INSTITUTO
UNIVERSITÁRIO
DE LISBOA

Electric cars implementation pace in the European Continent (a comparison between Norway and Portugal)

Rui Miguel Figueira da Silva Soares

Master in Internacional Studies

Supervisor
PhD, Ana Margarida Fernandes Esteves, Integraded Researcher,
ISCTE - Instituto Universitário de Lisboa

September, 2024

iscte
SOCIOLOGIA
E POLÍTICAS PÚBLICAS

Department of History

Electric cars implementation pace in the European Continent (a comparison between Norway and Portugal)

Rui Miguel Figueira da Silva Soares

Master in International Studies

Supervisor
PhD, Ana Margarida Fernandes Esteves, Integraded Researcher,
ISCTE - Instituto Universitário de Lisboa

September, 2024

Acknowledgements

I would like to thank, first of all, to my dissertation supervisor, for the guidance provided, motivational encouragement, personal availability and exchange of points of views.

I would also like to thank my Master's colleagues for their fellowship spirit and opinions, as well as close friends for their support and encouragement.

Finally, also a special word of appreciation to my co-workers at the Office for Economic Policy and International Affairs - Ministry of Finance of Portugal, in Lisbon - in particular to Carla Alves (Head of Unit), Beatriz Teixeira (Director of Department) and Ana Barreto (Director of Department), and also colleagues at the Camões Institute (Ministry of Foreign Affairs of Portugal), in particular Lígia Figueiredo (Director of Department), for the availability that they provided for the international experience and roles in the Cooperation and International Affairs Departments of these organisations, which was important for the enhancement of this Master's Degree.

Abstract

As an environmental issue, climate change has been emphasised on a global level in the last decade. Its influence is already beginning to be felt through the observed change in climate patterns and the rise in global temperatures.

As we know, there is an urgent need to reduce the emission of greenhouse gases (GHGs) into the atmosphere, which are mainly responsible for these changes. In order to keep the average global temperature rise below 2°C and pursue efforts to reach 1.5°C, GHGs need to be reduced 50% by 2030.

This is where the existence of electric cars, considered to be cars with zero GHGs emissions, comes into the equation. For daily and individual use, it is expected that, due to their technical characteristics, electric vehicles will be fundamental in helping to tackle the climate issue.

In Europe, a continent where, in 2019, 71.7% of all emissions of polluting gases came from the road sector, political concern about these issues began at the beginning of this century. However, there is one country, Norway (a non-European Union country), which holds 1st place on the podium when it comes to implementing electric mobility, where, in 2022, 4 out of 5 new vehicles sold were 100% electric vehicles. Not being the only country on the European continent where electric cars exists, it is important to objectively understand the reasons why this country has been so successful and differentiated in this area.

Is it due to political, economic, cultural or other reasons? This is what this dissertation intends to discover by comparing the results with the Portuguese reality.

Keywords: Climate Change, Electric Mobility, European Continent, Norway, Portugal.

Resumo

Sendo uma questão da área ambiental, as alterações climáticas têm merecido, na última década, destaque a nível planetário. A sua influência começa já fazer-se sentir, através da alteração constatada de padrões climáticos e aumento da temperatura global.

Como sabemos, torna-se urgente a diminuição da emissão dos gases com efeito de estufa (GEE) para atmosfera, principais responsáveis por essas alterações. Para mantermos um aumento da temperatura média global abaixo de 2ºC e perseguir esforços para atingir 1.5ºC, os GEE precisam de ser reduzidos em 50% até 2030.

É nesta equação que entra a existência de carros elétricos, considerados carros com zero emissões de GEE. De uso diário e individual, espera-se que, pelas suas características técnicas, os veículos elétricos sejam fundamentais na ajuda à questão climática.

Na Europa, continente que, em 2019, 71.7% de todas as emissões com gases poluentes provinham do sector rodoviário, começou-se desde o início deste século a se preocupar politicamente com estas questões. Contudo, existe um país, a Noruega (país não pertencente á União Europeia), que detém o 1º lugar do pódio no que respeita à implementação da mobilidade elétrica, e onde, em 2022, 4 em cada 5 novos veículos vendidos eram veículos 100% elétricos. Não sendo o único país no continente europeu onde circulam carros elétricos, importa perceber objetivamente as razões que levaram este país ter tanto sucesso e diferenciação nesta área.

Será devido a questões políticas, económicas, culturais ou outras? É o que esta dissertação se predispõe a descobrir, comparando com os resultados e a realidade portuguesa.

Palavras Chave: Alterações Climáticas, Mobilidade Elétrica, Continente Europeu, Noruega, Portugal.

Index

APPENDICES

Index of Tables and Figures

Index of Tables

Index of Figures

Glossary of Acronyms

AC - Alternating Current

AFIR - Alternative Fuel Infrastructure Regulation

BEV - Battery Electric Vehicle

CCC - UK Climate Change Committee

Cº - Centigrade

CH_4 - Methane

CO - Carbon Monoxide

CO_2 - Carbon Dioxide

CFC - Chlorofluorocarbon

DC - Direct Current

EAFO - European Alternative Fuels Observatory

EEA - European Environment Agency

EC - European Commission

EU - European Union

EV - Electric Vehicle

€ - Euro (currency)

Fº- Fahrenheit

FA - Fundo Ambiental

FCEV - Fuel Cell Electric Vehicle

GEE - Gases com Efeito de Estufa

GHGs - Greenhouse Gases

Gt - Giga Ton

ICCT - International Council on Clean Transportation

ICE - Internal Combustion Engine Vehicle

IPCC - The Intergovernmental Panel on Climate Change

ISV - Imposto Sobre Veículos (Vehicle Tax)

IUC - Imposto Único de Circulação (Single Circulation Tax)

HEV - Hybrid Electric Vehicle

kWh - Kilowatt-hour

MOBI.E - Pilot infrastructure of public charging points

MSP - Mobility Service Provider

NASA - National Aeronautics and Space Administration

NOAA - National Oceanic and Atmospheric Administration

NOK - Norwegian Kroner (currency)

NOx - Nitrogen Oxide

N_2O - Nitrous Oxide

O_3 - Ozone

OECD - Organisation for Economic Cooperation and Development

PHEV - Plug-in Hybrid Electric Vehicles

SO_2 - Sulphur Dioxide

UN - United Nations

UNFCCC - United Nations Framework Convention on Climate Change

USD - United States Dollar

UVE - Electric Vehicle Users' Association

VAT - Value-Added Tax

Introduction

Human activities usually have been appointed as the main cause of the current and future effects of climate change. For many decades, the combustion of fossil fuels such as coal, oil and gas from various sources has led to the proliferation of greenhouse gases, which are recognised as contributing to the retention of the sun's heat on our planet and causing, ultimately, a progressive increase in global temperatures. Being this an international issue which concerns all the countries that compose our globalised world, this is a theme that has no borders. Under the spotlight of international debate and despite of several scientific articles, consensus and agreements (being the most famous the recent Paris Agreement in 2015), the climate challenge is also a matter of climate justice.

In this context, public engagement is also a critical aspect of the response to climate change, which emphasises the importance of involving the general public, communities and various stakeholders (such as policy makers, scientists or even social media) in understanding and addressing it. Furthermore, this engagement has the potential to transform climate change from an abstract theme into a shared question that people feel responsible for dealing with. By engaging others in conversation and action, innovation can create the momentum needed to achieve meaningful and lasting solutions to the climate crisis.

In addition, and in technical terms, the topic of electric vehicles is intrinsically linked to environmental issues. Electric vehicles are often considered a new technology for reducing environmental problems not only in cities, but also in the atmosphere as a whole, as they contribute significantly to reducing total ongoing emissions and, consequently, strengthen the worldwide tackle against climate change.

In this context of electric mobility, it should be noted that exists different types of vehicles that are considered electric (according to their means of propulsion). Therefore, there are Plug-in Hybrid Electric Vehicles (PHEVs), that uses both an electric motor and a gasoline engine, and can be charged from an external power source, using gasoline as a backup when the battery is depleted; Hybrid Electric Vehicles (HEVs), that have an electric motor and a gasoline engine, but they cannot be plugged-in (however, using, also, regenerative braking to recharge the battery); Fuel Cell Electric Vehicles (FCEVs), that are similar to a full electric vehicle, but use hydrogen to generate electricity through a fuel cell, emitting only water vapor as a byproduct, and finally, Battery Electric Vehicles (BEVs), that run´s exclusively on electricity and are powered by a rechargeable battery. In this type of electric vehicle, the battery is charged from an external power source (usually electric charging points or stations), using also regenerative braking to recharge the battery. So, to be clear and to create an investigation focus in this dissertation, I state that *my research will be focused only on the BEVs, or, in other* *words, passengers' vehicles for individual use that run exclusively on electricity and are powered by a rechargeable battery that can be charged from an external power source*.

