The Danish Consumer Interests Regarding Electric Vehicles

An Interactive Qualifying Project

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Submitted on: 3/5/2014

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Abstract

We summarize the Danish consumers' interests and concerns regarding electric vehicles for the use of the Danish Consumer Council. To gain a strong understanding of the consumers' interests we will utilize extensive background research, individual interviews, focus groups, and consumer surveys. We will analyze our findings and then communicate the consumers' perspective the Danish Consumer Council so they may better protect the consumers' interests. Electric vehicles can be an instrumental part in reaching Denmark's goal of becoming carbon neutral by 2050.

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1. Introduction

Emissions from burning fossil fuels are contributing to air pollution, ozone layer depletion, and global climate change. World energy needs are steadily increasing and one alarming fact is the world consumption of oil has increased by 61.4% over the past 30 years, from 57 million barrels per day to 92 million barrels per day (Oil Market Report, 2014 & IndexMundi, 2011). Additionally, 61.5% of total oil consumption is consumed in the transportation sector with 85% of that oil used in road transportation alone (Rodrigue & Comtois, 2013). Electric Vehicles provide a significant opportunity to reduce the global oil consumption and in turn reduce the world's dependency on fossil fuels.

Denmark is an environmentally conscious country and has developed a strategic energy plan in order to combat their fossil fuel emissions. They have an ambitious goal of becoming the first fossil fuel free country by the year 2050 (Borreskov, 2012). To achieve this goal the Danish government invested significant amounts of money in alternative energy sources such as wind power. As a result they are now the world leader with 30% of their electricity being produced through wind power (Shahan, 2012). The government also developed a number of tax incentives designed to promote electric vehicles and reduce the carbon emissions in the transportation sector. For example, gas-powered automobiles are taxed at a 180% rate while electric vehicles are exempt from that tax. The Danish government also offers a $40,000 tax break to electric vehicle purchasers (Bergman, 2010). Even with these major incentives only 647 electric vehicles were sold in Denmark in 2013, which highlights the lack of consumer adoption (Marth, 2013). These barriers continue to limit the development of the electric vehicle industry.

In order for electric vehicles to reduce the amount of fossil fuels consumed, consumers must continue purchasing and utilizing electric vehicles in larger numbers. Our sponsor, the Danish Consumer Council, identifies how they can better represent and protect consumer interests. They have a responsibility to inform and advise consumers on the advantages and disadvantages of products and services. Regarding electric vehicles, the Danish Consumer Council wants to inform consumers on the costs, benefits, incentives, and downsides of owning

an electric vehicle. The Danish Consumer Council has a vague understanding of the general consumer opinion regarding electric vehicles, and intends to gain a more in-depth understanding in order to identify a solution for the acceptance of electric vehicles for the near future.

Offering incentives such as free access to toll roads, free charging stations, and free parking have been instrumental in catapulting Norway to be the world leader in electric vehicles (Bevenger, 2013). Denmark has implemented many of the same incentives, but they have not achieved the same level of success enjoyed by their Scandinavian neighbor Norway. Understanding the reasons that electric vehicles have not been highly adopted by consumers in Denmark is a central objective for this project. One major barrier is the failure of Better Place, a $850 million investment program designed to develop electric vehicle infrastructure that went bankrupt in 2012 (Farber, 2013). The program was primarily focused in Denmark and Israel but after its massive failure the result was a generally negative opinion of electric vehicles in Denmark.

Our project intends to identify the Danish consumers' views and opinions regarding electric vehicles and then support the Danish Consumer Council as they gain a better understanding on how to represent the consumer. We intend to utilize the Consumer Council's quarterly survey as well as interview leading edge professionals in the electric vehicle industry to identify major issues and barriers to electric vehicle uptake. This research will summarize the collected data into a compiled report for the access of the Danish Consumer Council. Determining the Danish consumers' interest in electric vehicles will provide the Danish Consumer Council with a plan of action to promote the acceptance of the EV industry and in turn reach Denmark's carbon neutral goals.

2. Literature Review

The term consumer is defined as a person or organization that uses a commodity or service. Consumer interests can heavily influence the products and services they use as companies fight with one another to fulfill customer needs.

In today's world, greenhouse gases emitted by human activities are raising concerns about global climate change. Gas-powered vehicles are one of the major contributors to this issue. Unlike gas-powered vehicles, electric vehicles are eco-friendly and do not emit pollutants into the atmosphere. Consumers have the ability to prevent any further damage by gas-powered vehicles by adopting electric vehicles. In order for this to take place, it is imperative that the consumer's best interests be taken into consideration. Ultimately it doesn't matter how efficient electric vehicles are if they are not utilized due to the consumer's needs not being met. This is where the Danish Consumer Council comes in, as their job is to represent the consumer interests.

In this chapter electric vehicle ideals are introduced as they relate to the consumer body. In depth information is provided regarding the importance of consumer councils, the fundamentals of the electric vehicle, the global electric vehicle initiative, and the Danish electric vehicle market. All of these aspects are tied together with their overall relevance to the consumers. We will identify potential barriers to the electric vehicle uptake in Denmark.

2.1 Consumer Councils and Their Role in Implementing Electric Vehicles

Consumers need to be guaranteed that the goods and services offered, including the vehicles they drive, are safe and reliable. On March 15, 1962 United States President John F. Kennedy addressed the U.S Congress with his vision for what consumer rights should be (Bhaksur, 1999). This was the first time any politician addressed consumer rights. This sparked the creation and development of consumer councils, which tend to be non-profit organizations that inform and protect consumers.

Consumers International is a worldwide consumer council that has 240 member organizations within 120 countries (Consumer Rights, 2014). Their mission is to protect

consumers by promoting, defending, and developing consumer rights. Consumers International works within specific member locations to secure the rights of consumers. Consumers International has identified eight basic rights that define the principles that they strive to support. These eight rights can be found in table 2.1.

Table 2.1 (Consumer Rights, 2014)

Consumer International's 8 Consumer Rights	
Right	**Explanation**
The Right to Satisfaction of Basic Needs	To have access to basic, essential goods and services: adequate food, clothing, shelter, health care, education, public utilities, water and sanitation.
The Right to Safety	To be protected against products, production processes and services that are hazardous to health or life.
The Right to Be Informed	To be given the facts needed to make an informed choice, and to be protected against dishonest or misleading advertising and labeling.
The Right to Choose	To be able to select from a range of products and services, offered at competitive prices with an assurance of satisfactory quality.
The Right to Be Heard	To have consumer interests represented in the making and execution of government policy, and in the development of products and services.
The Right to Redress	To receive a fair settlement of just claims, including compensation for misrepresentation, shoddy goods or unsatisfactory services.
The Right to Consumer Education	To acquire knowledge and skills needed to make informed, confident choices about goods and services, while being aware of basic consumer rights and responsibilities and how to act on them.
The Right to a Healthy Environment	To live and work in an environment that is non-threatening to the well being of present and future generations.

