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## THE FUTURE OF ELECTRIC CARS IN ICELAND: MARKET READINESS AND GROWTH OPPORTUNITIES

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### Abstract

This study aims to examine the future of electric cars in Iceland in the context of market readiness and growth opportunities. Iceland is found to be one of those countries which are heavily dependent on imported oil in order to fulfill their transportation requirements. This situation has considerably affected the economic as well as the environmental conditions of the country. Thereby, adequate alternative resources need to be adopted in Iceland. In this regard, the emergence of electric cars can be considered as one of the greatest initiatives towards the reduction of environmental vulnerabilities as well as cost efficiencies. It is also expected that electric cars will eventually reduce the need of importing fossil fuel. This research has analyzed different factors, which have assisted in establishing that electric cars have tremendous opportunities in the automobile market of Iceland. This study has adopted mixed methodology (qualitative and quantitative), in order to acquire more coherent and credible information. Qualitative data was collected from secondary resources, whereas, primary data was gathered by conducting a survey questionnaire with the Icelandic citizens.

**Keywords:** Electric Cars, Market Readiness and Iceland.

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### Introduction

Technological developments have played an inevitable role in transforming the lives of people. It is due to the fact that innovative and advanced technologies have allowed people to perform their daily routine tasks, in a more efficient, convenient, and cost effective manner. In this regard, the emergence of electric vehicles (EVs) can be considered as one of the greatest initiatives towards more efficient and sustainable transportation. Research, which has been conducted by Helmers and Marx (2012), has revealed the fact that the utilization of EVs in Iceland has progressively been gaining momentum from the public/private investors to

government sector. In this regard, Hreinsson (2009) has affirmed that both, environmental and economical factors have caused this rising interests, as it is likely to produce electricity in a renewable and cheap manner in Iceland. It has been documented in the report Icelandic Energy Authority (2014) that geothermal heat as well as the hydropower weighted for more than 85,3 percent of the primary energy consumption of the country, i.e., Iceland. It is important to bring into notice that these defined percentages of energy are used in different sectors of the country, excluding transport sector (Kjartansdottir, 2013). It is due to the fact that the transport sector of Iceland mainly depends on the imported oil, the only non renewable energy source in Iceland (apart from coal alloys used in alluminum smelters).

However, the transport sector of Iceland can utilize renewable domestic sources and the amount of energy, which is already being generated in Iceland. The analysis of Iceland's energy generation has revealed the fact that the generated electric energy of the country is sufficient enough to fulfill the requirements of the transport sector. An electric transport sector of countries, specifically Iceland, may play a great role in minimizing excessive emissions of greenhouse gases. On the other hand, it has also been established that the reeducation of emissions also depends on the type of electricity sources. Apart from environmental aspects, another positive characteristic of electric transportation in Iceland is related to the economic benefits. After identifying all of these advantages, the private and governmental entities of the country are intending to switch from conventional vehicles to the electric automobiles. Nemry and Brons (2010) have claimed that the city of Reykjavík and government sector of Iceland have vowed to become leading entities in the electric transport.

In addition to this, the universities and educational institutions of Iceland are also continually researching the electric transport sector, in order to replace electric vehicles from conventional vehicles. Apart from wide range of benefits, EVs also possess several problems and ambiguities, which are needed to be consider by the manufacturers of electric vehicles. Most prominent issues are related to batteries, higher cost of the vehicles, and infrastructure and charging (Helmerts & Marx, 2012). Therefore, it is considered as one of the foremost responsibilities of the manufacturing companies, specifically EVs manufacturing companies, to focus on the resolution of these issues, in order to ensure the successfulness of EVs in Iceland (Kjartansdottir, 2013). This research study is aimed at examining and assessing the future of electric cars in Iceland, in terms of market readiness and growth opportunities. Significance of the Research.