Norway despite being commonly recognized as one of the biggest oil producers in western Europe, offers also a strong number when referring to electric mobility. In this country, composed of around 5.5 million inhabitants, almost 80% of new cars sold in 2022 were battery-powered, bringing a series of environmental and societal benefits. On the contrary, in Portugal, despite the existence of incentives for the purchase of BEVs, created with the purpose of promoting these vehicles from an environmental protection perspective and to try the increase of their numbers, only 11.1% of passenger vehicle sales in the first 11 months of 2022 were 100% electric. This fact alone, led me to the leading and starting question of this research: *What are the reasons that lead Norway and Portugal to present different sales numbers for new electric cars, during the period 2013-2022?*

So, in short, it can be said that the main goals of my research will be, firstly, to explain the reasons for the difference in values regarding the sale of new electric cars in Norway and Portugal (during the period 2013-2022) and to visualize the efforts that Norway and Portugal have made in this area of the implementation of electric cars in their own societies, in order to contribute to the fight against climate change. However, and even more importantly, from an academic and a social researcher's point of view, with this dissertation I hope to contribute with suggestions for the improvement of current public policies and implemented framework associated with electric mobility in Portugal, to enhance the daily and individual use of this mean of transportation by the Portuguese population. As usually said, we should observe and learn from the most successful examples, so in this case, if Norway had interesting success rates, I think it would be important to take advantage of this opportunity to extract useful insights for my country.

To conclude, regarding to the structure of this dissertation, it begins with Chapter I, which is revised the literature on this subject, highlighting the importance of climate change and its relationship with the electric vehicles. This chapter also describes the main technical characteristics of the world of electric mobility (cars, charging stations, advantages, limitations, etc.), as well examines the European perspective. Afterwards, in Chapter 2, it is presented the principal data figures for electric vehicles in Europe and, particularly, in Norway and Portugal. Later, on Chapter 3, I will try to answer the starting question of this research (described above), seeking, throughout the variables under study, to establish whether the hypotheses are confirmed or not, or if there could be another reason that contributes to answer the original research question. Finally, in Chapter 4, the conclusions of this research are shown, and, based on that, recommendations for a better implementation of BEVs in Portuguese market.

Chapter 1 - Literature review

1.1. Climate change

From the United Nations perspective, "climate change refers to long-term shifts in temperatures and weather patterns. Such shifts can be natural, due to changes in the sun's activity or large volcanic eruptions. But since the 1800s, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels like coal, oil and gas"[1]. According to this world-renowned organisation, the combustion of fossil fuels leads to the production of greenhouse gases (GHGs). These GHG´s that acts like a layer around the Earth, retaining the sun's heat and, therefore, leading to the gradual increase of global temperatures.

Even though that "there is no single, comprehensive account of climate change that can do full justice to the physical manifestations, political discourses and imaginative power of the phenomenon" (Hulme, 2022), its prolonged effects are undeniable. In the last decade, even the language relating to this issue has shifted. The expression global heating has been renamed global warming, a person who is a climate sceptic has become a climate science denier and, lastly, there has been an implementation of the term climate emergency. Also, it is known that, regarding to also to the soils and the health of humans, "climate change creates additional stresses on land, exacerbating existing risks to livelihoods, biodiversity, human and ecosystem health, infrastructure, and food systems" (Masson-Delmotte *et.al*, 2019:15), and particularly, some territories will be facing increased threats, while some regions facing previously unforeseen risks.

To exemplify this concern, there is no greater evidence than the existence of charts from organisations that ensure the credibility of this results. According to the NOAA Climate chart (based on data from the National Centers for Environmental Information) and displayed in Appendix A, the Earth's temperature has increased by an estimated 0.14° Fahrenheit (0.08° Celsius) per decade since 1880, that is, by about 2° Fahrenheit in total (1 degree Celsius). In addition, 2022 was the 6th warmest year on record and the 10 warmest years on recorded history have all occurred since 2010[2]. Plus, "that extra heat is driving regional and seasonal temperature extremes, reducing snow cover and sea ice, intensifying heavy rainfall, and changing habitat ranges for plants and animals - expanding some and shrinking others"[3]. In turn, NASA, a world reference in monitoring the evolution of climate change, published the graph (Appendix B) on its website, which proves, once again, the differences between the years 1880 and 2020 in terms of global temperature, which includes the land mass and oceans.

[1] Available in www.un.org/
[2] See also www.climate.gov/
[3] Available in www.climate.gov/

In this case, the key takeaway is that Earth's global average surface temperature in 2020 statistically tied with 2016 as the hottest year on record, continuing a long-term warming trend due to human activities[4].

It is also worth mentioning that related to this subject, and on a more social level, there is a derivative concept, namely the concept of climate justice. By definition, "climate justice is a framework that brings into view the intersection between climate change and the way social inequalities are experienced as structural violence" (Porter, 2020:293). According to this author, "often presented as a question of human rights, climate justice debates are often focused on the distributional effects of climate change – pointing out that those effects disproportionately burden the poorest and least disadvantaged. Much discussion in the climate justice field has examined the global maldistribution of climate change impacts, particularly between developing and developed nations" (Porter, 2020:293). This subject focuses on the global misallocation of the impacts of climate change, mainly amongst developing and developed countries. And doing so, does it in two broad human groups: "the first is those who have benefited from fossil fuel - and colonialism - enabled economic development and now sit in positions of privilege" (Rickards, 2020:295), and "the second group: the much larger and more diverse population who have long been, and continue to be, exploited and sacrificed in the development processes that have birthed climate change" (Rickards, 2020:295). It can therefore be said that, despite contributing less to climate change and, in fact, already suffering from it, most of the world's population will suffer the worst effects of this global problem.

So, given this scenario, we first need to be aware of the problem and then act globally accordingly to try to minimise it. Contained in the United Nations Sustainable Development Goals, more specifically in "Goal 13: take urgent action to combat climate change and its impacts"[5], as well as in the long-term goal of the Paris Agreement, in which we must keep the "increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels"[6], emissions must be reduced now, needing to be almost cut in half by 2030, which, at the moment, is only 6 years away. Therefore, for this necessary change to happen, it must involve our behavioural practices as a society, something that I will explore in more detail next.

1.1.1. Behaviour changes to address climate change

Changing behaviour is a key aspect of the fight against the climate emergency, since "most of the interventions required to reach global emission reduction targets (i.e., climate *mitigation*) require at least some behavioural change (UK CCC, 2019, *apud* Witmarsh *et.al*, 2021:76) and

[4] See also www.climate.nasa.gov/
[5] Available in www.un.org/
[6] Available in www.unfccc.int/

adapting to the growing impacts of climate change similarly requires significant lifestyle and societal change" (IPCC, 2014, *apud* Whitmarsh *et.al,* 2021:76). So, in this specific topic, there are already two important concepts to note: *climate change mitigation*, which is "the action to limit the magnitude of climate change, often by trying to limit GHG emissions" (Dietz *et.al*, 2020:138)., and *climate change adaptation*, related to the "action to reduce the vulnerability of social systems and ecosystems to climate change" (Dietz *et.al*, 2020:137).

This issue had been emphasised for a long time, since according to Kellogg & Schware (1981:1) "the political, economic, social and ethical implications of a global environmental change must be considered". To further complement, "understanding climate change requires conceptualizations of the interactions between human actions and social structure on the one hand and ecosystem dynamics on the other" (Dietz *et.al*, 2020:137). For these authors, sociology as a science definitely can help to improve the global discussion on the climate crisis and its relationship with society, in which it can be analysed from 3 different angles: On a *macro-scale*, where population and the structure of the political economy are important factors in GHG emissions; on a *meso-scale*, where enterprises actions vary between climate scepticism and active engagement with mitigation or adaptation (although conditioned by political and economic circumstances); and finally, on a *micro-scale*, where both structural social factors (ideology, education, gender, etc.) and psychological social factors (identity, values, perceptions, etc.) influence both public opinion and individual responses to tackling climate change, reflected in the political endorsement, voting or domestic behaviour. Of course, from a more everyday point of view, consumers can reduce their carbon impact by, for example, minimising air travel (replacing it with travel by train), reducing meat consumption (a more plant-based diet) or buying electric or more energy efficient products. For this to happen, communication is, therefore, a vehicle for changing practices.