Consumers International is engaged in a wide array of work to preserve the integrity of these rights. Some of this work includes but is not limited to consumer advice, campaigning and lobbying, dispute resolution, networking, product testing, and even publishing. While some of these activities and methods require multi-national support, others may only pertain to an individual location.

The Danish Consumer Council, also known as Forbrugerrådet, is a representative member for Consumers International in Denmark. The Danish Consumer Council consists of representatives from 27 different national organizations. These organizations include environmental organizations, women's organizations, trade unions, educational organizations, and organizations representing the nation's youth and elderly. 'Tænk', which is the Danish Consumer Council's magazine, informs their 85,000 subscribers with current activity and progress. Another goal of this magazine is to provide the consumers with tips about goods and services. Recently, the Danish Consumer Council has been addressing complaints involving food quality, environmental protection, health services, telecommunications, and legal services. Currently, the Danish Consumer Council is investigating why consumers have been reluctant to purchase electric vehicles (The Danish Consumer Council, 2014).

2.2 Electric Vehicle Timeline

First manufactured on a large scale in 1897 by the Pope Manufacturing Company, the electric vehicle (EV) has been a symbol of future technology for the past century. So why after disappearing for over 80 years is the electric vehicle being produced once again? The following timeline can provide insight into its reemergence by highlighting the major events in the electric vehicle industry.

The first electric motor was invented in 1834 by Thomas Davenport who utilized electromagnets and a primitive battery. The motor was not used for automobiles which had not yet been invented, but Davenport did successfully model his motor with a model train in Springfield, MA in 1835 (Wicks, 1999). Fast forward 60 years to the invention of the first electric vehicle built by William Morrison in 1891. In the year 1897 the first large scale electric automobile was manufactured by the Pope Manufacturing Company who produced a line of electric taxis for use in New York City (History of the Electric Car, 2009). By 1900 38% of all automobiles produced in the United States were electric. In the same year Professor Ferdinand Porsche created the first hybrid car (Engelman, 2011). In 1908 Henry Ford invented the Model T and in 1912 the electric starter was invented that would soon replace the hand crank. Both of these developments had a profound effect on the electric vehicle industry as gas-powered

vehicles became much more alluring. By 1920 there were no electric vehicles in mass production due to their lack of horsepower, low range, and the high availability of gasoline (Wicks, 1999).

The electric automobile was a dormant technology around the world from the 1920s until the Arab Oil Embargo of 1973. Internal combustion engines were more powerful and the EV battery technology was not advanced enough. Automobile manufacturers had no reason to continue developing EVs as they already had very profitable gasoline automobiles, and consumers had no real interest in EVs. In 1966 the United States Congress introduced the first bill endorsing alternatives to gasoline automobiles in an attempt to reduce air pollution. Then in 1973 the Arab Oil Embargo created an even larger stir in EV interest due to high oil prices and the limited availability for consumers. Dependency on foreign oil became a focal point for all non-oil producing countries including Denmark. Prior to the embargo Denmark utilized foreign oil for 90% of its energy needs (Koch, 2009). Due to the embargo, large amounts of funding for EV programs began to flow from governments across the globe, and several electric vehicles were developed. The most popular was CitiCar which sold over 2,000 units but stopped production in 1977 (CitiCar, 2009).

The 1990s saw the return of EVs due to host of new bills promoting their use and offering tax incentives, but consumer interest in EVs was still limited. Factors included consumer reluctance to change from gas powered automobiles, limited EV range (about 80 miles), limited charging infrastructure, and lack of manufacturer backing. The popular EV1 was released by General Motors in 1996 for lease only, but was later recalled in 2000 with no concrete reasons given. Many customers wanted to keep their EV1s but GM forced consumers to give them back. GM's public relations nightmare continued when it was found out that GM was simply crushing the cars and "recycling" their parts even when many people had offered large sums of money to keep their car (Who Killed the Electric Car?, 2006). At the same time Toyota began developing the Prius Hybrid which was released in Japan in 1997. The Prius was not a plug-in EV but was recharged by utilizing regenerative braking which stores energy each time the car brakes. The Prius sold over 18,000 units in its first year of production and proved to

automobile manufacturers that there was a global market for hybrids (Anderson, 2013). Even with this emerging market for hybrids, all strictly electric vehicles ceased mass production until 2006 when Tesla Motors unveiled the Tesla Roadster. Released in 2008 with a listing price of $98,950, the Roadster was the first modern fully electric sports car. The model had a range of 245 miles and a 0-60 speed of 3.7 seconds proving to the world that electric vehicles can be very powerful. Another example of a successful modern electric vehicle is the Nissan Leaf which sells for about $30,000 and has a range of 100 miles.

The current situation shows that the electric vehicle is once again becoming prevalent in the automobile industry but there is still a lot room to grow. Norway is currently the world leader in electric vehicle sales and hit a record 12% of total automobiles sales in November, 2013 (Shahan, 2013). If Denmark was to follow suit, it would go a long way towards reaching their carbon neutral goals and greatly decrease their reliance on foreign fuel. In 2014 even more automobile manufactures have begun producing electric vehicles such as BMW, Volkswagen, Kia, Mercedes, Nissan, etc. (Shahan, 2014). As competition for the market increases, so too will the quality of the products produced.

2.3 How Electric Vehicles Function

In order to illustrate to consumers the difference between gas-powered and electric vehicles this section will highlight their differences. Electric Vehicles may look very similar to gasoline vehicles on the outside but on the inside they are very different. Electric powered cars use electric motors that send a current from the battery pack, to the controller, which then turns the wheels. There is no muffler, catalytic convertor, tailpipe, or need for a clutch assembly. Instead there are needs for an electric water heater to provide internal heat, and a vacuum pump for the brakes; both of which are built into internal combustion engines (ICEs). Gas gauges are replaced with voltage meters, and the gas tank is replaced with batteries and a charging port. Aesthetically, EVs can look the exact same as gasoline powered cars (Brain, 2002). When driving an EV the most noticeable difference is the low engine noise, and most everything else feels like a normal car.

