	1			**7**
TN	1	2	1	2			**6**
TX	1	2	5	3	1		**12**
US	12	3	8	1	4	4	**32**
UT	3	2	1			1	**7**
VA	4	6	5	1	2	1	**19**
VT	1				1		**2**
WA	5	7		2	1		**15**
WI	3	3	2	1			**9**
WV	3	2		2		1	**8**
TOTAL	**137**	**130**	**88**	**71**	**53**	**39**	**518**

Table 16: Vehicle Registrations in Georgia in 2015 by Month (IHS, 2016)

Vehicle	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Chevrolet Volt	22	7	3	31	13	6	9	3	4	7	7	11
Nissan LEAF	756	348	479	727	1,029	1,008	588	58	38	22	27	38
Toyota Prius Plug-in	1	1	0	1	1	1	0	0	0	0	0	0
Tesla Model S	99	23	65	71	38	123	84	28	29	40	15	11
Ford C-MAX Energi	5	4	9	10	13	8	7	5	8	9	4	12
Ford Fusion Energi	6	9	10	9	7	10	7	9	9	9	9	10
BMW i3	48	25	50	44	52	104	39	12	23	12	6	16
Remaining PHEV	8	6	3	7	6	7	11	9	8	8	11	22
Remaining EREV	1	4	3	5	3	5	0	0	1	2	0	1
Remaining BEV	5	7	13	28	36	66	31	10	8	6	3	3
Hybrid Electric Vehicles	610	552	675	661	788	687	754	669	726	550	500	654
Conv. Vehicles	38,820	35,914	44,871	40,699	41,304	42,813	42,864	39,365	46,310	39,495	44,177	44,177
Total Plug-In Electric Vehicles	40,381	36,900	46,181	42,293	43,290	44,838	44,393	40,168	47,163	40,161	38,211	44,955

Table 17: Vehicle Registrations in Georgia from 2010 to 2016 (IHS, 2016)

Vehicle	2010	2011	2012	2013	2014	2015	2016 (as of Feb)
Chevrolet Volt	1	147	431	310	203	123	15
Nissan LEAF	0	94	362	3,676	9,201	5,118	55
Toyota Prius Plug-in	0	0	16	10	7	5	0
Tesla Model S	0	0	22	302	412	626	59
Ford C-MAX Energi	0	0	80	147	132	94	8
Ford Fusion Energi	0	0	0	88	174	104	15
BMW i3	0	0	0	0	219	429	35
Remaining PHEV	0	0	33	17	11	107	38
Remaining EREV	0	0	0	0	25	25	1
Remaining BEV	2	5	14	85	156	216	13
Hybrid Electric Vehicles	5,497	5,670	9,002	10,943	10,230	7,826	1,117
Conventional Vehicles	322,192	361,372	389,532	419,898	443,738	494,261	85,381
Total	327,692	367,288	399,492	435,476	464,508	508,934	86,737

Table 18: Vehicle Registrations in the U.S. from 2010 to 2015 (IHS, 2016)

Vehicle	2010	2011	2012	2013	2014	2015
Chevrolet Volt	209	7,453	22,996	22,913	18,563	15,402
Nissan LEAF	6	8,442	9,949	22,575	29,669	17,815
Toyota Prius Plug-in	0	0	12,436	11,891	13,273	4,234
Tesla Model S	0	0	1,825	18,001	14,411	25,295
Ford C-MAX Energi	0	0	1,985	7,214	8,516	7,527
Ford Fusion Energi	0	0	41	5,834	11,500	9,628
BMW i3	0	0	0	0	4,347	10,982
Remaining PHEV	0	0	836	842	1,071	3,655
Remaining EREV	0	0	0	3	1,411	915
Remaining BEV	268	945	2,356	7,839	14,966	18,725
Hybrid Electric Vehicles	273,718	258,653	396,833	470,785	442,748	368,221
Conventional Vehicles	11,205,533	12,382,424	13,864,909	14,811,522	15,792,927	16,700,291
Total	11,479,734	12,657,917	14,314,166	15,379,419	16,353,402	17,182,690

Table 19: LEV and ZEV Income Tax Credit Certificate Filings from 2000 to 2016 (IHS, 2016)

Calendar Year	LEV Tax Credit Certificates	ZEV Tax Credit Certificates	Total
2000	2	0	2
2001	0	6	6
2002	0	306	306
2003	0	12	12
2004	4	2	6
2005	0	0	0
2006	0	1	1
2007	0	0	0
2008	0	5	5
2009	47	11	58
2010	0	3	3
2011	1	3	4
2012	1	132	133
2013	34	1,372	1,406
2014	100	6,697	6,797
2015	37	8,432	8,469
2016 (to Mar.)	0	1,158	1,158
Total	226	16,982	17,208

Table 20: LEV and ZEV Income Tax Credit Certificate Filings in 2015 and 2016 by Month (IHS, 2016)

Month	LEV	ZEV
January (15)	0	1,112
February (15)	1	965
March (15)	0	1,304
April (15)	0	1,354
May (15)	13	769
June (15)	11	691
July (15)	0	737
August (15)	1	427
September (15)	0	311
October (15)	0	276
November (15)	11	225
December (15)	0	261
January (16)	0	367
February (16)	0	370
March (16)	0	421

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