So, "public engagement is a critical aspect of the response to climate change. Achievement of the required rapid social change with the consent and participation of the population demands effective communication and the active engagement of the public" (Clarke *et.al*, 2020, *apud* Kumpu, 2022:304). Policymakers and professionals dealing with climate change topics should, in this sense, communicate the issue in a recognisable manner that the non-scientific public can understand and that could inspire citizens to take action.

Also, in accordance to the opinion of this author (Kumpu, 2022:306), and quoting others, "there are at least three major contextual factors that have contributed to the way in which public engagement has been adopted as a policy goal and as a research object. First, in science and technology studies, the concept has been related to a move from *deficit to dialogue* in science communication (Stilgoe *et.al*, 2014:5*, apud* Kumpu, 2022:306), in other words from approaching the public as knowledge deficient and in need of education towards pursuing a dialogical relationship with scientists that involves listening to popular views and negotiating the meaning of scientific and technological issues (Carvalho *et.al*, 2017:123, *apud* Kumpu, 2022:306). Second, there has been multidisciplinary research on individual engagement as a psychological construct comprising affective, cognitive, and behavioural dimensions (Johnston, 2018:17, *apud* Kumpu, 2022:306). Third, in political science and political theory, civic engagement has been promoted as a solution to the democratic deficit in decision-making with the potential to increase its quality and capacity" (Berger, 2009, *apud* Kumpu, 2022:306). As such, it is evident that engaging the public psychologically plays a major role in bringing about the social change needed to tackle climate change, although this is not always achieved. In this way, "the biggest focus of governments and companies should be on making the climate friendly behaviour the easy behaviour by securing a correct reflection of carbon footprint in prices, climate friendly products that compare favourably to climate unfriendly alternatives, and trustworthy and comprehensible carbon labeling to make it easier to make climate friendly choices" (Thøgersen, 2021:12).

To conclude this short topic, it can be said that changing behaviour towards climate change should require a combination of individual, community, and governmental endeavours. This will often involve making sustainable choices in everyday life, supporting environmentally friendly policies and technologies, and pushing for change in a systemic way. In particular, I can be said that education, awareness-raising and collective action become essential components in promoting behavioural change and effectively tackling climate change. The repeated use of terms and the normalization of practices such as renewable energy adoption, sustainable consumption, waste reduction, reducing carbon footprint and also transportation choices (which means shifting from single-occupancy vehicles to public transportation, carpooling, biking, and walking to reduce emissions associated with transportation) are fundamental for a more favourable climate change mitigation and/or adaptation. Electric vehicles (EVs) usually are also considered as an option to minimize the carbon footprint of personal transportation. Therefore, I will focus on the transportation subject, in the following chapters, as it is related the central theme of this dissertation.

1.1.2. Relation with internal combustion-based engine transportation

Confirmed by none other than NASA itself, "the greenhouse effect is the process through which heat is trapped near Earth's surface by substances known as greenhouse gases". These "greenhouse gases (GHGs) consist of Carbon Dioxide (CO_2), Methane (CH_4), Ozone (O_3), Nitrous Oxide (N_2O), Chlorofluorocarbons (CFC´s), and Water Vapor"[7]. In addition, indirect GHG`s such as Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Nitrogen Oxides (NOx), and non-methane volatile organic compounds are also included. The accumulation of these GHG´s

[7] Available in www.climate.nasa.gov/

in the atmosphere enhances the natural greenhouse effect, leading to a gradual increase in global temperatures. However, "scientists have determined that CO_2 plays a crucial role in maintaining the stability of Earth's atmosphere. If CO_2 were removed, the terrestrial greenhouse effect would collapse, and Earth's surface temperature would drop significantly, by approximately 33°C (59°F)"[8].

As also reported by the United Nations, "the main GHG´s that are causing climate change include carbon dioxide and methane. These come from using gasoline for driving a car or coal for heating a building, for example"[9]. Moreover, farming and gas and petrol operations are the main contributors to methane emissions, and energy, industry, transportation and construction are among the leading sectors causing GHG emissions.

Specifically, in the case of combustion-powered transport, there is not only a strong environmental influence and damage that they cause, but it´s also often proven to be related to the damage to public health. As emphasised by Kumar *et.al* (2021:2), "particulate matter exposure causes a global loss in life expectancy of almost three years (Lelieveld *et.al*, 2020*, apud* Kumar *et.al*, 2021:2) and results in more than seven million premature deaths annually owing to household and ambient air pollution" (WHO,2016, *apud* Kumar *et.al*, 2021:2). In addition to promoting a high risk of developing illnesses such as lung cancer, cardiovascular problems, asthma and even dementia, "particulate matter pollution also damages the climate and ecosystems (Landrigan *et.al*, 2018*, apud* Kumar *et.al*, 2021:2), urban settlements (Oliveira *et.al*, 2019*, apud* Kumar *et.al*, 2021:2) and built infrastructure" (Kumar and Imam, 2013, *apud* Kumar *et.al*, 2021:2).

In accordance with the International Council on Clean Transportation (ICCT)[10], "on a global scale, the production and combustion of fuels in the transportation sector currently results in the emission of approximately 12 Gt of CO_2 equivalent into the air per year, and this is about 25% of all anthropogenic GHG emissions. With projected population and economic growth, global transportation demand is expected to increase substantially. Without further policy action, transport sector GHG emissions from combustion and production of fuels and electricity are expected to almost double to 21 Gt CO_2 equivalent annually by 2050" (Bieker, 2021:3). Plus, "light-duty vehicles, the vast majority of which are passenger cars, are responsible for the largest share of transport-related GHG emissions, currently about 5 Gt CO_2 equivalent" (Bieker, 2021:3). Furthermore, this scenario in Europe becomes particularly critical. The people living in Europe's major cities are faced with N_2O concentrations which frequently surpass the fixed air quality limits. These "most exceedances occur in city centres, mainly caused by traffic-related NOx (nitrogen oxides) emissions originating from diesel cars"

---

[8] Available in www.climate.nasa.gov/
[9] Available in www.un.org/
[10] Available in www.theicct.org/

(Degraeuwe *et.al*, 2017:330). Therefore, “a reduction in the NOx emissions per km of diesel cars can decrease the ambient NO_2 concentrations in European cities” (Degraeuwe *et.al*, 2017:336).

As observed in the Figure 1.1, it is noted that in 2019, 71.7% of all GHG emissions were from road transport, and within, the majority coming from individual cars (60.6%) and 27.1% from heavy transport trucks. Only 14.0% of GHG was related to water navigation transport and perhaps contrary to popular notion, only 13.4% concerned to the aviation sector. Mentioned by the European Commission, “to achieve climate neutrality, it is needed to reduce transport emissions by 90% by 2050”[11]. Also, as said by the European Environment Agency (EEA), if Europe pursues the goal of climate neutrality within 2050, “this cannot be achieved without a sustainable mobility system, based on cleaner and more active transport modes, cleaner fuels and, where possible, reducing the need for mobility”[12]**.** Also, “given the urgency of reaching the goals of the Paris agreement in the near future, a range of different policies need to be explored and adopted” (Gedik *et.al*, 2022:2).