EVs (electric vehicles) can be considered as one of the greatest initiatives towards sustainable and cost effective Icelandic transportation sector. It has been documented in the study of Nemry and Brons (2010) that EVs have opened new doors for Iceland, in terms of minimizing fuel cost and reducing excessive emission of green house gases. However, several concerns are also associated with this technology, in terms of battery issues and higher prices. This research study may help in understanding and examining different aspects, which are related to the electric cars; hence, identifying the potential growth and opportunities for EVs in Iceland. In accordance with the study of Hreinsson (2009), when new technology or products enters into the new market, it is significant to recognize the potential challenges and growth opportunities,

associated with that product. Thereby, this study may help in examining the probabilities, which are associated with the market readiness and growth opportunities for EVs in Iceland.

### **Objectives of the Research**

One of the major objectives of this study is to inspect and examine the future of electric cars in Iceland, in the context of growth opportunities and market readiness. It has been assessed that market competition, economic status, as well as government incentive are found to be the greatest factors, which may influence the adoption of new technology and products. Thereby, it is essential to recognize and estimate the factors, which may affect the buying behavior of the consumers.

### **Literature Review: Past, Present, and Future of Electric Cars**

It has been established from the analysis of the study, which was conducted by Helmers and Marx (2012) that the European Automobile Manufacturers Association has categorized the pre-existing electric vehicles into three types. These categories include BEV (battery electric vehicles), EREV (extended range electric vehicles), and PHEV (plug-in hybrid vehicles). BEV can be understood as the vehicles, which uses battery as primary power source. On the other hand, EREV is the vehicle which utilizes battery as a primary source of energy for daily trips, but also utilize combustion engine (mainly depends on the burning of hydrocarbons), in order to overcome battery limitations (Dvorak, et al, 2011). However, PHEV uses battery as a main source for daily trips, but usually runs on the common hybrid mode, along with the hydrocarbon based combustion engine.

According to Nemry and Brons (2010), electric cars have emerged since the era of 1830's and the most initial electric vehicle was launched during the era of late 80's. During that era, most popular electric vehicle was the Detroit Electric and 1914 model, which had a maximum range of 130 km. It has been assessed that the sales of EV started to decelerate, because of the emergence of cost-cutting gasoline car and Henry Ford's mass production in the year 1912.

Another factor behind the declined demands electric vehicle includes the development of the starter motor. According to Helmers and Marx (2012) electric car reappeared during the era 90's, when leading car manufacturing companies, like GM, Ford, Honda, and Toyota presented the idea of electric cars. Afterwards, during 2010, the idea of electric cars got tremendous boost, because of economic recession. Furthermore, increased gasoline prices as well as environmental awareness also led the automakers and governments to reconsider the production of electric cars.

Researches of Shafiei, et al (2012) have revealed the fact that the United States and Japan are the biggest manufactures of electric cars, followed by China and Europe. According to Nemry and Brons (2010), estimated global sales for electric cars, during 2011, is ranged from 45-50.000. Mitsubishi i-MiEV and the Nissan Leaf are the leading sellers, along with 11.000 i-MiEV's and 23.000 Leaf's sold that year. It is expected from the analysis of continually increasing adoption rates of electric vehicles that the conventional vehicles will be completely

replaced by electric cars. It is due to the fact that electric cars offer extensive range of benefits to its consumers, in the context of price, efficiency, and sustainability of the environment (Hreinsson, 2009).

### **Potential Economic Effects of Electric Cars**

According to Shafiei, et al (2012), road vehicles or automobiles are the leading consumers of the imported oil. Additionally, second biggest oil consuming sector in Iceland is airplanes and fishing. Thereby, the switch from imported energy resources to domestic energy for vehicles will have appreciable impacts on the economy of Iceland. It has been acknowledged in the report of Icelandic Ministry that the evolution from conventional cars to electric cars will present wide range of economic benefits to the Iceland (Hauksdottir, 2010). It is due to the fact that the domestically produced electricity will be utilized, instead of importing oil from other countries; hence, result in the attainment of economic development and growth.

### **Auto Market of Iceland**

The analysis of Icelandic auto market may considerably assist in assessing and evaluating the current trends, as well as the potential of growth and market readiness for the innovative and advanced technology, i.e., electric cars (Ho & Huang, 2014). The proceeding manuscript encapsulates the assessment of different characteristics, which are associated with the auto market of Iceland.