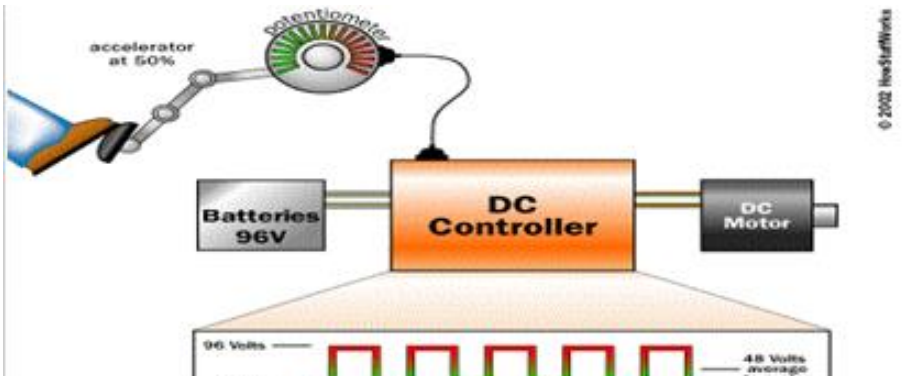

Figure 2.1 (Brain, 2002)

Figure 2.1 shows how a DC controller in an EV functions. The DC controller is connected to the battery pack and DC motor. When the driver pushes on the pedal the controller determines the amount of voltage transferred from the battery to the motor which dictates the speed of the car.

Batteries are perhaps the most important technological advancement to the future of EVs. In truth over the past century batteries have held back the electric vehicle. Today the main type of battery used in EVs are lithium ion batteries which can store large amounts of energy but are also heavy, bulky, and can overheat. (Hiler, 2013) Lithium ions are far superior to lead-acid batteries which are just as heavy but provide less energy output and do not fare well in cold weather. (Bullis, 2013) Hybrid cars can use lithium ion, lead-acid, or nickel-metal-hydride batteries which are found in cars such as the Toyota Prius and the Honda Civic Hybrid. Lithium-ion is the best battery type used in mass production currently, but there is room for improvement. A few possible battery advancements are on the horizon that could be the reason the electric vehicle takes the next big step. One promising development is lithium-sulfur batteries which can store almost 4 times as much power but have a much shorter life time than lithium-ion (Battery Development, 2014). The study was based on electricity produced strictly from coal in order to prove that EV's carbon footprint remains better than gasoline in any case.

2.4 Environmental Impact and Changing Gas Prices

2.4.1 Consumers and the Environment

The impact of Global climate change has been rapidly occurring since the first industrial Revolution when humans began to release emissions into the atmosphere. These emissions

result in the trapping of heat that is trying to leave Earth, which is also known as the greenhouse effect (Jenkins, 2014). Over 20% of the total global climate change pollution is directly linked to gasoline-powered vehicles (Cars, Trucks, and Air Pollution, 2013). A greenhouse gas known as carbon dioxide has increased its natural presence in the atmosphere by one-third since the industrial revolution. Gasoline-powered vehicles are a direct cause of this because the burning of one gallon of gasoline results in the emission of 20 pounds of carbon dioxide into the atmosphere (Fuel Economy.Gov, 2013). To add to this, other greenhouse gases besides carbon dioxide are emitted from gasoline-powered vehicles as well. Over a third of the greenhouse gases known as carbon monoxide and nitrogen in the atmosphere today are emitted from gasoline-powered vehicles. As temperatures increase around the world, many species' habitats are changing, creating negative effects and in some cases extinction. Sea levels are rising as glaciers and the polar ice caps melt. Due to the rise in sea level there is heightened risk for floods in coastal areas, as well as increased erosion. Lastly heat waves and cold fronts are going to be reaching extreme temperatures as the greenhouse effect continues (Jenkins, 2014). Since greenhouse gases emitted from gasoline-powered vehicles have a huge contribution to the greenhouse effect, countries around the world are working to encourage the implementation of electric vehicles in an attempt to prevent any further damage to the Earth. For example, The United States provides a federal tax credit to electric vehicle consumers of up to $7,500 based on the capacity of the battery used in the vehicle. In Norway electric vehicle consumers are exempt from the initial car tax and have a free pass when it comes to all of Norway's toll roads. Lastly in Sweden the government can provide subsidies of up to 40,000Kr, approximately $6093 dollars, to persons who purchase green cars (Teslamotors, 2013). Denmark is encouraging the sale of electric vehicles by exempting buyers of fully electric powered vehicles from the current vehicle registration tax. The vehicle registration tax places a 180% tax on the purchase of any vehicle after the first 65,900 Danish Krone or $11,987 dollars of the price of the vehicle (Berman, 2013).

2.4.2 Electric vs. Gas-Powered Vehicles from Cradle to Grave

This section focuses on the environmental impact of electric vehicles compared to their gasoline powered counterparts. EVs can play an active role in achieving Denmark's goal of being

carbon neutral by 2050. Common questions regarding EVs environmental impact include: *Are they actually better for the environment? What if the electricity is produced by coal power plants? What are the impacts of producing and disposing of their batteries?*

To answer these questions fairly, Renault released an assessment of its Fluence sedan comparing its electric version to its gas- and diesel-powered versions. This was the model utilized by the Better Place Initiative. The assessment took into account the entire life cycle of the cars from raw material to completed product to waste or recycling, which is depicted in figure 2.2.

