The advantages of electric vehicles that their current consumers can highlight in order to inspire other consumers to choose a sustainable option.

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ABSTRACT

Electric vehicles have a number of advantages that help people live a more sustainable lifestyle, but the role of their users in encouraging others to embrace them has not been studied. Recent studies have identified three major motivations for people to embrace electric vehicles as a sustainable mode of transportation: personal benefits, moral standards, and hedonic. In this study, we focused on the key benefits of electric vehicles to see what motivations they elicit among car buyers, so that current owners of electric vehicles could highlight them while encouraging other groups of consumers to select electric cars over conventional ones. We noticed that reducing GHG emissions and ownership costs motivate at least two of the key motivations, increasing the likelihood of persuading people to accept EVs to join the consumers with responsible lifestyles.

Keywords: Electric vehicles, motivation, benefit, sustainable lifestyle, conscious consumption

1. Introduction

An unsustainable way of life has resulted in wide-ranging environmental problems, including poor air quality, climate change, and ocean pollution. As a response, businesses manufacture and sell sustainable goods that have less negative environmental effects, with some government support. Consumer acceptance of sustainable products, on the other hand, is slow (Bodur et al., 2015; Prothero et al., 2011). Understanding the underlying motivations for adopting sustainable goods is crucial to intervening and accelerating the adoption of sustainable products (Testa et al., 2015). Green businesses can benefit from this knowledge by tailoring their company and marketing strategies to the motivations of their target customers.

The reasons why consumers adopt sustainable goods have been studied from various theoretical perspectives. Integration of three key motivations has been established as a determining cause for sustainable consumption in one study (Steg & Vlek, 2009). First and foremost, the personal benefits from sustainable consumption have been identified as a significant motivator. If consumers believe that the benefits of sustainable products outweigh the costs, then they are more likely to buy sustainable products (Bamberg et al., 2015). Consumers can see these financial advantages not only during the purchasing process but also during the maintenance process as well. Second, previous studies have indicated that normative motives, or individual perceptions of moral correctness and incorrectness (personal moral norms), play an important role in the purchasing of sustainable goods (Jansson, 2011;

Jansson et al., 2010). If consumers agree that buying sustainable products is the right thing to do, the likelihood of making a green purchase rises. Third, hedonic motivation, or whether sustainable consumption enhances one's emotions, is an important explanation for consumer purchases of sustainable products. Expecting satisfaction and excitement from the purchase of sustainable goods will increase the probability of selecting a green purchase (Onwezen et al., 2013; Rezvani et al., 2017). Rezvani et al. (2018) investigated the interplay and importance of gain, normative, and hedonic incentives for sustainable product consumption in an environment where social norms are also at play. Their findings revealed that while all three motivations are significant in consumer electric vehicle adoption intentions, the direct impact of hedonic motivations on behavioral intention is greater for consumers who perceive high social norms regarding sustainable consumption (Rezvani et al., 2018).

Conscious consumers who now own electric vehicles believe they have a responsibility to the environment and strive to use sustainable goods to improve people's quality of life. Many studies have been undertaken to determine what is most significant to them when purchasing an electric vehicle. According to the results of a study conducted by Peters et al. (2014), enhancing electric vehicles' environmental benefits and offering financial incentives for purchase are essential factors in EV promotion (Peters & Dütschke, 2014) ,therefore, to get more people to purchase electric cars, it appears that emphasizing the environmental advantages of EVs is essential.

Many investigations have been performed to determine what motivates people to purchase electric vehicles; however, few of them have looked at how EV owners can persuade others to do so. The aim of this study is to look at how people who live in a sustainable manner can encourage other customer groups to make environmentally friendly decisions while buying products. In this research work, we are attempting to emphasize the factors that EV owners can highlight in order to assist other groups in choosing a sustainable way of life. To achieve this goal, we use the most recent research results to demonstrate that raising public consciousness about the source of electricity used in the charging process of electric vehicles would result in a substantial reduction in CO2 emissions. Furthermore, we show that electric vehicles have lower maintenance costs than traditional cars, which should be stressed by EV owners to inspire people to buy environmentally friendly vehicles. Through categorizing these aspects and their consequences in one of the above-mentioned motivations, buyers of electric vehicles can better understand why these benefits can be used to persuade other groups to buy a sustainable vehicle. In the last section of this paper, we propose several ways to effectively deliver these motivations by sharing the experiences of people who use electric vehicles and attempting to increase the number of people who live in a sustainable manner.