### **Government Policy – Greenhouse Gases**

In the year 2002, the Icelandic government took an initiative to control and minimize excessive emissions of green house gases. According to the Ministry for the Environment (2014), the government of Iceland established a new policy, which aimed at ascertaining the legally binding limits, which were defined by Kyoto and enhance the appropriation of carbon. Helmers and Marx (2012) have stated that the main objective of the Kyoto agreement was to control the hazardous emissions and up to 90%. Additionally, another policy was added up into the agreement, which aimed at reducing approximately 50%-75% of the emission, by the year 2050. In such situations, Iceland has discussed for new commitment period, 2013-2020 and concurred to control and reduce the emission of carbon dioxide gas by 30 percent (Wolf, et al, 2014).

### **Green vehicles**

Iceland has recently adopted the approach of green development, in terms of automobiles and cars. In this account, the manufacturing companies are intending to fabricate low emission cars, in order to ensure environmental integrity and sustainability (Levi, et al, 2010). Therefore, it can be affirmed that electric cars have a range of growth opportunities and market readiness in Iceland.

## **Electric Cars in Automobile Market of Iceland**

The electric vehicle market of Iceland can be referred as niche market, because of its price, technology, and small size. Several studies have been carried out, in order to bring electric cars from niche market to mass-market. For the year 2015 it is estimated that 715 electric cars (0,35% of passenger cars) will be driving in Iceland, doubling every year since 2011 when only 15 electric cars were registered and driving. It was observed that the majority of electric cars are owned by commercial sector and very few of them are privately owned (Crist, 2012), but since then private ownership has picked up (data update: Transportation Authority 2015). Of the electric cars that are available in the Icelandic vehicle market, including Citroen C-Zero, from Brimborg and Mitsubishi i-MiEV, from Hekla. The price of these cars are quite similar, i.e., 3.890.000 ISK. Nissan Leaf is another electric car, which has been launched in the auto market of Iceland (Hauksdottir, 2010). This car has been chosen as the car of the year in the 2011, in Europe, as it offers appreciable benefits, including battery life and overall efficiency.

## **Challenges of Electric Cars**

Wide ranges of benefits are associated with the utilization of electric cars, in comparison with the vehicles, which are based on the internal combustion engine. Apart from this, various different challenges are also associated with the utilization of electric cars. According to Crist (2012) battery is the most crucial issues in electric cars, as it gives boost to other issues, like safety, price, lifetime, and quality. Apart from this, range, infrastructure, and charging time are other issues, which are related to electric cars. Levi, et al (2010) has avowed that all of these challenges are playing a major role in affecting the purchasing decisions of consumers, as they do not feel it feasible to switch from their comfort zone of conventional, fuel-based vehicles. Some of the most prominent challenges/issues are incorporated in the proceeding manuscript.

## **Battery Problems and Range Anxiety**

According to Amundsen (2014), tremendous and rapid advancements have been observed in the battery technology, it is also established that the technology has gone through the unstable and turbulent times. Undoubtedly, this technology has considerably improved in the past few years, but still it possesses certain disparities. According to Hauksdottir (2010), the majority of the electric vehicles are equipped with lithium-ion batteries. The technology of lithium-ion batteries are the most optimum and effective solutions for electric cars, as they possess high charging possibilities and energy densities. Apart from these benefits, these batteries also pose certain drawbacks, including battery aging (Driscoll, et al, 2012). Battery aging has become one of the greatest concerns for the users as well as producers of the electric cars.

Crist (2012) has contended that because of considerable advancements in material sciences, lithium batteries have made significant progress, since the era of 90s. The power specificity and energy specificity (2000-4000 W/kg; 100-150Wh/kg) of lithium ion batteries are capable enough to fulfill the need of electric cars. Certain other factors, including discharging situations, humidity, and temperature may influence the performance and capacity of the battery. In order to resolve this issue, researchers are intending to invent more integrated and improved

solutions. It is expected that these solutions will incredibly improve the durability and life of the batteries, which are being used in electric cars. Range anxiety or range per charge is an issue for the driver of electric car and is usually termed as the fear of becoming trapped with the discharged battery. According to Hauksdottir (2010), range anxiety can be understood as the most prominent barrier in the espousal of electric vehicles; hence, becoming greatest concern for the manufacturing companies.