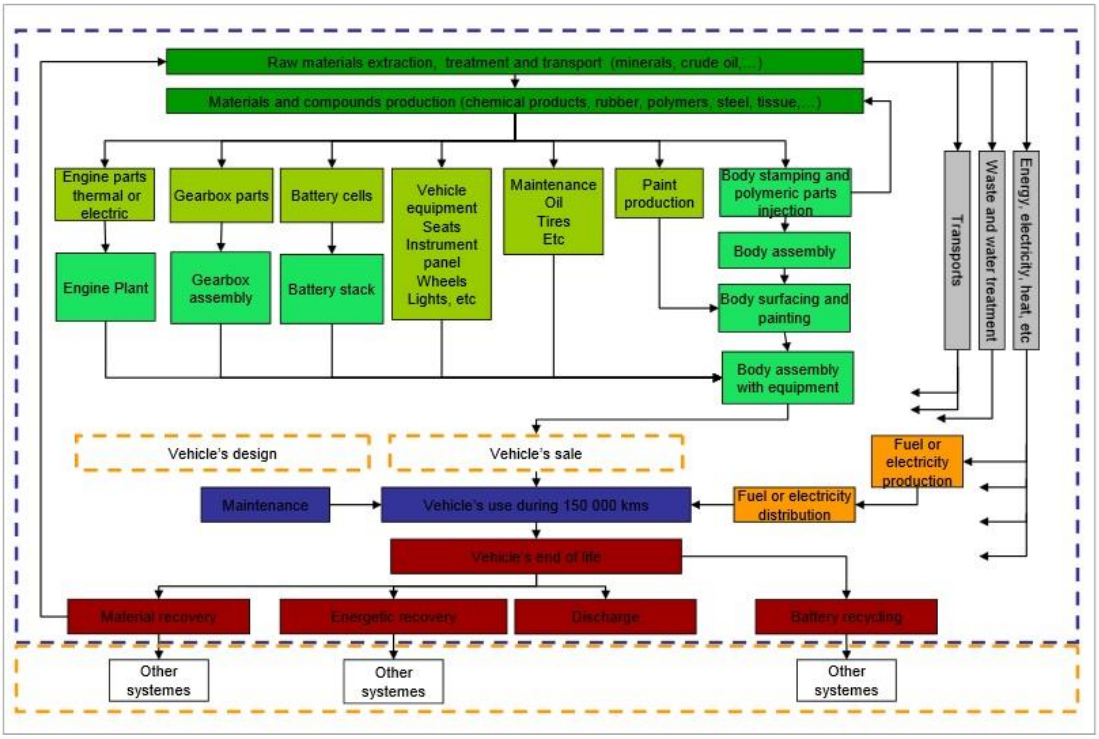

Figure 2.2 (Renault, 2011)

The deciding factors that determined which car was more eco-friendly included greenhouse-gas emissions, ozone pollution, resource consumption, and total energy demand (Bullis, 2013). The results of the study were that EVs have a larger environmental impact during manufacturing due to the toxic compounds released when producing the solvents and process chemicals for things like batteries (Conca, 2013). However, the more impactful part of the life cycle process in terms of C02 emissions is product use. This is where the emissions from gas powered cars quickly pile up and overtake the gap between emissions released from manufacturing. This can be illustrated in figure 2.3 which shows the CO^2 emissions from production to end of life for these models. EVs finished ahead in all factors except contribution to acid rain and cause of algae blooms, which were still very close to the internal combustion engines (Renault, 2011).

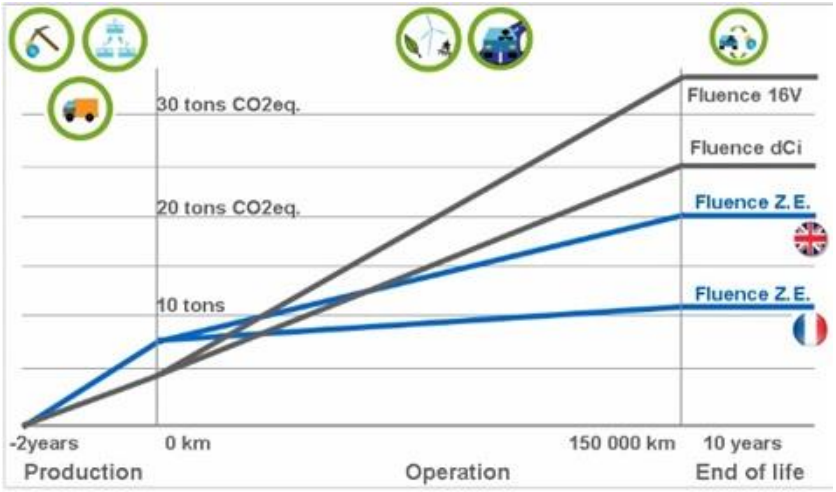

Figure 2.3 (Renault, 2011)

EVs do prove to be more environmentally friendly compared to internal combustion engines according to the Renault study, however there is still room for improvement. Some opportunities to become even greener include reducing the amount of fossil fuel used to produce electricity, and also developing more alternative energy sources. Continued reliance on fossil fuels for electricity production limits the emissions-reductions that could be achieved with EVs. One promising fact is that Denmark is currently the world leader in wind power which accounts for 30% of their total energy (Shahan, 2012). Further alternative energy production will negate the increased need for electricity due to EVs from coal power plants which have high CO^2 emissions. The recycling industries are also trying to do their part by staying ahead of the game by developing better practices for recycling EV and hybrid batteries. The batteries from the first generation of Prius and Honda Insight are just now reaching their end and the recycling industry is ready to begin disposing of the used batteries (O'Dell, 2012).

2.4.3 Cost of Fuel on Consumers

The world's dependence on oil has a large influence on consumer interest towards the development of electric vehicles around the world. Gasoline prices are directly impacted by the price of oil because gasoline is approximately 70 percent oil. In reference to figure 2.4 below, the world consumption of liquid fuels on average has been higher than the world's production of liquid fuels since 2009 (Short-Term Energy Outlook, 2014).

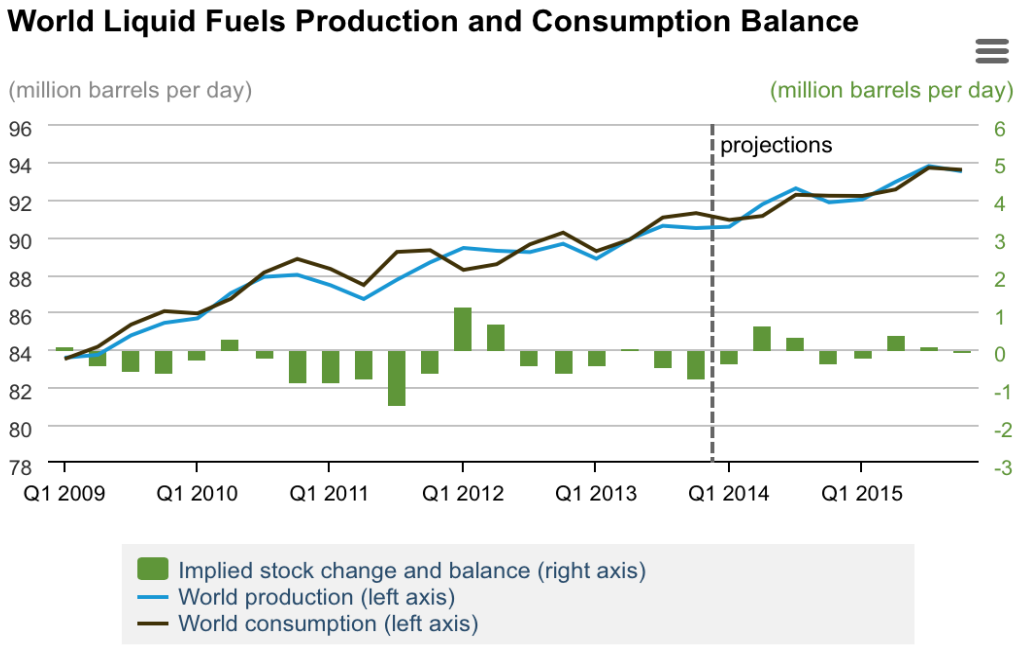

Figure 2.4 (Short Term Energy Outlook, 2014)

In 2013 on average the world consumption of liquid fuels was 90.35 million barrels a day whereas the average world production of liquid fuels was approximately 89.95 million barrels per day. The supply and demand of oil is the first of the four main components as to why gasoline is expensive (IER, 2013). The second component that composes the cost of gasoline are taxes that are levied by federal, state, and local governments. Many countries that produce their own oil levy hefty taxes on gasoline. Some countries that partake in heavy taxing of gasoline are Norway, Sweden, and Denmark. These taxes put the price per gallon of gasoline around the $10 dollar range. Norway levies a tax of almost 50% on gasoline and feeds these taxes into national services like providing free college education and improving infrastructure.