2. Theory

The contribution of electric vehicles to reducing greenhouse gas (GHG) emissions is the primary reason for public interest in their adoption and use. Owners of electric vehicles must consider how effective their choice is in terms of improving air quality and reducing emissions, which is the primary cause of global warming. Only in this way would they be able to persuade other vehicle owners to select a sustainable vehicle as part of their buying process, since, as previously mentioned, environmental benefits are one of the most important factors in convincing people to purchase an electric car. We also need to talk about how electric cars are more cost-effective in terms of

maintenance after purchase, which helps to offset their higher purchase price, which is a barrier to purchasing a sustainable form of transportation.

1. Emission reduction from electric cars

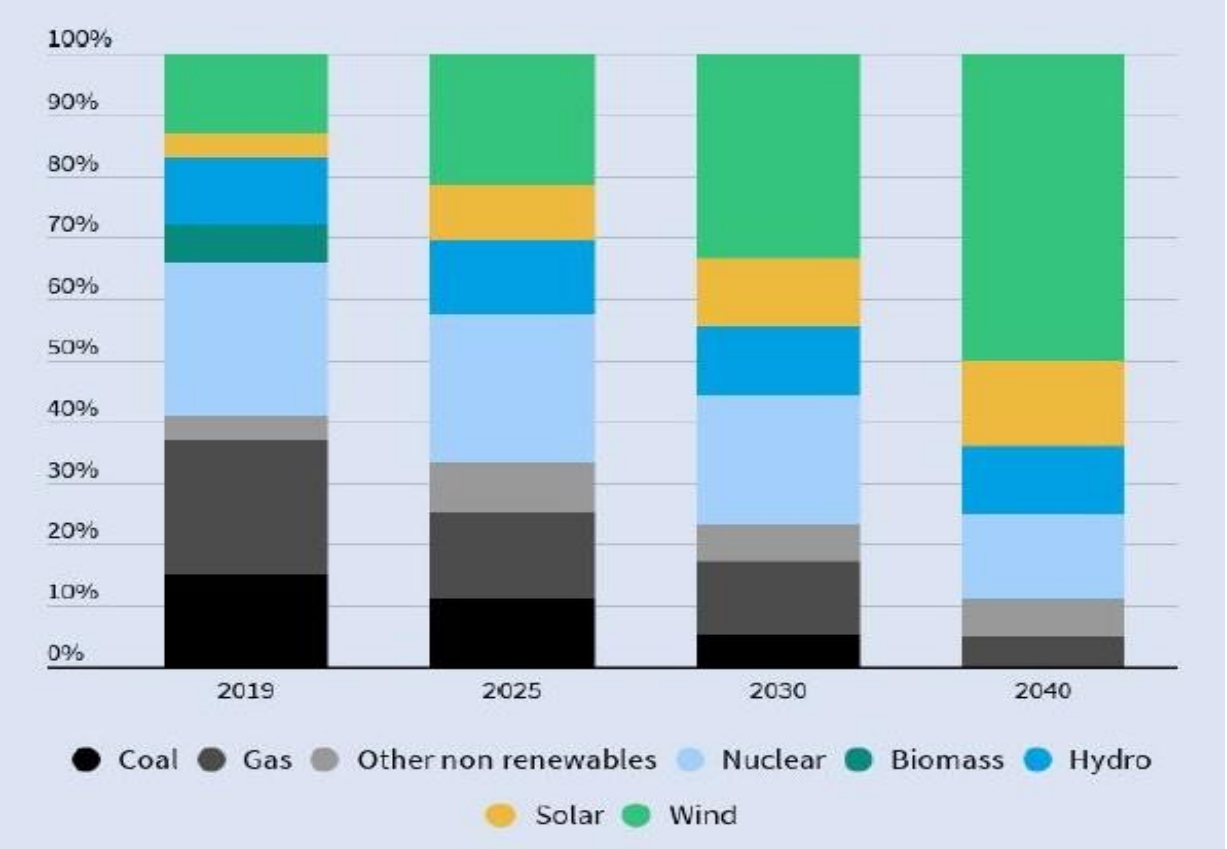
One of the reasons why the number of electric vehicles on the road is still small is that customers' expectations of their benefits in terms of mitigating climate change by lowering GHG emissions have not yet matured (Rezvani et al., 2015). As a result, it's important that existing and future electric vehicle users have a greater understanding of how clean EVs are and how they help to reduce emissions not only in current time but in the future.