### **High Price and Viecle Depreciation**

Pricing of the products are one of the crucial challenges, which are being faced by the producers of the electric vehicles. Major cost drivers of electric cars include lithium-ion batteries, as the overall cost of these batteries is considerably higher and it can be estimated for 25 to 50 percent of the total cost of production. According Green Car Report (2015) the lack of battery and charging standards and high replacement cost the life of the battery limits the utility of the car to about 8 years versus average of 13 years for combustion engine cars. Unless improvements are made about the battery lifetime and cost reduction of replacement batteries more rapid depreciation of electric cars remains the highest operational cost compared to conventional passagers cars.

### **Infrastructure and Charging**

According to Hreinsson (2009), the countries which have started to utilized plug-in hybrids and electric vehicles, are at different stages of the implementation and application of a charging infrastructure. In this account, Amundsen (2014) has claimed that the governmental entities of some of the countries are also providing financial support to the charging projects. However, other countries are dependent on financially viable business models and investors. In some of the regions of the world, the selling of electricity is considered to be an illegal activity, if the supplier does not have proper permission or license. Apart from this, electric car's infrastructure is another biggest hurdle, in the adoption of electric cars. It is observed that consumers usually show reluctance in purchasing electric cars, when they are not sure about the supportive platform.

### **Materials and Methods**

This research study has adopted mixed quantitative and qualitative approach of data collection. One of the major goals, behind the adoption of this research method was to gather pertinent and ample data about the given topic of research. Secondary qualitative research method was chosen to collect unbiased information, in a convenient, cost effective, and integrated manner. It is significant to bring into the notice that secondary method of data collection has enabled the researcher to gather the desired information in a timely and cost efficient manner. In order to collect diversified information, the researcher has accessed a number of libraries. Some of the most prominent libraries include JSTOR, Emerald, EBSCOHost, and IEEE. All of these libraries have indispensably assisted in the acquisition of authentic, reliable, up-to-date, and credible information. Additionally, various other sources of data, including journals, text books, and governmental reports have also been considered in this research study.

Apart from this, primary quantitative data was acquired by conducting a survey questionnaire with the Icelandic citizens. It is significant to bring into the notice that participants of the research were informed by the preliminary text, affirming that participation was voluntary and it will barely take four to five minutes. The researcher also assured to keep the confidentiality and privacy of the participant's information, in order to avoid any disparity and unfavorable situation. The selection of participants was random and the survey was conducted with the random consumers of Iceland and was posted on the online social network. The questionnaire was open-ended and incorporated five point likert scale having the options of strongly agree, agree, neutral, disagree, and strongly disagreed. The obtained data was tested on the SPSS (Statistical Package for Social Science) software, in order to have more cohesive and valid information about the growth opportunities of electric cars in Iceland.

### Results and Discussion

This research study has examined the future of electric cars in Iceland, in the context of analyzing market resources and growth opportunities. In this regard, the researcher has adopted mixed methodology (qualitative and quantitative). The qualitative data was acquired by accessing different secondary resources and primary quantitative data was collected through conducting a survey questionnaire. The survey was carried out with the citizens of Iceland, without having any restrictions on the age and gender of the participants. Random participants were selected for the survey and the questionnaire was posted on the online social network.

When the participants were asked about the harmfulness and hazardous emissions, which are related with the use of conventional cars, 34 percent of the participants were strongly agreed with the statement. However, 40 percent of the participants were agreed that the conventional cars are one of the major sources of hazardous and harmful emissions. On the other hand, 21 percent of the participants gave neural responses, 4 percent were disagreed with the statement and only 1 percent of the participants said that they are strongly disagreed with the statement (see table 1.1). This shows that the inhabitants of Iceland understand the limitations and constraints, which are associated with the utilization of conventional cars. Therefore, it can be affirmed that electric cars have tremendous opportunities, in terms of future growth and development. Below mentioned table and pie chart incorporates the acquire responses from the participants.