Sweden also levies heavy taxes on gasoline but does so in an attempt to reduce emissions that are contributing to the greenhouse effect. Despite these high taxes Sweden remains the 10th largest consumer of oil per capita in the world (Randall, 2013). Distribution and market costs comprise the third component as to why global prices of oil are expensive. The world's largest exporters come from a variety of countries that make up the Organization of the Petroleum Exporting Countries also known as OPEC. OPEC's purpose is to unify and stabilize the oil market. OPEC consists of 12 member countries: Iran, Iraq, Kuwait, Saudi Arabia, Venezuela, Qatar Indonesia, Libya, the United Arab Emirates, Algeria, Nigeria, Ecuador, Gabon, and Angola (Member Countries, 2014). With over 81% of the world's crude oil reserves belonging to OPEC member countries, OPEC is able to control the majority of the market. The last component that results in high gasoline prices are the oil refining costs. The cost of refining crude oil into the chemical components of gasoline on average makes up 8% of the retail price of gasoline (IER, 2014). This percentage can fluctuate depending on the accessibility to different additives and processing steps of gasoline formulations as well as seasonal changes that effect oil refining operations. Gasoline prices are an important factor to consumers when considering electric vehicles. Consumers do not want to spend large parts of their yearly income towards gasoline so many consumers are looking to electric vehicles to drop their large gasoline expenses.

2.5 Global Market for Electric Vehicles

Today, electric vehicles account for .02% of the globe's registered vehicles (Navigant, 2014). An opportunity for the other 98.8% to reduce their fueling costs is an alluring prospect to consumers. If humans were to convert their ICE's (Internal Combustion Engine) to EV's, there is a potential have a large reduction on their carbon footprint. As the green movement gains more traction, nations are expressing interest in electric vehicles all over the globe. However, successful implementation can only be boasted by a handful of these nations which fluctuates based on geographical region. Navigant's research found that consumer interest in EV's is increasing and forecasted that the sales rate of EV's will jump by 86% by 2015 (Navigant,2014).

2.5.1 The Electric Vehicle Initiative

The Electric Vehicle Initiative (EVI) is a global program under the Clean Energy Ministerial (CEM) that desires to push the deployment of 20 million EV's by 2020, including

plug-in EVs as well as hybrids (Energetics Inc., 2014). The current members of the Electric Vehicle Initiative are China, Denmark, Finland, France, Germany, India, Italy, Japan, the Netherlands, Portugal, South Africa, Spain, Sweden, the United Kingdom, and the United States (Clean Energy Ministerial, 2013). So far, the Electric Vehicle Initiative boasts many accomplishments including a casebook published in 2012 providing studies on EV deployments among nine nations. The casebook's purpose is to share experiences regarding electric vehicles to better understand what the most effective policy measures are in fostering EV uptake (EV City Casebook, 2012). This information is available to the public so that consumers can learn about these deployments in other nations as well as their own.

The CEM is a global forum that shares best practices to ease the transition to a global clean energy economy (Energetics Inc., 2014). The Clean Energy Ministerial realizes the potential for EVs to change the world's methods of transportation by reducing carbon emissions and pollutants. Currently the transportation industry accounts for 10 percent of energy-related carbon dioxide emissions (Energetics Incorporated, 2014). The EVI intends to pursue their goals by ensuring that gaps in EV technology development are being addressed. They also push to align the concerns of relevant stakeholders (for example: government, industry, consumers) in order to focus on benefits of EV technological innovation.

2.5.2 Leading Nations in the Electric Vehicle Industry

Numerous nations are pushing to put more electric vehicles on the road, however some countries are more successful here than their counterparts. Norway, for instance, has the highest electric vehicle ownership per capita and total sales with 21,000 EVs on the road (The Ecologist, 2014). The two tops selling vehicle models in Norway in 2013 were EVs, the Tesla Model S and the Nissan Leaf. This massive uptake is in part due to Norwegian consumers enjoying free charging, free parking, waived tolls, and other generous government incentives that equate to an estimated savings of $8,337 per vehicle (The Ecologist, 2014). Following Norway the other leading nations in order are Japan, Ireland, the Netherlands, France, United States, Denmark, and Switzerland, although Norway is far and away the leader.

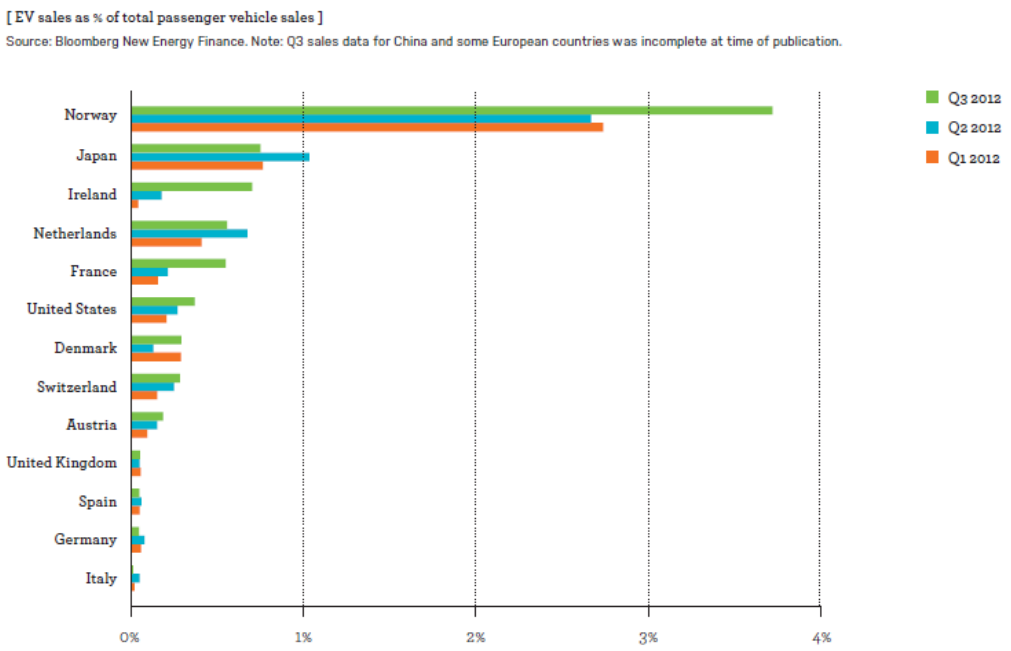

Figure 2.5 (Greenbang, 2012)