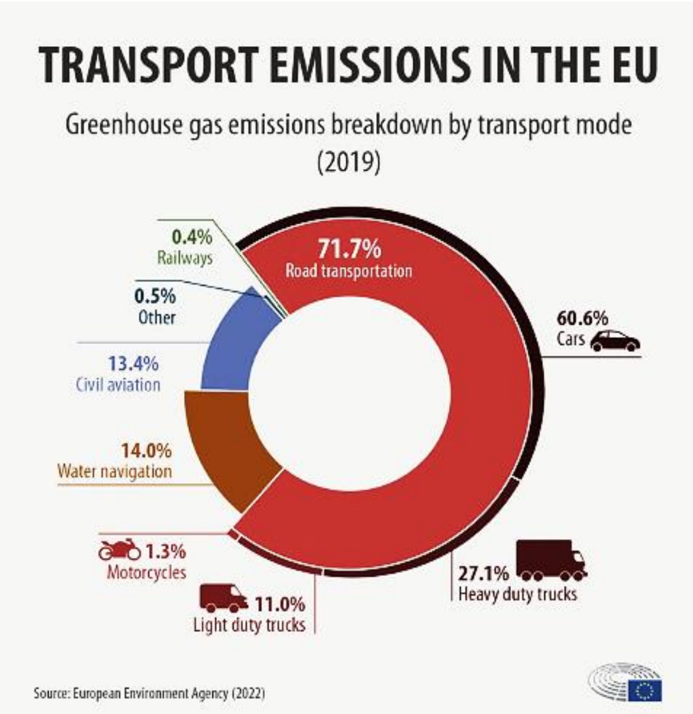


Figure 1.1 - 2019 EU GHG´s emissions by transport mode
Source: European Parliament www.europarl.europa.eu/

1.2. Electric vehicles

From this point, it is important to clarify that “in order to meet future mobility needs, reduce climate as well as health relevant emissions, and phase out dependence on oil (‘peak oil’), today's propulsion technologies have to be replaced by more efficient and environmentally friendly alternatives” (Helmer & Marx, 2012:2). Therefore, electric cars (that is, passengers’ vehicles for individual use that run exclusively on electricity and are powered by a rechargeable battery that can be charged from an external power source, known as Battery Electric Vehicle, or BEV), “are often considered a new technology to reduce environmental problems in cities,

[11] Available in www.climate.ec.europa.eu/
[12] Available in www.eea.europa.eu/

and in the entire atmosphere" (Meyn, 2015:1), as they can make a significant contribution to cutting ongoing emissions and, consequently, to the fight against climate change.

According to the Electric Vehicle Users' Association (UVE), "electric vehicles emit zero polluting gases during their circulation, as there are no fuels involved in the operation of the electric motors. In addition, if the Electric Vehicle is charged at night, the emissions are, in most cases, completely clean, including at the source of the electricity that is being consumed. By choosing to charge at night, surplus renewable energy (wind, hydro, etc.) is utilised, which is currently wasted many nights due to lack of demand and the fact that there is no way of storing it"[13]. Plus, and technically speaking, "the main components of a BEV can be divided into the electric battery, the electric motor, and a motor controller (Figure 1.2). The technical structure of a BEV is simpler compared to Internal Combustion Engine (ICE), since no starting, exhaust or lubrication system, mostly no gearbox, and sometimes, not even a cooling system, are needed. The battery charges with electricity either when plugged in the electricity grid via a charging device or during braking through recuperation" (Helmer & Marx, 2012:3). Then, the motor controller provides the electric motor with a varying amount of power depending on the load condition, and the electric motor converts the electrical energy into mechanical energy.

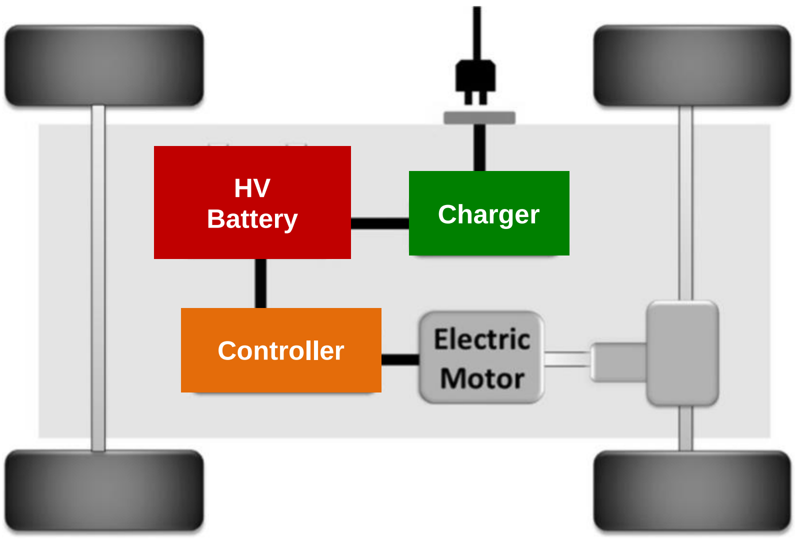


Figure 1.2 - Main components of a Battery Electric Vehicle (BEV)

Source: Helmer & Marx (2012:3)

1.2.1. Main advantages

Prominently, BEVs "can provide many benefits over internal combustion engine-based vehicles. They produce no on-road GHG emissions or criteria air pollutants and the upstream pollution they do produce can be considerably less severe, depending on the electricity source used for battery charging and the energy intensity of manufacturing" (Mersky *et.al*, 2016:56).

[13] Available in www.uve.pt/

The main advantages of the electric vehicle are, are, therefore, its respect for the environment, through the absence of emissions and also the use of cheap fuel, namely electricity. Also, “the total energy efficiency of the electric vehicle is two times higher than the nearest competitor - hybrid cars and hydrogen fuel cells” (Gelmanova *et.al*, 2018:3).

In terms of performance, users also report superior driving qualities, including unparalleled acceleration. It is described that “an electric motor outperforms a combustion engine in terms of agility, despite its inferior technical specifications. The cause is the faster emergence of acceleration” (Meyn, 2015:10). Other advantages include a reduced noise pollution (BEVs are generally much quieter than traditional vehicles), a long range of smart features and new technologies (such as regenerative braking, autonomous driving or an extended connectivity options) and a reduced cost of maintenance, since BEVs have fewer moving parts than internal combustion engine-based vehicles.

1.2.2. Some limitations

However, BEVs “are currently more expensive, have more limited ranges, longer refueling times and fewer public infrastructure refueling opportunities than petroleum-fueled vehicles. Additionally charging technology is significantly slower than refueling with liquid hydrocarbons”. (Mersky *et.al*, 2016:56-57). The shortage of suitable and convenient charging infrastructures is one of the main issues for the development of electric vehicles in many places, meaning “a robust network of charging stations is essential for electric car drivers” (Razmjoo *et.al*, 2022:6).

Another important aspect has to do with the lifecycle of the electric vehicle and its batteries, since “one disadvantage of BEV is the acidification potential associated with the smelting processes of copper, nickel, and cobalt since a lot of copper and, in some battery types, nickel and cobalt also are essential elements of electrical components. Additionally, there are acidifying emissions of coal-fired power plants depending on the local value of this type of power production” (Helmers & Marx, 2012:14). For the concern of maintenance, durability and cost of batteries, although a BEV has no engines, the significant expense results from the large battery packs that are necessary. Consequently, “given the high share of battery costs in total EV costs, it is likely that the success of BEVs will be mainly driven by developments in battery costs. The costs associated with Li-ion batteries are expected to drop dramatically due to advancements in battery designs and production techniques” (Wolfram & Lutsey, 2016:9). This could be done by replacing expensive materials with lower-cost ones, implementing economies of scale and low-waste production processes of massive volume. Presently, being Li-ion batteries, the main type of battery used, it is anticipated that new research could lead the development of new types of batteries (such as lithium-air, metal or sulphur batteries).

Finally, about vehicle autonomy, there has been a continuous increase in the autonomy (kilometres) provided by the batteries, which can currently actually reach between 600 to 650 kilometres on a single charge in the most expensive models, usually announced by the top brands itself. Thereby, "consumers preference for affordable vehicles with large driving ranges and high operating efficiency signals to manufacturers that battery technology must continue to be improved" (Razmjoo *et.al*, 2022:14), meaning that the autonomy aspect of a BEV assumes extraordinary importance when purchasing BEVs, as "results show that in the baseline model, 60% of drivers can replace their gas cars entirely with 400-mile battery ranges, and less than 40% can do so with 200-mile battery ranges. Even when all the travel needs are satisfied, the optimal battery ranges can still cause range anxiety issues for all the drivers" (Zhang & Tian, 2021:332).

In conclusion, and about the construction of BEVs, it is also important to note that "emissions are usually higher in the production phase, but these are more than offset by lower emissions in the use phase over time"[14].

1.3. Charging stations

As expected, "the charging equipment for EVs plays a critical role in their development, grid integration and daily use: a charging station generally includes charge cord, charge stand, attachment plug, power outlet and vehicle connector and protection system" (Falvo *et.al* ,2014:1134). Nevertheless, the configuration of the charging station may vary in terms of voltage, frequencies or connection to electricity grid, from one country to another.