Table: 1.1 Conventional cars are one of the major sources of harmful and hazardous emissions

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	34	34.0	34.0	34.0
	Agree	40	40.0	40.0	74.0
	Neutral	21	21.0	21.0	95.0
	Disagree	4	4.0	4.0	99.0

Strongly Disagree	1	1.0	1.0	100.0
Total	100	100.0	100.0	

In order to reduce and overcome the vulnerabilities of conventional fueled cars, it is essential to adopt an adequate and effective alternative, in the form of electric cars. It is due to the fact that electric cars are found to be one of the greatest initiatives towards sustainable environmental conditions. When it was asked to the participants, 30 percent of the participants strongly agreed with the statement. However, 44 percent agreed and 19 percent of the participants gave neutral responses. Besides that, 5 percent of the participants said that they disagreed with the statement and only 2 percent strongly disagreed with the statement (see table 1.2). This shows that the residents of Iceland understand the risks, associated with the use of conventional fuel based vehicles. Thereby, it is assumed that they will considerably appreciate electric cars, as they offer environmental sustainability.

Table 1.2 Electric cars are the greatest initiatives towards sustainable environmental conditions

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly Agree	30	30.0	30.0	30.0
Agree	44	44.0	44.0	74.0
Neutral	19	19.0	19.0	93.0
Disagree	5	5.0	5.0	98.0
Strongly Disagree	2	2.0	2.0	100.0
Total	100	100.0	100.0	

Apart from several benefits, one of the greatest limitations of electric cars includes high purchase and maintenance costs. Although maintenance and purchase prices are high, but electric car offers long-term benefits to its users. When it was asked by the participants, 29 percent of them strongly agreed with the statement. On the other hand, 39 percent agreed with the statement and approximately 23 percent of the participants gave neutral responses. However, only 9 percent disagreed with the statement (see table 1.3).

Table 1.3 Electric cars have high purchase and maintenance costs

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly Agree	29	29.0	29.0	29.0
Agree	39	39.0	39.0	68.0
Neutral	23	23.0	23.0	91.0
Disagree	9	9.0	9.0	100.0



Table 1.3 Electric cars have high purchase and maintenance costs

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly Agree	29	29.0	29.0	29.0
Agree	39	39.0	39.0	68.0
Neutral	23	23.0	23.0	91.0
Disagree	9	9.0	9.0	100.0
Total	100	100.0	100.0	

It is assumed that the switch from conventional cars to electric cars, in Iceland, have played an indispensable role in providing economic benefits to the users as well as to the country. It is due to the fact that electric cars eventually reduce the need of imported oil; hence, results in economic outcomes. When it was asked by the participants, approximately 46 percent of the participants strongly agreed with the statement. However, 31 percent of participants agreed and 15 percent gave neutral responses. On the other hand, 6 percent of the participants disagreed with the statement and only 2 percent said that they are strongly disagreed with the statement. This shows that there are potential benefits for the electric cars, specifically in the market of Iceland (see table 1.4).

Table 1.4 Switch, from conventional cars to electric cars have provided economic benefits to the users

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly Agree	46	46.0	46.0	46.0
Agree	31	31.0	31.0	77.0
Neutral	15	15.0	15.0	92.0
Disagree	6	6.0	6.0	98.0
Strongly Disagree	2	2.0	2.0	100.0
Total	100	100.0	100.0	

It has been stated by Amundsen (2014) that electric cars will minimize or completely eliminate the dependence of the country, Iceland, on fossil fuel and imported oil. It is due to the fact that these cars are powered by electricity. When it was asked by the participants, 43 percent of the participants strongly agreed with the statement and 33 percent said that they agreed with the statement. On the other hand, 21 percent of the participants gave neutral responses and 3 percent disagreed with the statement. This shows that the electric cars are the greatest step towards more improved economic conditions, as they offer an opportunity to reduce the reliance on imported oil or other fossil fuels (see table 1.5).