1.1. Evolution of Emission factors

Many reports suggest that diesel and petrol cars emit no more greenhouse gases than electric cars, making many potential customers hesitant to buy a sustainable vehicle, despite recent meta-studies showing that EVs emit significantly less emissions (Hall & Lutsey, 2018). Some life-cycle assessments that show no noticeable difference in emissions reduction between EVs and conventional vehicles are based on outdated or inaccurate assumptions and study theories for electric vehicles that do not represent the current state of the technology or its recent or future developments (Transport & Environment, 2020). For example, according to a research, electric vehicle batteries are now three times cleaner than they were two years ago (Emilsson & Dahllöf, 2019). Other incorrect assumptions included the assumption that the power grid would not decarbonize during the use of electric vehicles that emission values for conventional vehicles were unrealistic, and that battery evolution in terms of long-distance efficiency was not taken into account.

It is important to take a look at the evolving factors determining EV life-cycle emissions in the near future in order to provide up-to-date details on their contribution to reducing CO2 emissions. One of the important factors in the assessment of electric cars' emissions is the calculation of the carbon intensity of a country's electricity grid. This can be done by bottom-up calculation based on realistic electricity generation mix evolution, factors of emission for different energy sources, and electricity transmission and distribution losses (Transport & Environment, 2020). According to the T&E report, electricity output mixes in EU countries will adjust based on some scenarios describing the European energy future up to 2050, which show renewable electricity generation increasing from 35% in 2019 to 43% in 2025 and 55% in 2030 (Figure 1). This rapid adoption of renewables has a major consequence: an EV purchased today will continue to get cleaner over time, which is something that previous studies have not taken into account. To reflect the correct understanding of reducing emissions, the carbon intensity of the grid should be estimated based on total life cycle CO2 emissions. For example, the calculated EU countries' average carbon intensity of the electricity grid is 319 gCO2e/kWh in 2020, 168 gCO2e/kWh in 2030, and 84 gCO2e/kWh in 2040.

Figure 1: Electricity generation mixes in the EU (ENTSO-E 2020 TYNDP)



Another significant factor in evaluating electric vehicles' contribution to a sustainable environment is battery production emission, which is often debatable when it comes to whether or not EVs are successful in reducing emissions. Since the electricity used to manufacture batteries will change in the future, emissions from the battery manufacturing process should be forward-looking. Furthermore, scientific evidence from recent battery plants indicates that by improving the heating source, emission ranges can be reduced from 150 to 200 kgCO2e/kWh (2017) to 61 to 106 kgCO2e/kWh (Emilsson & Dahllöf, 2019).

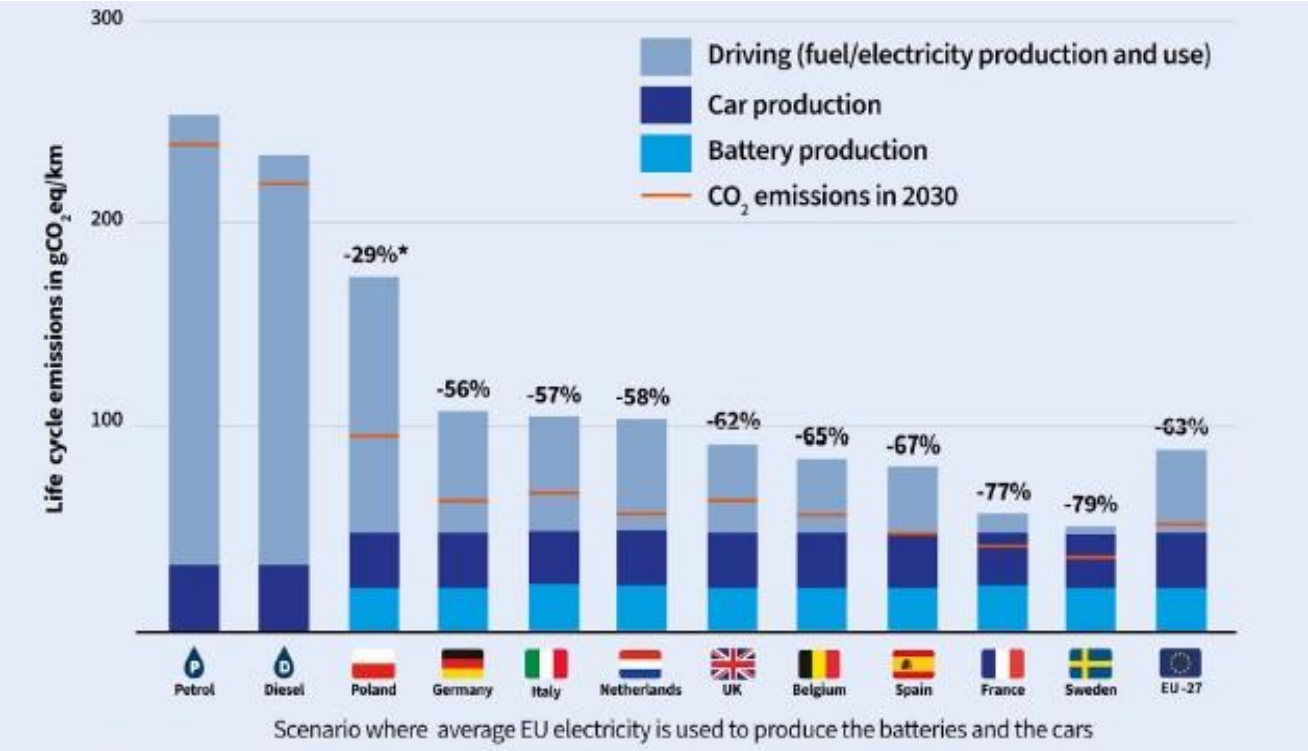
1.2. Amount of Emission reduction by electric cars