As widely known, BEVs can be charged at home, in public places or at work. One of the most popular ways of charging BEVs is by using the household's own electricity, making it a convenient and economical option for many BEVs owners. It´s main advantages are convenience and time-saving (simply connecting the vehicle to the power supply during the night and it will be ready for use in the morning), lower cost (the cost per kilowatt-hour of electricity is generally lower than the cost per litre of petrol or diesel), flexibility, independence and comfort in charging (since the vehicle can be charged whenever the owner wants, without depending on public infrastructure and in a comfortable way).

However, outside the household and on the road, the charging stations it is an aspect of extraordinary relevance. Experts argue that the "charging behaviour has been researched since the first uptake of electric vehicles and is seen as deliberate behaviour of EV users to refill their EV at a preferred charging location (e.g., home of public, work) for a specific amount of time. Depending on the subject of research charging behaviour includes the following actions: locate a charging point, drive to specific charging point, check occupancy, in case of occupancy find an alternative, connect to charge, disconnect and the reconnection process after a certain amount of time or kilometres driven" (Helmus & Wolbertus, 2023:3).

[14] Available in www.eea.europa.eu/

To confirm this importance, “studies have shown that the lack of charging stations has become one of the most crucial obstacles faced by EV´s when they compare with regular motor vehicles in a analogical range and safety awareness” (Melendez and Milbrandt, 2006; Melendez *et.al*, 2007, *apud* Sun *et.al*, 2020:48). Therefore, “to foster the use of EV´s, how to appropriately deploy charging infrastructure becomes an important issue for stakeholders”. Travel demands of urban residents can be classified into two categories; one is short distance commute, the other is long distance travel” (Sun *et.al*, 2020:48).

In this way, and in a more political perspective, to encourage the establishment of BEVs, “governments at various levels are keen to help with funding charging infrastructure. Yet, in developing such charging infrastructure, policy makers face the challenge of efficiently using tax payers’ money and this challenge is exacerbated by rapid technological developments such as fast charging stations (up to 350 kW) and (static and dynamic) wireless charging which further complicate decision-making“ (Wolbertus *et.al*, 2018:1). So, in an attempt to avoid the risk of becoming quickly technologically obsolete, “efficient planning of charging infrastructure for electric vehicles involves accurate modelling of charging demand. In predicting EV charging demand, understanding variations in the starting time and location of charging sessions is recognized to be of key importance” (Wolbertus *et.al*, 2018:1). In the case of European Union (EU), and according to the European Alternative Fuels Observatory (EAFO)[15], “recharging points are classified in to two main categories, based on their power output and speed”:

Table 1.1 - Recharging modes based on power output

Category	Sub-category	Maximum power output	Definition
Category 1 (AC)	Slow AC	P < 7.4 kW	Normal power recharging point
	Medium-speed AC	7.4 kW ≤ P ≤ 22 kW	Normal power recharging point
	Fast AC	P > 22 kW	High power recharging point
Category 2 (DC)	Slow DC	P < 50 kW	High power recharging point
	Fast DC	50 kW ≤ P < 150 kW	High power recharging point
	Ultra-fast DC	150 kW ≤ P < 350 kW	High power recharging point
	Ultra-fast DC	P ≥ 350 kW	High power recharging point

Source: EAFO www.alternative-fuels-observatory.ec.europa.eu/

Category 1 is recharging via Alternating current (AC), while Category 2 is recharging via Direct Current (DC). In Portugal, for instance, it can be found in outdoors “Normal Charging Stations, Fast Charging Stations, and Ultrafast Charging Stations”[16]. Normal Charging Stations

[15] Available in www.alternative-fuels-observatory.ec.europa.eu/
[16] Available in www.uve.pt/

and Fast Charging Stations are mainly found in residential areas, parking areas or shopping centres. Ultrafast Charging Stations, on the other hand, are mostly located in service stations next to motorways.

1.4. The European Union perspective

In general, the EU perspective on electric mobility in recent years has become quite favourable and will continue to be necessary, to reflect in a significant effort and commitment to the transition to electric vehicles as part of efforts to reduce GHGs and fight climate change. It is recognised that “electric mobility had great developments in the 2010s. By 2010, the overall EU fleet of Ev´s (BEV passenger cars and light commercial vehicles) was 6094; whereas, by 2015, it grew to 148.228; and as of 2020, 1.249.146 BEVs were operating within the EU, which represents a growth rate of 100% within a decade” (EAFO, *apud* Martins *et.al*, 2023:3). So, in the view of these authors, for the EU, “EVs are a scalable solution for road mobility, as an alternative to ICE vehicles” (Martins *et.al*, 2023:3). The European Commission is, therefore, trying to promote alternatives to ICE vehicles with “policies such as government subsidies, investment in research especially for batteries, utilization of new technology, congestion charge exemptions, incentives to purchase and use EVs, improvement of charging infrastructure (and innovation in charging infrastructure such as rapid charging stations)” (Razmjoo *et.al*, 2022:7). In addition to some European governments encouraging the adoption of BEVs, privileged traffic lane access for buses, free charging at public stations, exemptions from road tolls, or free or favourable parking, are other examples of such policies.

Also, from this EU perspective, “the infrastructure for alternative fuels is also being funded to promote lower-carbon mobility. One of the most difficult questions is when electric vehicle technology will improve to the extent that it becomes a mainstream competitive option for consumers and automobile manufacturers facing carbon emission requirements” (Wolfram & Lutsey, 2016:2). Furthermore, the EU is also evaluating the possibility of implementing a methodology for evaluating and communicating data on these vehicles throughout their entire life cycle, and this “should capture the entire lifecycle of the vehicle with an accurate and up-to-date representation of regional electricity mixes (Hung *et.al*, 2021:2). It is hoped that this detail on geographical differences help to realise the importance of implementing BEVs in locations where they can provide the maximum climatic advantage.

Therefore, and in a broad sense, it should be noted that European environmental policy covers a wide range of different topics, and it is estimated that, according to the EEA, “the body of EU environmental legislation - also known as the environmental acquis - amounts to around 500 directives, regulations and decisions”[17]. Being a key agreement, “the EU’s overall

[17] Available in www.eea.europa.eu/

climate ambitions were first set in broad terms in the "Green Deal"[18] (Martins *et.al*, 2023:3). If specified "the goals to be achieved were a decrease of 55% in GHG emissions by 2030, compared with 1990 levels, and net-zero emissions by 2050" (Martins *et.al*, 2023:3). In the transport sector, the European Commission (EC) produced the "Sustainable and Smart Mobility Strategy" package[19], which "provides an action plan in the form of 14 phased milestones towards sustainable, smart, and resilient mobility, five of which are directly related to EV deployment" (Martins *et.al*, 2023:3). Furthermore, consulting the European Union's website, it argues that "EU and national governments have set out clear objectives to guide european environment policy until 2020 and a vision beyond that, of where to be by 2050, with the support of dedicated research programmes, legislation and funding"[20]. These objectives include, among others, to make the EU a resource-efficient, environmentally friendly (low-carbon) and, at the same time, a competitive economy.

In this sense, it is also important to mention that "the EU is revising legislation in sectors that have a direct impact under the "Fit for 55" package"[21] (EU's target of reducing net GHGs emissions by at least 55% by 2030), in the areas of energy, transport and climate, and as shown in the Appendix C. On the other hand, in terms of relevant EU legislation specifically for BEVs, the ones are the following below:

- Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014, related to the deployment of alternative fuels infrastructure[22], and more recently, in 2023, by the alternative fuels infrastructure regulation (AFIR)[23], for more recharging and refuelling stations for alternative fuels across Europe in the coming years;
- Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019[24], which sets CO_2 emission performance standards for new passenger cars and for new light commercial vehicles.