Table 1.5 Electric cars will reduce the dependence of Iceland on imported oil and fossil fuel

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly Agree	43	43.0	43.0	43.0
Agree	33	33.0	33.0	76.0
Neutral	21	21.0	21.0	97.0
Disagree	3	3.0	3.0	100.0
Total	100	100.0	100.0	

Electric cars offers long term benefits to the consumers, in the context of cost efficiency and higher durability. When it was asked by the participants, 32 percent of the participants strongly agreed with the statement. However, 40 percent of the participants said that they are agreed with the statement and 21 percent gave neutral responses. On the other hand, only 7 percent of the participants said that they are disagreed with the statement. Thereby, it can be affirmed that electric cars have high purchase and maintenance prices, but they also offer long terms benefits to its users. The responses of the participants have also revealed the fact that they are interested in the adoption of this technology and this technology is expected to boom the Icelandic market (see table 1.6).

Table 1.6 Electric cars offers long term benefits to its users, in terms of cost efficiency and higher durability

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly Agree	32	32.0	32.0	32.0
Agree	40	40.0	40.0	72.0
Neutral	21	21.0	21.0	93.0
Disagree	7	7.0	7.0	100.0
Total	100	100.0	100.0	

After considering the short-term and long-term benefits of the electric cars, it can be affirmed that the conventional cars must be completely replaced by the electric cars. When it was asked by the participants, 37 percent of them said that they strongly agreed with the statement. However, 42 percent of the participants agreed and 15 percent gave neutral responses. Besides that 5 percent said that they disagreed and only 1 percent strongly disagreed with the statement. This shows that the Icelandic citizens are ready for the adaptation of electric cars, as in place of conventional cars, as they are affecting their affordability (see table 1.7)

Table 1.7 Conventional cars and vehicles must be completely replaced by the electric cars

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	37	37.0	37.0	37.0
	Agree	42	42.0	42.0	79.0
	Neutral	15	15.0	15.0	94.0
	Disagree	5	5.0	5.0	99.0
	Strongly Disagree	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

Electric cars may also assist in reducing the continually increasing global warming and dependence on oil. When it was asked by the participants, 34 percent of them strongly agreed with the statement and 43 percent said that they agreed with the statement. However, 20 percent of the participants gave neutral responses and 2 percent disagreed with the statement. More so, only 1 percent of the participants strongly disagreed with the statement. This shows that the citizens of Iceland understand the benefits and positive aspects of electric cars, in the context of environmental conditions and cost; hence, they will easily embrace this technology (see table 1.8).

Table 1.8 Electric cars and plug-in vehicles are one of the most essential aspects for the future of Icelandic transportation sector, in terms of reducing global warming and increased dependence of oil

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	34	34.0	34.0	34.0
	Agree	43	43.0	43.0	77.0
	Neutral	20	20.0	20.0	97.0
	Disagree	2	2.0	2.0	99.0
	Strongly Disagree	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

It is essential for Icelandic car manufacturing companies to continue their efforts, in the context of fabricating more improved and cost-effective electric vehicles. When it was asked by the participants, 28 percent of them said that they strongly agreed with the statement. On the other hand, 43 percent of the students agreed and 25 percent gave neutral responses. However, only 4

percent of the participants disagreed with the statement. This shows that the Icelandic inhabitants are also intending to switch from conventional cars to electric cars (see table 1.9).

Table 1.9 The car manufacturing companies must continue their efforts, in terms of fabricating more improved versions of electric cars

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly Agree	28	28.0	28.0	28.0
Agree	43	43.0	43.0	71.0
Neutral	25	25.0	25.0	96.0
Disagree	4	4.0	4.0	100.0
Total	100	100.0	100.0	

### Conclusion

This research has explored an idea that Iceland is one of those countries, which have started to replace conventional vehicles to electric cars. Basically, this study has assessed and examined the future of electric cars in Iceland. One of the major objectives behind this activity was to understand the growth opportunities and market readiness. In this regard, the preceding manuscript has encapsulated the analysis of Icelandic auto market. More so, different challenges and issues, in terms of governmental policies and technological hindrances, have also been discussed in the paper, in order to examine the opportunities of EV's growth in Iceland. In order to gather more coherent results, the researcher has adopted mixed methodology. Analysis of different facts and responses has revealed the fact that electric cars have thremenous growth opportunities in the Icelandic auto market given that the range per charge can be improved and battery life can be improved beyond 8 years or be replaced at resonalbe price to obtain at least the same live time as conventional viecles.

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