Figure 2.5 displays the electric vehicle sales as a percentage of total vehicle sales for these countries as of 2012. To put it in perspective, 16 cities make up for one-third of all electric vehicles in use globally (Greenbang, 2012). Table 2.2 discusses the top ten cities for owning electric vehicles based on the number of EV's on the road, as well as their corresponding infrastructure.

Table 2.2 (Deloitte, 2014)

City	Electric Vehicles Owned (#)	Charging Stations(#)
Kanagawa Prefecture, Japan	2,183	450
Los Angeles, California, US	2,000	106
Shanghai, China	1,633	9 stations, 687 charging poles
Portland, Oregon US	1,300	225
Rotterdam, Netherlands	1,000	100
BrabantStad, Netherlands	755	500
Amsterdam, Netherlands	750	350
Barcelona, Spain	480	249

Berlin, Germany	350	220
Hamburg, Germany	350	200

Numerous countries are pushing for electric vehicles because they are considered to be the next generation of personal mobility (Deloitte, 2014). The reduction of the world's carbon footprint as well as various incentives for EV owners, are factors to be considered by the global consumer body. For this reason countries around the globe are providing certain initiatives in order to promote implementation.

2.6 Denmark's Market for Electric Vehicles

Within the past decade, the Danish Government began pushing for the implementation of electric vehicles instead of the more popular gas powered options. With increased realization of human impact on global climate change, the Danish population is beginning to take actions to limit carbon emissions. According to a survey by Better Place in 2009, 34% of Denmark's population stated that they would be willing to purchase an electric vehicle or a hybrid form as their next vehicle ("Drivers and inhibitors of electric vehicles", 2011). The Danish Government introduced consumer incentives to provide an opportunity for car buyers to eliminate emissions. Despite the green movement in Denmark, electric vehicles have not found the support that gas-powered vehicles have.

2.6.1 Consumer Influence on Transportation in Denmark

The following is a depiction of the current vehicle situation in Denmark. One aspect of the plan is to replace individual gas-powered vehicles with electric ones. In the year 2013, only 647 electric vehicles s were sold in Denmark, 533 to individuals and 113 to the government (Marth, 2014). The potential for electric vehicle sales in Denmark is limited due to the small percentage of Danish car owners. According to a 2012 census, only 3.5% of families in Denmark bought a car within the past 5 years (Dalbro, 2012). Furthermore, only 29 % of Danish families own 1 or more cars, compared with the 95% of citizens who own a bicycle (Troy, 2012). The percentage of Danes who drive and own vehicles is low partly because of the established preference for bicycling. Over 35% of employed citizens commute to work via bicycle in the capitol of

Copenhagen ("Denmark.dk", 2011). Copenhagen, along with other main cities in Denmark, has converted from an automobile oriented city to a bicycle friendly one. Despite common use of bicycles in Denmark, the few vehicles driven continue to negatively impact the environment. The Danish Government invested in Better Place with the objective to increase clean energy transportation.

2.6.2 Consumer Implications on Fallout of Better Place

Consumers were recently affected by the bankruptcy of Better Place in May, 2013. Negative consumer opinions about the EV industry have been formulated due to the failure of Better Place. In 2011, the Danish government invested in Better Place with the intentions of developing a stable EV infrastructure. Better Place proposed a system for Denmark which would provide battery swapping stations throughout the country. This system intended to provide an inexpensive recharge that would take approximately 5 minutes (Pearson, 2013). The main attraction to consumers was the capability to reduce charging time from 8 hours to 5 minutes. Additionally, consumers would not be limited to the short range of travel that most electric vehicles have (Deloit, 2011, pp. 6). Because of financial issues, Better Place declared bankruptcy in May, 2013. They only had one contract, with Renault, to produce and implement compatible batteries with the charging stations. Since Renault only made one vehicle model with Better Place's battery technology, the quantity of vehicles capable of utilizing the charging stations was very low. Better Place was only able to install 17 battery swap stations and 30 charging points (Danish Infrastructure Experiences, 2013). The lack of demand for recharging stations directly influenced the fallout of the company. Another major problem was that Better Place attempted to develop infrastructure in multiple countries simultaneously (Pearson, 2013). Better Place ended up failing financially due to the inability to develop a successful network in any country.

2.6.3 Government Taxation Removal as Incentive Strategy

As mentioned in earlier sections, the Danish government is attempting to promote EV use by consumers through multiple incentives. One incentive is the elimination of the vehicle registration tax for fully electric vehicles. The tax states that the first 65,900 DKK of the vehicles price will be taxed 105%, while the remainder, if any, will be taxed at 180% (Marth, 2014). The

Danish Parliament decided that the tax exemption on electric vehicles will continue through December of 2015 and be revaluated in the start of the following year (Jankovic, 2013). Removing the tax provides the financial capability for the everyday consumer to acquire new electric vehicles. Other financial benefits for electric vehicles are exclusions from road taxes and free city parking (Trigg, 2013). These incentives affect the consumers by providing an additional opportunity to save money and add to ease of use.

2.6.4 Infrastructure Challenges

The Danish Government is met with the challenge of providing a reliable electric vehicle infrastructure. To eliminate consumer skepticism about low battery capacity in electric vehicles, charging stations have become a high priority to the success of electric vehicles. There are only 750 charging stations in Demark compared to thousands of gas stations and signage (Danish Infrastructure Experiences, 2013). In order to meet consumer's needs there must be infrastructure capable of supporting the shift to electric vehicles.