However, there are already some findings of this environmental concern on the part of the European Union, specifically in relation to electric vehicles. For example, a study conducted by Martins *et.al* (2023) tried "to evaluate the performance of the 27 EU Member States in terms of their current policymaking agenda for EV transition, recognising that, despite having a common roadmap, each of the 27 EU members states implements its policies independently, at a national level" (Martins *et.al*, 2023:14). The results report that, "in all eight iterations,

[18] Available in www.eur-lex.europa.eu/
[19] Available in www.eur-lex.europa.eu/
[20] Available in www.european-union.europa.eu/
[21] Available in www.eur-lex.europa.eu/
[22] Available in www.eur-lex.europa.eu/
[23] Available in www.data.consilium.europa.eu/
[24] Available in www.eur-lex.europa.eu/

Germany was the only country assigned to category C4 (Very Good) or between C3 (Good) and C4. The Netherlands, Italy, Sweden, Belgium, Austria, and Denmark are consistently assigned to categories C3 and C4, whereas France was mostly assigned to category C3. On the other side of the spectrum, oftentimes assigned to C1 (Weak) or between C1 and C2 (Moderate), stand countries from Eastern and South-Eastern Europe, such as Poland, Greece, Lithuania, Estonia, Romania, Cyprus, Bulgaria, and Croatia. The remaining countries fluctuated around C2" (Martins *et.al*, 2023:15), which is considered moderate. So, it can be realized that "few countries in Western Europe seem to be transitioning at a quick pace towards electric passenger mobility, with the exception of Norway" (Ortar & Ryghaug, 2019:2).

Moreover, based on another study published also by Ortar and Ryghaug (2019), "the online debates revealed that citizens are aware and concerned about the inequality and distributional effects of shifting to EVs" (Ortar & Ryghaug, 2019:13), being linked to issues of energy justice, namely access to the electricity grid in cities and rural regions, or energy production methods. Furthermore, "concerns are also raised about the price of the EVs" (Ortar & Ryghaug, 2019:13). As such, despite a certain normalisation of climate principles and a commitment to electric mobility in the last decade, is important to embrace that "a reduction or removal of incentives before 2020 was expected to slow down electric car growth and might lead, for the most generous subsidy level, to even temporary market stagnation. Therefore, it may be premature to remove electric car purchase subsidies over the next years, if the policy goal is to speed up the market penetration of this technology or at least keep its current pace in the EU" (Vilchez & Thiel, 2019:10).

Finally, in conclusion, it can be said that there are critical aspects of the expansion of the EU´s electric vehicle market, regarding technologies, opportunities and barriers, being these perspectives critical to policymakers, car manufacturers and consumers. In overall, "the expansion of EVs is not easy for governments and policymakers in different countries, but appropriate policies and strategies can overcome existing problems" (Razmjoo *et. al*, 2022:3).

Chapter 2 - Electric vehicles data

In this chapter it will be presented the most relevant data on electric mobility (BEVs) collected for this research. Firstly, the data at European level is shown, considering the 27 current constituent countries of the European Union, and since this research also focuses on Norway, this country is also included in this comparison with the other countries of the EU. Afterwards, a profound comparison and interpretation are made solely between Norway and Portugal, with the addition of a few more indicators. It is also important to mention that this data was obtained from the European Alternative Fuels Observatory (EAFO), which is the European Commission's key reference portal for alternative fuels, infrastructure and vehicles in Europe[25]. The EAFO is a key information support tool for the European Commission for the implementation of Directive 2014/94/EU, and even collaborates closely with Eurostat[26].

2.1. European continent countries

As mentioned above, a comparison of the 27 constituent countries of the EU (plus Norway), from the perspective of the fleet of BEVs as a percentage of the total fleet; and newly registered BEVs as a percentage of the total number of registrations, is, as follows It is highlighted that, in order to harmonise this comparison, the time period chosen and presented for all the graphs will be around a decade, more specifically, the period between 2013 to 2022.

2.1.1. Fleet of BEVs as a % of the total fleet of cars in circulation

As can be seen in Appendix D (graphic) and Appendix E (data), with regard to the fleet of BEVs as a percentage of the total fleet of cars in circulation (including combustion engine vehicles) in the respective country, Norway clearly distinguishes itself from the percentage presented by the EU countries, with a value of 20.3% in 2022, while the country of the EU with the highest percentage in the same year, presented only 4.2% (meaning Sweden). So, primarily, in this aspect of the fleet of BEV's as a percentage of the total fleet of the respective country, it can be said that there is clearly a division between 2 groups of results: the Norwegian result, and the results of all the other countries that are politically part of the European Union. Also, this has occurred not only during the year 2022, but since 2013, and progressively over the last decade.

It should also be noted that the countries in Northern Europe and belonging to the EU, namely the Netherlands and Denmark, in 2022 presented values in the order of 3.7% and 3.5%, respectively, being followed by Germany, with around 2%, This suggests a tendency for Northern European countries to present higher values of fleet of BEVs as a percentage of the total fleet, when compared to the remaining European countries.

So, according to these results, it can be said that in Norway, in 2020, more than 1 in every 10 vehicles in circulation were already BEVs, and that this number increased to 1 in every 5 vehicles in circulation in 2022. Just in the span of these 2 years, in this country, there was almost a double increase in the percentage of BEVs in circulation, in relation to the total number of vehicles in circulation of the respective country (something that previously had already happened, however during the period from 2017 to 2020). Therefore, this statistic

[25] See also www.alternative-fuels-observatory.ec.europa.eu/
[26] See also www.ec.europa.eu/eurostat

doesn’t provide much surprise, since on average, according this data, from 2013 and until 2022, Norway has had at least 5 times and even more BEVs in circulation, than the countries of the EU.

It is also worth noting that 2018 was the year in which a considerable increase began in the case of the Netherlands (0.5%), being a country that will be followed and reached by some european countries like Sweden (4.2%), Denmark (3.5%) and Luxembourg (3.3%), only in 2022. The remaining EU countries, on the other hand, presented lower figures during the 2013-2022 period, reaching a maximum of only 2.1% (Austria) in 2022. Moreover, another important indicator for this, is concerning to the number of newly registered BEVs, something that will be revealed below.

2.1.2. Newly registered BEVs as a % of the total number of registrations

It can be said that the newly registered BEVs as a percentage of the total number of registrations (available in Appendix F - graphic and Appendix G - data) is the indicator that most realistically reflects the reality of the implementation of the individual electric mobility in each country, as it compares the number of vehicles sold with the number of BEVs sold.

So, in this field of newly registered BEVs as a percentage of the total number of registrations, again Norway clearly stands out, where in 2022, around 79.3% of all new vehicles registered were already BEVs (or in other words, practically 4 out of every 5 new cars sold on 2022 in Norway were BEVs). After Norway, but much further down the list, there are mainly countries from the rest of northern Europe, such as Sweden (19.1% in 2021, 32.8% in 2022); the Netherlands (19.9% in 2021, 23.3% in 2022); Denmark (13.4% in 2021, 20.7% in 2022); Finland (10.3% in 2021, 17.8% in 2022), and even Germany, with 13.4% in 2021 and 17.5% in 2022. It is also noted that in this indicator Norway began to outperform the other European countries from the very beginning, reinforcing the fact that since 2017 and until 2022, as the graph shows, it has grown by, at least, 10% to 15% every year. The rate of growth of newly registered BEVs in this country over the last decade has been remained almost constant.

Thus, unlike Norway, it wasn't until 2017 that European countries began to distinguish themselves and grow in percentage, with the Netherlands reaching 5.4% in 2018 and 20.4% in 2020, followed in 2019, with more European countries differentiating themselves and with a little some significant percentages. So, it can be said that the true implementation of individual electric mobility in the European continent began in Norway even before the year 2013, while in the EU countries it began to take it´s real (but small) steps and growth only in the year 2017 (or even in 2019, for most countries).

Accounting that this research compares Norway and Portugal in these aspects, a comparison between these two countries is following next, in relation to the main indicators.