A medium-sized EU-average electric car emits about 90 gCO2e/km over its lifespan, while a diesel car emits 234 gCO2e/km and a gasoline car emits 253 gCO2e/km, including upstream emissions, for cars sold in 2020. Therefore, EVs, diesel cars and gasoline cars emit 20 tons, 53 tons, and 57 tons of CO2 over their lifetimes, respectively. Consequently, on average in the EU, electric cars emit 2.7 times less CO2 than conventional cars in 2020.

As previously mentioned, the carbon intensity of the electricity used to charge electric vehicles has the greatest impact on EV CO2 emissions over their lifespan. In this circumstance, assuming that electric cars used in the EU have batteries made with EU average electricity, the only difference is the electricity used to charge the vehicles, which varies from country to country. For example, if an EV is

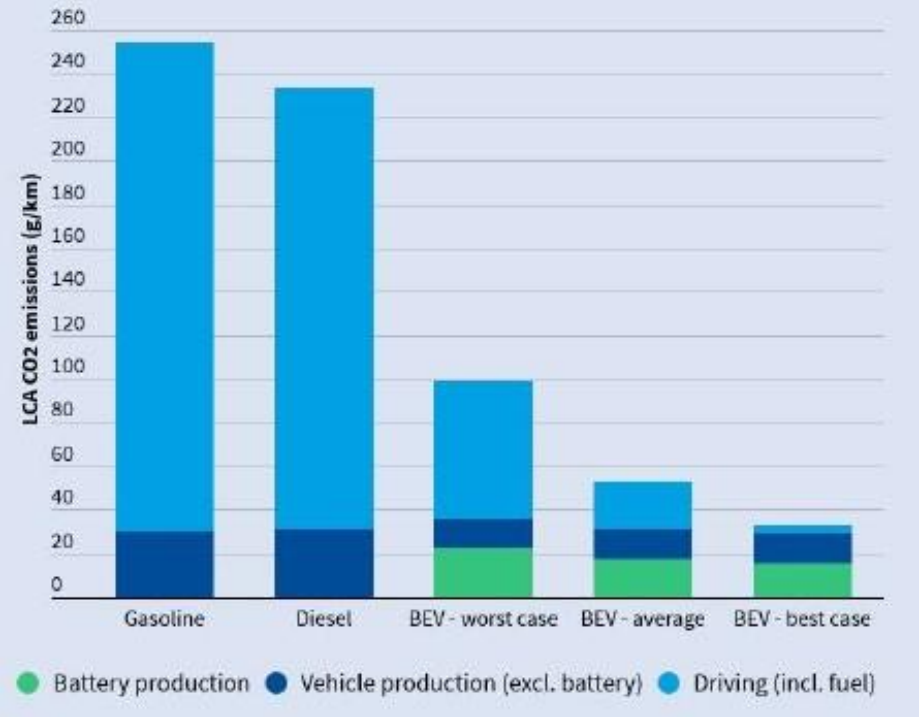
recharged in Poland, the country with Europe's most carbon-intensive electricity grids, it emits 26% and 31% less carbon than diesel and gasoline vehicles, respectively. Electric vehicles can be more than two times cleaner than conventional cars if they are charged in the Netherlands and Germany.The cleaness amount of EVs in France and Sweden is four to five times (Figure 2).