The high demand for gas vehicles resulted in a century of infrastructure development. The large quantity of gas stations in Denmark provides consumers with a reliable and convenient way to refuel. On the contrary, the low number of charging stations located in Denmark can be correlated to the lack of demand. In order for the stations to make a profit, the quantity of electric vehicles must increase. A limiting factor for electric vehicles is the lack of a sustainable infrastructure. Potential buyers must consider the infrastructure when comparing gas and electric models. The dilemma arises when there are not enough electric vehicles for charging stations to succeed, but the lack of a charging infrastructure negatively affects electric vehicle sales. The government attempted to solve this dilemma by investing in Better Place which negatively influenced consumer opinion of electric vehicles in Denmark (Berman, 2013). Denmark has yet to develop the required infrastructure needed to convert from gasoline vehicles to electric ones. This dilemma outlines the struggles of the government to implement electric vehicles and reach their carbon neutral goals.

2.6.5 Government Future Plans for Electric Vehicles in 2014

The Danish Energy Agency's projected numbers for 2014 represent substantial growth in the sales of electric vehicles ("1500 New Electric Cars for Denmark", 2013). Funding through the Danish Energy Agency is expected to double the number of electric vehicles over the next two years. The plan involves providing charging infrastructure for 400 cars in Copenhagen, partnering with private companies to bring 500 electric vehicles to the streets, and numerous small business partnerships which could lead to 400 new electric vehicles ("1500 New Electric Cars for Denmark", 2013). Along with the Energy Agency's funding, BMW is revealing its new model, the i3, in May 2014. The BMW i3 already has 1000 orders logged in Denmark (Marth, 2013). The future is uncertain in the EV market, but the government has created the potential for growth.

2.6.6 Danish Consumer Council Future Plans

The Danish Consumer Council represents the opinion of consumers regarding numerous topics. Currently, the Consumer Council is looking to represent public interest regarding the future of electric vehicles in Denmark. The government's goals may not align with the interests of the consumers regarding the implementation of EV's. The government wants to replace gas vehicles with electric vehicles to propel the country closer to carbon neutrality. The Danish population may agree to this, but the cons to electric vehicles are just as evident as the benefits. Electric vehicle and battery technology is constantly improving, but the consumer's needs have to be met for the EV movement to reach its full capacity. In order to better understand the Danish consumer's interests and concerns our team will have to further identify the major barriers to EV uptake through the use of interviews, surveys, and focus groups.

3. Methodology

The goal of this interactive qualifying project is to determine the Danish consumer's interests and concerns regarding electric vehicles. The adoption of electric vehicles by consumers will contribute to Denmark's goal of becoming carbon neutral and significantly reduce the Danish dependency on oil. Our team will communicate the consumer's perspective to the Danish Consumer Council so the organization can better protect the interests of the consumer.

Scope of Project:

The objectives of our project are the following:

1. Identify the barriers limiting major uptake of Electric Vehicles by consumers in Denmark.
2. Determine the interests of the Danish consumer regarding electric vehicles.
3. Discover the major concerns consumers have regarding electric vehicles.

We will attempt to better understand the interests and concerns of Danish consumers regarding electric vehicles utilizing various data collection methods. Our group will conduct interviews with diverse parties affected by electric vehicles including current EV owners, EV manufacturers, and Danish Politicians involved in legislative efforts regarding the green movement. We will be utilizing the Danish Consumer Council's quarterly survey to gain a general understanding of consumer's perspectives towards electric vehicles. To obtain firsthand consumer opinions of current vehicles, we intend to organize a focus group of current owners. The information gathered will be analyzed and relayed to the DCC so that the consumer interests are protected.

3.1 Interviews

Interviews will be a primary method of research to complete our objectives. We defined the categories of individuals and organizations to interview in Appendix A. Our prioritized list will allow us to gain a broad range of perspectives from a number of affected parties and assist in determining the consumer viewpoints of electric vehicles. We plan on drafting emails to these identified resources by introducing the group, defining our mission, and asking for their

cooperation. Our sponsor, the Danish Consumer Council, will assist us in contacting reliable resources.

We expect to utilize our sponsor's resources to put us in touch with our interviewees via phone or email. Our interview process will include 2-3 group members per interview, each with designated roles. The team members will rotate through the following roles: Leader, Secondary Inquisitor (optional), and Secretary. The Leader is responsible for running the meetings, keeping the group on task, and asking pre-determined questions. The Secondary Inquisitor, if present, will come up with questions throughout the interview. This position will aid the Leader in the discussion. The Secretary is responsible for taking notes or recording the Interview. The entire group will analyze the interview together and compile important facts.

3.2 Survey

The Danish Consumer Council releases a quarterly magazine called Tænk. Tænk provides consumers with information regarding current council activity as well as offering advice on purchasing services and goods. In this upcoming quarterly magazine Tænk requests its subscribers to answer an online survey to better understand the current consumer interests. Our sponsor, Martin Salamon, has allotted us space for five questions in this survey which will be sent out to 2000 subscribers. We expect a response rate of about 50%. This will allow us to analyze the quantitative answers of around 1000 individuals. The survey questions that we will be asking can be found in Appendix B, along with explanations for the content.

In this survey we intend to gain information from everyday consumers regarding current interests and concerns of electric vehicles. We will organize and analyze the data in order to gain a better understanding of consumer's interests. Furthermore, we plan on these results propelling the specificities of our interviews.

3.3 Focus Group

To supplement our interviews and the consumer survey, we hope to organize a focus group to gain more in depth research. The purpose of this focus group will be to provide a platform for automobile owners to discuss their interests and concerns on the subject. The members of the group will be a mix of electric vehicle owners and gas automobile owners, to

provide an unbiased discussion and spur conversation. We intend to facilitate the discussion by posing intriguing questions designed to bring out the contrasting views on EVs. Sample questions are provided in Appendix C.

Conducting this focus group will enable consumers to provide more detailed explanations to their thoughts regarding EVs. The survey is a multiple choice format and lacks the ability for write in answers, so the focus group can serve to elaborate on some of the data we receive and answer why the consumers feel a certain way.

3.4 Methodology Overview

We created Table 3.1 (see below) in order to make a graphic representation of how we plan to organize our time in Copenhagen.

Table 3.1 Methodology Tasks

	Weeks							
Methodology Tasks	**Prep**	**1**	**2**	**3**	**4**	**5***	**6**	**7**
Create and Submit Survey Questions								
Prepare for Interviews								
Prepare for Focus Group								
Conduct Interviews								
Perform Focus Group								
Organize and Evaluate Data								
Finalize Findings for DCC Report								

* Work will be slowed in the end of week 5 and beginning of week 6 due to the extended Easter break

We hope to gather information through the methods provided above in order to achieve our project objectives. Once the interviewees' responses and the survey results are collected, we will thoroughly analyze the data. We will analyze survey data using the software provided by the sponsor. If graphs are not provided through the software, then we will use Microsoft Excel to produce them. To analyze interviews, we will make a spreadsheet in Excel to compare and contrast opinions. The notes

from the focus group will be added to this spreadsheet to further compare opinions. After this process we will have a much greater understanding of the consumer interests and concerns towards electric vehicles.