2.2. Norwegian *versus* Portuguese data

2.2.1. Newly registered BEVs

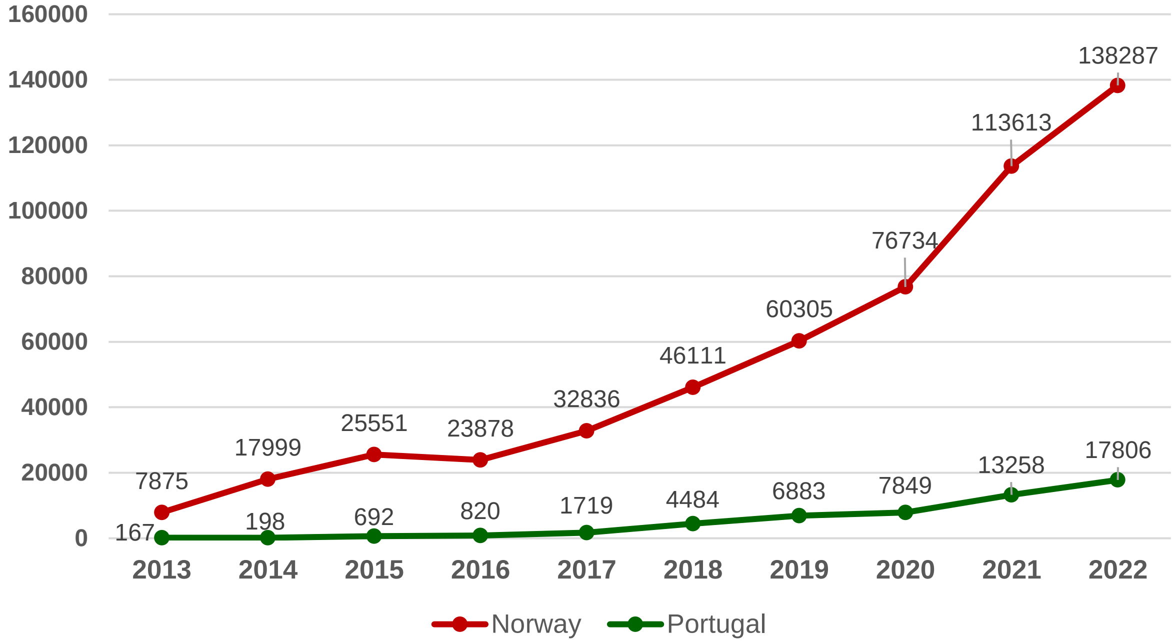


Figure 2.1 - Newly registered BEVs

Source: EAFO www.alternative-fuels-observatory/ and www.alternative-fuels-observatory/

Comparing Norway and Portugal in terms of newly registered BEVs, it can clearly be seen the difference between the two countries. In 2013, Norway had already sold 7875 new BEVs, while Portugal had only registered 167, and this difference continued to strongly grow in the following years, with Norway achieving around 138287 new BEV registrations in 2022, while Portugal achieved, in comparison, only 17806 new BEVs sales. So, it can be realised that, in the years 2021 and 2022, Norway had sold, respectively, approximately 8 to 9 times more new BEVs than Portugal.

It should also be noted that the only year in which Norway sold fewer BEVs than the previous year was in 2016, with 23878 new sales, while in 2015 it sold 25551. In the case of Portugal, the number of sales in the following year was always higher than the number of sales in the previous year, with a more significant increase in the last years from 2017 to 2018 (161% growth), and from 2020 to 2021 (69% growth).

It's also worth noting that in both countries there are three distinct periods of growth: from 2013 to 2015, from 2016 to 2020 and from 2022 to 2022. In these 3 periods, as can be seen in the graphic, there was a more pronounced rise in the sale of new BEVs, in both countries. So, the difference in these specific values between these two countries is massive, being even more staggering given the fact that, in the last decade, according to Eurostat, Norway had an average of around 5 million inhabitants, while Portugal had around 10 million[27] (meaning Norway had on average half the inhabitants of Portugal).

2.2.2. Newly registered BEVs as a % of the total number of registrations

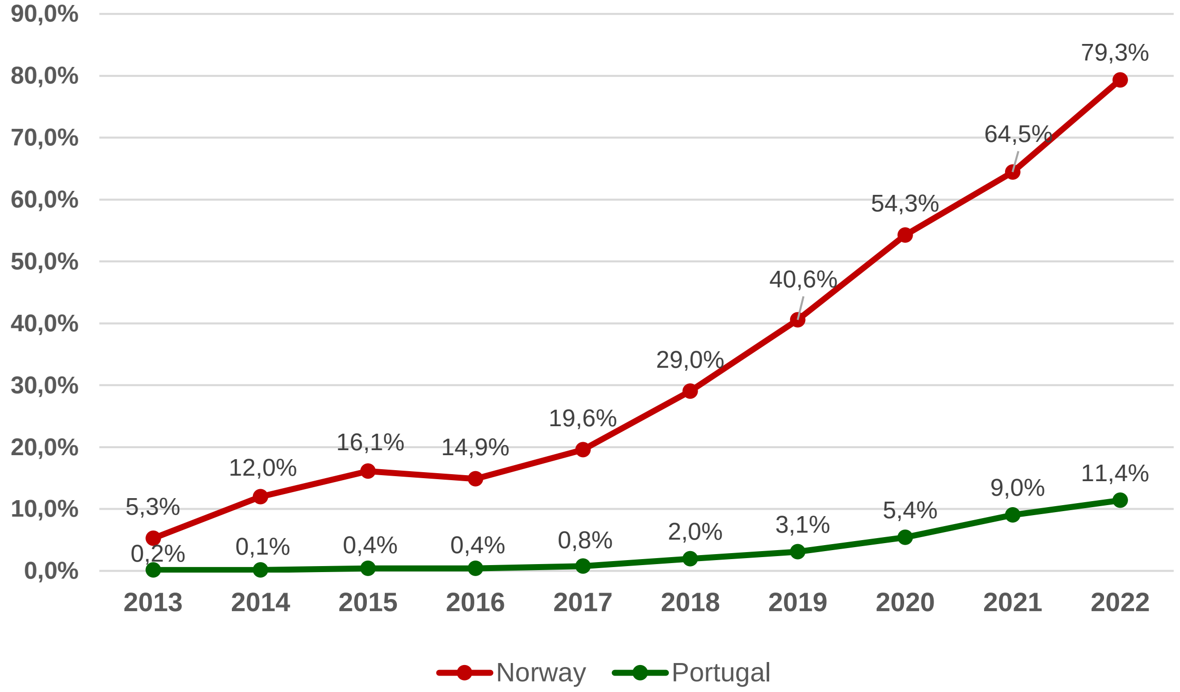


Figure 2.2 - Newly registered BEVs as a % of the total number of registrations
Source: EAFO www.alternative-fuels-observatory/ and www.alternative-fuels-observatory/

Directly related to the previous one, this indicator clearly emerges as one of the most significant indicators for this study, representing the difference between these two countries in this subject. As can be observed, in 2022, while in Portugal only 11.4% of new vehicle sales were BEVs, in Norway, the sale of new BEVs reached an impressive 79.3%. Although in 2013 Norway's 5.3% of new vehicles sold were BEVs, in Portugal the number was only 0.2% and in 2015, while Norway's percentage was 16.1%, Portugal's was still only 0.4%. It should also be noted that in 2017, when Portugal was almost reaching 1% of newly registered BEVs as a percentage of the total number of registrations, Norway was reaching almost 20% for the same indicator (19.6%). So, as expected, the difference between the two countries in terms of newly registered BEVs as a percentage of the total number of registrations has always been large.

As far as progression itself is concerned, it is important to note that Portugal's progression has been constant, or in other words, always increasing, although quite slowly and with

[27] Available in www.ec.europa.eu/eurostat/

modestly. In Portugal, the years with the biggest growth leap were between 2020 and 2021, when there was a rise from 5.4% to 9.0%, respectively. In the case of Norway, the rise can be described as strong (even impressive), although there was one year (2016) when the value was lower than the previous year, as it showed the newly registered BEVs as a percentage of the total number of registrations at around 14.9%, compared to 16.1% in 2015. For the rest of the years, in the Norwegian case, this increase represented an overwhelming 10 to 15 percentage points per year.