Figure 2: Lifetime CO_2 emission savings from electric cars in key EU countries



To highlight the lower emission caused by electric vehicles, we should look at the lifecycle emissions of EVs sold in 2030, which shows how EVs can continue to get cleaner. As shown in Figure 3, EV emissions are significantly lower in 2030 compared to 2020, accounting for 41% lower on average of electric cars. Because of rapid energy decarbonizing until 2030, an average EU medium EV is 4.2 times cleaner than a diesel car and 4.5 times cleaner than a gasoline car.

Figure 3: Lifetime CO_2 emissions of an electric car in 2030



2. Reduction in costs of the electric vehicle ownership

When purchasing a car, many people underestimate the importance of maintenance and repairs. Fuel and maintenance costs can add up to much more than the original purchase price of a conventional gas-powered vehicle over its lifetime. However, even though EVs have higher upfront costs, they can save consumers a lot of money in the long run on operating expenses.

2.1. Resale value of electric cars

The electric vehicle market is rapidly evolving, owing to significant reductions in battery costs over the last decade. The expanded driving range is one of the most notable improvements. The sharp improvement in range delivers far more utility for many consumers which is likely to be reflected in higher resale values. According to a study that looked at how the values of electric cars will hold up over time, existing longer-range battery electric vehicles (BEVs) are expected to hold their value almost as well as comparable internal combustion engine (ICE) vehicles over the next five years. Furthermore, over the same time span, plug-in hybrid electric vehicles (PHEVs) are expected to keep their value almost as well as conventional hybrids in the same vehicle segment (Harto, 2020).

2.2. Maintenance costs of electric vehicles

Since electric motors and other drivetrain components have less moving parts than internal combustion engines and do not require fluid changes, electric vehicles (EVs) are supposed to be less expensive to maintain. According to Consumer Reports, pure electric vehicles need less maintenance and are less expensive to maintain than gas-powered vehicles. While the higher purchase price of an electric

vehicle could deter some buyers, converting from a conventional gasoline-powered vehicle to an electric vehicle can be a great way to save money over the vehicle's lifetime (Preston, 2020).

The findings of the report, which included hundreds of thousands of EV users, indicate that electric vehicle owners spend half as much on repairs and maintenance. As opposed to a gasoline-powered car, consumers who buy an electric car can expect to save $4,600 in repair and maintenance costs over the life of the vehicle. According to vice president of marketing and sales at RepairPal, EVs cost about $900 a year to repair and maintain by the time they hit their fifth year, which is when costly things like tires wear out, while equivalent gasoline-powered vehicles cost about $1,200.

The reason for this lower cost of maintenance for EVs is that ordinary maintenance items in EVs include the cabin filters, tires, braking pads, and suspension components, such as shock absorbers, steering tie rods ends, and ball joints. Cooling system in EVs is similar to gasoline engine's radiator system in using antifreeze but because contamination by engine oil or combustion byproducts has a zero chance, it rarely needs to be changed. Since EVs and some hybrids use the resistance from the electric motors to slow the vehicle, brake pads aren't used as much as they would be in a gasoline-powered vehicle. On the other hand, the relative simplicity of electric vehicles eliminates the need for oil changes and engine tune-ups that we are all familiar with in gas cars.

Based to the results of an analysis in the Consumer Reports website, repair and maintenance costs per mile for two types of EVs and traditional cars have been measured, and it has been proven, as shown in table 1, that on average, conventional car costs are nearly double those of electric cars over the course of their lives, though this amount is slightly higher for conventional cars in the first 50000 miles.