4. Results

5. Analysis

6. Conclusion

Appendix A: Interviews

Below is a prioritized list of the interviews we intend to conduct.

1) Current owners of Electric Vehicles (Renault Fluence Z.E., Nissan Leaf, Tesla Model S, etc.): Our first priority is to contact current owners of electric vehicles in Denmark. Through this, we intend to gain firsthand perspectives of the benefits and drawbacks that consumers have observed.

The questions we plan to ask include the following:

1. What prompted you to purchase an electric vehicle?
2. What are the primary benefits of owning an electric vehicle?
3. What are the negative aspects of owning an electric vehicle?
4. Was your purchase affected by the government incentives offered?
5. What changes about electric vehicles would you like to see in the future?

2) Electric Vehicle Companies: Following consumer interviews, we intend to speak with electric vehicle companies. We intend to gain knowledge about what potential buyers value in a new vehicle.

The questions we plan to ask the companies include the following:

1. Why do you think there are more EV sales in Norway than Denmark?
2. On average, how many people per day come in looking for an electric vehicle? Gas vehicle?
3. What is your electric vehicle strategy for the future?
4. What have you found the major concern to be for potential EV buyers?
5. Would you purchase your own electric car?

3) Politicians involved in the Danish green movement: With heavy government legislation concerning the environment, we need to understand how consumer perspective affected the incentives put in place. Furthermore, we intend to gain a better understanding of how these incentives are being advertised to the consumers.

The questions we plan to ask include the following:

1. How important are electric vehicles to the country's carbon neutral plan?
2. What do you think the biggest barrier is for consumer acceptance of electric vehicles?
3. Have you thought about more possible incentives to push EV sales?
4. Do you think the general population is on board with the country's carbon neutral plans?
5. Do you own a car? If so is it electric? If not, would you buy an electric one?

4) Danish Environmental Organizations: We intend to gain a better understanding of how consumers are being educated on the environmental benefits of the electric vehicle. This is a less direct method than the previous two categories for obtaining information on consumer interests.

The questions we plan on asking these organizations include:

1. How are you involved with electric vehicles?
2. Do you think the adoption of electric vehicles will play a crucial role in the country reaching its carbon neutral goals?
3. Do you know anything about the environmental impacts of electric car battery recycling?

5) Former employees of Better Place: This interview may be unrealistic because Better Place has been disbanded for almost 1 year. The interview has the potential to gain insight on why consumers did not invest in Better Place technology.

The questions we plan on asking the former employees include:

1. What was your impression of working for Better Place?
2. What was the company's overall strategy to implement the cars?
3. How many charging stations did you implement and where?
4. How did you attack the infrastructure issue?
5. Why do you think the initiative failed?

Appendix B: Consumer Survey

We decided to use the term “car” instead of “vehicle” for the survey because we expect the population to be more familiar with this terminology. The following is the list of questions we intend to pose on the Taenk survey.

1) What would you consider to be the longest acceptable time to fully recharge the battery of an electric vehicle?
    a) Over 8 hours
    b) 5-8 hours
    c) 2-5 hours
    d) Less than 2 hours

This question will give us an idea if current EV’s are satisfying the needs of the consumer regarding recharge time. Based on a side by side comparison of all electric vehicles, the range of charging time is between 2.5 hours and 12 hours at 240 volts (fueleconomy.gov). The majority of cars fall within choices b and c. Answer a is based on an average night sleep. Answer d is unrealistic.

2) What is the range that an electric vehicle would need before you would consider buying or leasing it?
    a) Under 80km
    b) 80-160km
    c) 160-320km
    d) 320-450km
    e) Over 450km

This question will provide us with the general population’s daily travel distance. Based on a side by side comparison of electric vehicles, the range varies from 48 miles to 450 km. Answer a only includes 3 models. Answer e is unrealistic because zero models travel more than 460km. The majority of electric vehicles range from 80 to 160 km, which is answer b. Only the expensive tesla models cover the distance required for answer d. Answer c is the difference between the tesla models and the remainder of the electric cars (Clean Technica , 2013).

3) To what extent to you agree or disagree with the following statement:

   The exemption of the vehicle registration tax for fully electric vehicles would strongly influence me to buy an electric car.

   a) Strongly Disagree
   b) Disagree
   c) Neither Agree or Disagree
   d) Agree
   e) Strongly Agree

This question will allow us to determine how effective the current tax incentives are to the Danish population. Based on the responses, we can find out if they impact electric vehicle sales.

4) What improvements concerning electric vehicles would substantially impact your decision to purchase one? (Please select all that apply)
   a) Longer range per single charge
   b) Reduced charging time
   c) Increased availability of charging stations
   d) Cheaper MSRP (manufacturer's suggested retail price)
   e) Aesthetics
   f) Other

These answers will allow us to achieve our 3rd objective of identifying the major concerns of consumers. It will also allow us to identify some of the major barriers preventing electric vehicle uptake. Our answers identified the major concerns we found through research.

5) Before taxes, what is the price range you would be willing to spend on a new vehicle?
   a) Under 103,500 DKK
   b) 103,500-220,000 DKK
   c) 220,000-325,000 DKK

d) 325,000-545,000 DKK

e) Over 545,000 DKK

This question will give us information on whether or not consumers are willing to pay for electric vehicles to make an environmental impact. These numbers are based on price values comparing different electric vehicles. The cheapest electric car is 103,500DKK. The majority of electric cars range from 103,500DKK to 325,000 DKK. We decided to split this range into two categories because above 220,000 DKK corresponds to the price of a luxury gasoline car. Answer d is the price range for the Tesla models.

Appendix C: Focus Group

The following is a list of questions we will pose to the focus group.

1. What do you look for in a vehicle?

This allows us to gauge what the group's interests are and what benefits they consider important.

2. What is your level of understanding on electric vehicles?

This question will enable us to determine what the background knowledge regarding EVs are prior to the discussion moving onto EVs.

3. Could your needs be met by an electric vehicle?

This allows us to analyze how current EV models are fulfilling consumer needs and what could be changed.

4. What are your feelings regarding the government vehicle taxes and incentives?

By bringing in the political side of the debate we can determine by how effective the current government incentives are towards greater EV uptake.

5. What are your concerns about your current vehicle?

This addresses our objective of discovering the major concerns consumers about purchasing EVs.

6. Would you consider purchasing an EV? Why or why not?

The question above will gauge the level of interest the average consumer has in EVs and identify some of the barriers that will need to be overcome before large scale uptake can occur.

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