Table 1: Estimated Per-Mile Repair and Maintenance Costs by Powertrain. BEV (Battery Electric vehicle), PHEV (Plug-in Hybrid Electric Vehicle), ICE (Internal Combustion Engine Vehicle)

Powertrain Type	0-50K Miles	50K-100K Miles	100K-200K Miles	Lifetime Average
BEV	$0.012	$0.028	$0.043	$0.031
PHEV	$0.021	$0.031	$0.033	$0.030
ICE	$0.028	$0.060	$0.079	$0.061

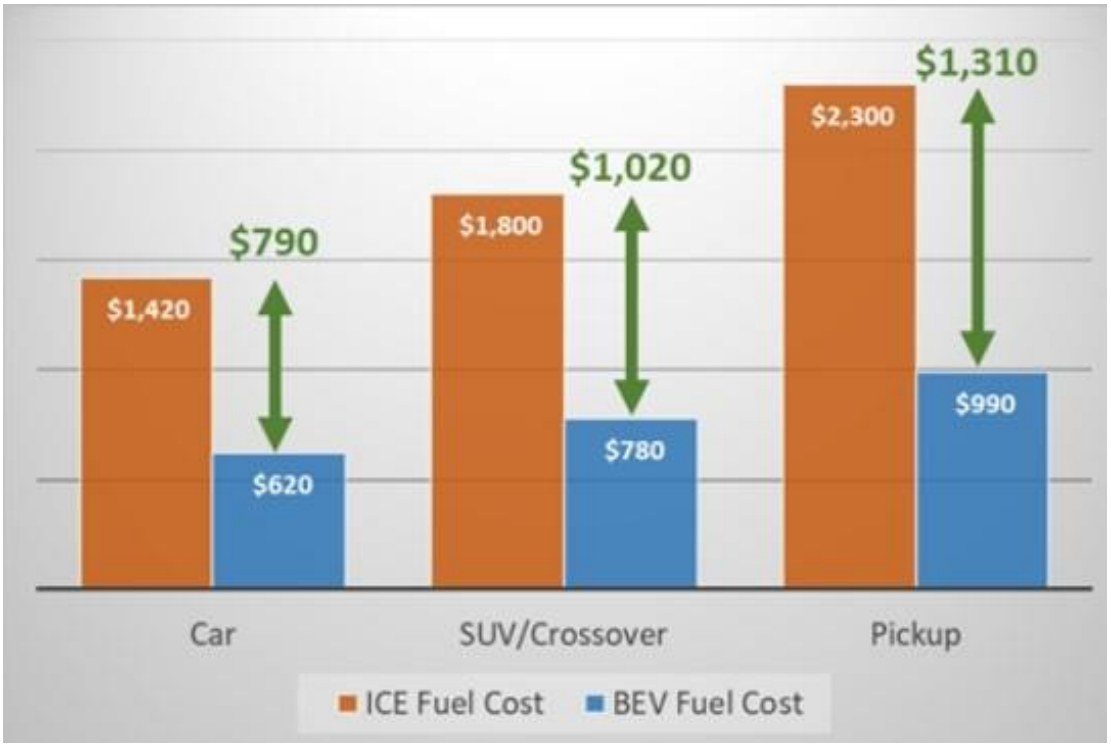
2.3. Fuel cost savings

Consumers of EVs will benefit from home charging in a variety of ways, one of which is the ease of not having to stop at a gas station several times per month. Furthermore, charging a BEV at home is far less costly than paying for fuel.

Figure 4 illustrates the estimated fuel savings a buyer would realize by purchasing an EV, comparing the cost of fuel for ICE vehicles versus BEV vehicles over 15,000 miles, the projected average annual

mileage for new vehicle owners. Even when charging at comparatively costly DC quick chargers is factored in, BEVs are estimated to cost around 60% less to fuel than comparable ICE vehicles, resulting in annual savings ranging from $800 to $1,300, depending on vehicle class (Preston, 2020).

Figure 4: Estimated Fuel Cost for 15,000 Miles by Vehicle Class

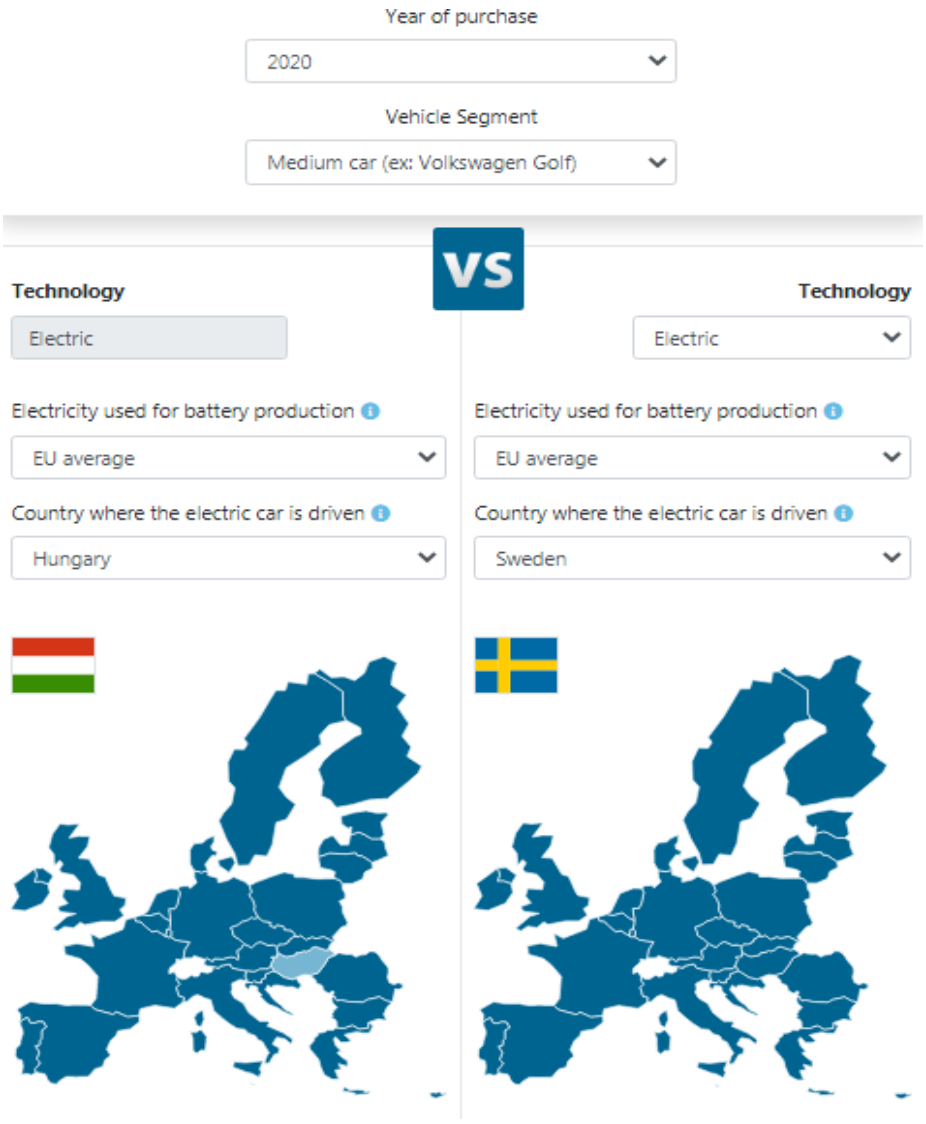


3. Methodology

We based this study on the findings and data from previous studies and credible reports available on the internet about CO2 emissions and maintenance savings from switching from conventional cars to electric vehicles. We used two developed tools on Transport and Environment, as well as the CHARGEVC websites, to obtain a greater understanding of how to reduce emissions and costs of usage and maintenance. These two tools, by providing precise amounts of reduced emissions and fuel savings, help people better understand the effect of electric vehicles on their quality of life.

The tool developed by Transport and Environment website complies with the most up-to-date data on CO2 emissions linked to the use of an electric, diesel, and petrol car. It takes into account all possible criteria such as the amount of CO2 emitted when electricity is produced or fuel is burnt, as well as the carbon impact of resource extraction for batteries or of building a power plant. In this study, we used this tool to compare lifetime CO2 emissions of an electric car is being used in Hungary with lower use of renewable energy in its electricity grid (high carbon intensity) and Sweden as a country with high use of renewable energy in its grid (low carbon intensity) as two electricity generation scenarios for cars are purchased in 2020 in medium-sized vehicle segment (figure 5).

Figure 5: Compare the lifetime CO2 emissions of an electric car in Hungry with another electric car in Sweden, Purchased in 2020 and Medium-sized segment.



To use the CHARGEVC website's tool to provide a distinct amounts of expenditures when driving a gas car and an electric car, we set the distance traveled to 30 miles per day.

In order to answer to the research questions, we will find a relation between any of these advantages of EVs with the motivations are mentioned in the introduction part that conscious consumers of EVs can elaborate on to inspire other groups to promote their life style to a sustainable way of life.

Findings

The results from CO2 emissions in consequence of using an electric car in Hungary and Sweden are 80gr/km and 51gr/km respectively, showing the difference of emissions in their lifetime will be equal to approximately 11 tons of CO2.

The amount of money would be saved by changing to an electric car from conventional one which uses gasoline as fuel per year, is equal to 798 USD based on the result came out by using CHARGEVC website's tool as shown in Figure 6.

Figure 6: Yearly savings on fuel when using an electric car instead of a gas car for daily 30 miles travel

4. Discussion and Conclusion

The features of electric vehicles that can be highlighted by their owners as conscious consumers to encourage other groups of people to choose sustainable options when buying a car were investigated in this study. To achieve this target, we first searched for motivations that would influence car buyers' decisions to select electric cars over internal combustion engine cars, resulting in a sustainable transportation, and avoiding global warming and climate change. Finding connections between the benefits of electric vehicles and motivations that would encourage people to use sustainable products will provide strong ideas for conscious electric vehicle consumers to effectively invite other consumers to adopt a sustainable lifestyle.

Electric vehicles, as we learned from the theory, can reduce emissions dramatically in any situation where electricity is produced. However, when using a clean energy electricity grid, this reduction in GHG emissions would be much greater than if a high-carbon intensity grid is used. This fact may indeed be related to the normative and hedonic motivations of people looking to purchase a new car or replace their current vehicle. People would feel morally right if they purchase a product that will improve their environment's state. Their sense of satisfaction would be heightened as a result of their commitment to improving environmental quality and, as a result, their own lives.

Knowing that using electricity generated from renewable energy will reduce emissions even further would encourage EV owners to charge their cars with a cleaner source of energy. As a result of getting

a thorough understanding of how EVs reduce greenhouse gases, electric vehicle owners may be assisting themselves in becoming a responsible community of consumers who prefer a sustainable way of life by joining those who already use renewable energy sources to meet their electricity needs. This goal, however, is contingent on the government's actions and intentions to build the necessary infrastructure for people to use renewable energy-generated electricity.

In this research unlike previous studies, we want to see whether, in addition to being cleaner, other aspects of electric vehicles, such as the key elements of lower EV ownership costs emphasized by their owners, would inspire other groups of customers to embrace EVs. One of the biggest worries of people who want to adopt EVs is that they think electric cars will lose their value more and faster than their conventional peers. Knowing that the electric cars will keep their value same as conventional cars would provoke their gain and hedonic motivations. The personal benefits and hedonic motivations of electric vehicle consumers will be enticed by their lower maintenance costs because it is self-evident that it saves EV owners money on repairs, resulting in a higher level of satisfaction with owning such a car. Moreover, a lower budget spent on fueling EVs will inspire consumers by all three key motivations: gain, moral norms, and hedonic motivations. Spending less on fossil fuels gives people the impression that they are doing something morally right and beneficial for society and the environment. Furthermore, saving money on gas provides customers with personal benefits and therefore satisfaction. We compiled all of the results in table 2 to summarize the relationships between these electric vehicle benefits and the determining motives.

Table 2. Relationship between selected electric car benefits and motivations of EV adoption

Motivations / **EV Benefits**	**Personal benefits**	**Moral norms**	**Hedonic**
Reducing emissions	------	X	X
Holding resale value	X	------	X
Lower maintenance costs	X	-----	X
Fuel costs reduction	X	X	X

Other benefits for EVs can persuade people to choose them, but current consumers who want to help other groups of consumers become more motivated should concentrate on the benefits we described in this study because, as we can see, they induce at least two key motivations to embrace EV transportation, while other benefits may only inspire one such as buying and using electric cars as luxury goods.

Aside from emphasizing the advantages, current consumers can help improve other consumer groups' knowledge of electric vehicles, thereby increasing their interest in adopting them, by joining any EV user associations. This will give the organizations enough bargaining power to affect government decisions in favor of those who have chosen a sustainable lifestyle. As previously stated, EV-related research suffers from a lack of reliable data, so EV owners can record any data about electric vehicles, such as costs and technical issues, and then share it with others looking to purchase one. This information can be shared with others via social media, apps, or in person. Participating in any electric vehicle research survey can also be one of the best ways to improve other consumers' knowledge and encourage them to buy an environmentally friendly car in order to live a more sustainable lifestyle.

When it comes to content analysis, this could be a good starting point. The new elements that need to be analyzed could be added, but future research could also extend on the numbers of games. It would be interesting to compare environmental games to other serious games that have an aim to educate consumers besides entertainment. Possible research could compare environmental games that target different generations, in this case, children and adults.

Another issue when it comes to environmental games is the lack of longitudinal studies. The real question remains: Are environmental games eventually leading to pro-environmental behavior? Therefore an extensive longitudinal research is needed in order to demonstrate the potential of the environmental games.

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