2.2.3. Total number of BEVs in circulation

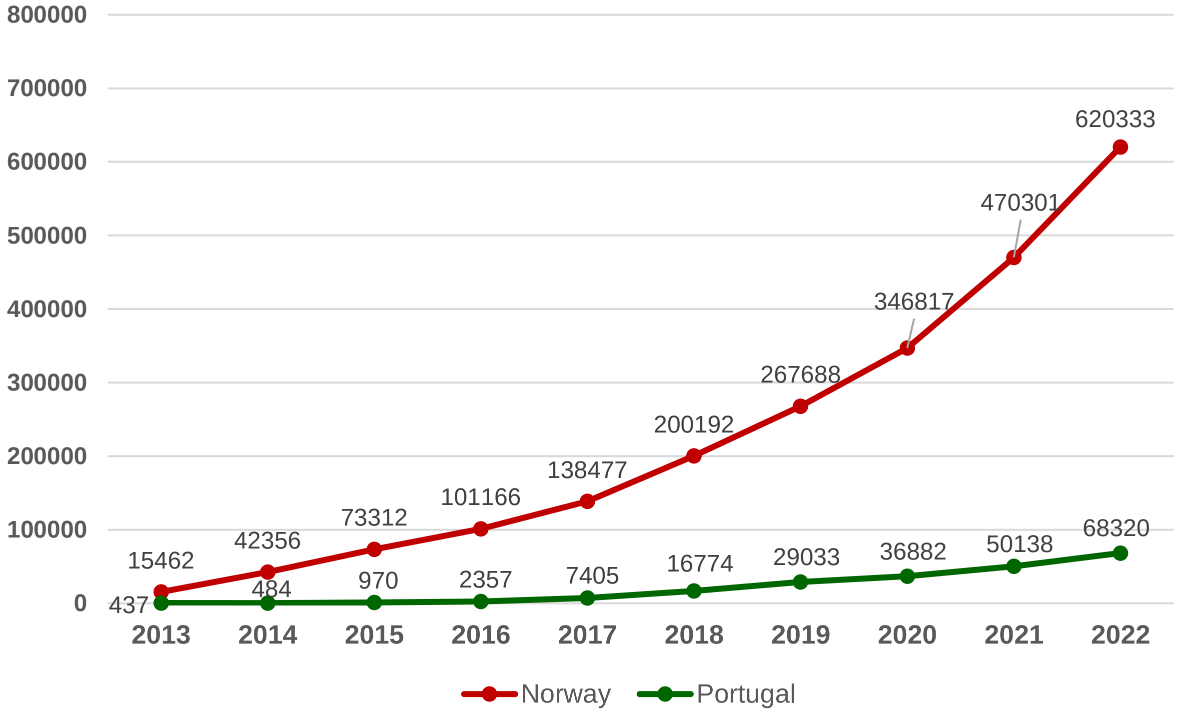


Figure 2.3 - Total number of BEVs in circulation

Source: EAFO www.alternative-fuels-observatory/ and www.alternative-fuels-observatory/

As far as the gross number of BEVs in circulation between these countries is concerned, and according to the previous data showed, it was expected that Norway had a higher number of BEVs in circulation than Portugal. And in fact, in 2013, Norway had around 15 thousand BEVs in circulation, while Portugal had only 437 units. Over the years (2013-2022) the difference between the two countries has increased, and by 2022, Norway had around 620 thousand BEVs in circulation, while Portugal had just 68 thousand (a difference, between these two countries, only in this last year, equivalent to 808%, or approximately 9 times more).

So, according to these figures, both Portugal and Norway have seen a continuous increase in the number of BEVs in circulation, although in Norway this has been much more substantial and in Portugal it has been more moderate or restrained. In the case of Portugal, and according to the calculations, the years in which there was the greatest growth in BEVs in circulation compared to the previous year were from 2016 to 2017, with an increase of 214%, and from 2015 to 2016 (with 143%). In Norway, although it has shown much higher growth figures than Portugal, the years where there was the highest increase were from 2014 to 2015 (with a 73% increase) and from 2017 to 2018, with a 45% increase. In the remaining years, in Norway, there was an additional of, at least, 30% quantity of BEVs in circulation when compared to the previous year. Lastly, and looking at the graphic, in both countries, the periods 2013-2016, 2017-2020 and 2020-2022 are 3 distinctive periods in the growth of the number of BEVs in circulation, where there is a more pronounced line of growth.

2.2.4. Fleet of BEVs as a % of the total fleet of cars in circulation

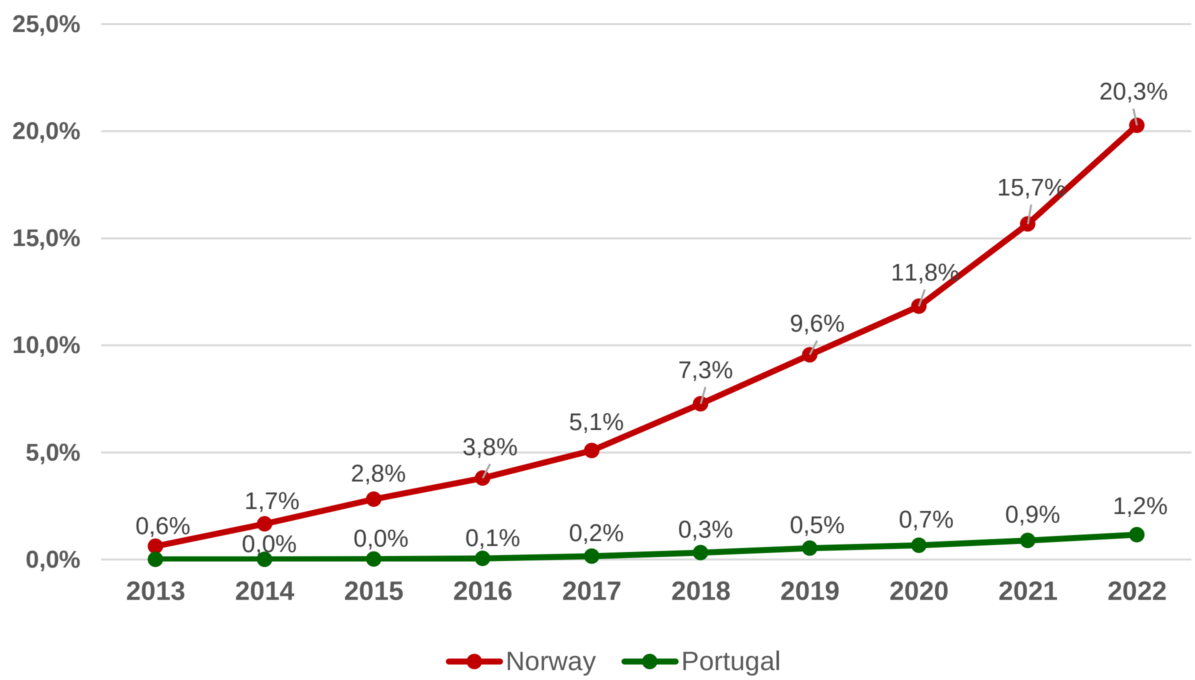


Figure 2.4 - Fleet of BEVs as a % of the total fleet

Source: EAFO www.alternative-fuels-observatory/ and www.alternative-fuels-observatory/

Comparing the fleet of BEVs as a percentage of the total fleet, and only between Norway and Portugal, it can once again be seen that Norway obtained, in all the years, an immensely higher percentage than the percentages verified in the Portuguese reality. Starting at 0.01% in 2013, Portugal only reached, in 2022, 1.2% of fleet of BEVs as a percentage of the total fleet, or in other words, just a little over 1% of all individual passenger cars in circulation in Portugal in that year were 100% electric. In the case of Norway, the figures could hardly be more different, since in 2014 (1.7%), they had already surpassed the figures presented by Portugal in 2022

(1.2%), reaching the record of 20.3% of fleet of BEVs as a percentage of the total fleet in 2022. Therefore, it is estimated that by 2022, 1 in every 5 individual passenger cars on the road in Norway would be 100% electric (and these numbers not considers the number of other passenger vehicles, like buses, motorbikes, trucks, etc., that are also powered by other types of alternative fuels, such as hydrogen or natural gas). Furthermore, there has been a constant increase in the difference between the percentages for each country over these years. suggesting that Norway has really made a strong commitment in this matter, whereas Portugal's commitment has been much more modest and in line with the growth shown by most of the rest of the European countries.

To finalise, it is important to emphasise that, in Norway, the total number of vehicles (including fossil fuel vehicles) in circulation during this period, per year, was 2.5 to 3 million, while in Portugal, also per year, it was almost 4.3 to 5.7 million[28]. Therefore, this occurrence reflects even more the difference presented by these two countries in this particular matter.

2.2.5. Total number of recharging points

In the field of electric mobility, as already mentioned, charging stations play a fundamental role in the success of sales and deployment of electric vehicles in a given society. The availability and functionality of these stations, their geographical location and distance from each other and other forms of accessibility are crucial aspects for a more effective or less effective, faster or slower, implementation of an electric revolution. Without these charging stations, electric cars simply won't work. Therefore, this aspect is not so directly related to what the individual consumer can or wants to do regarding to electric mobility, but rather to the public policies implemented or the governmental (or even private) investment made in this area.

According to EAFO, until 2019 there was a counting methodology called "old methodology", and from that year on there was a "new one", which respects the Alternative Fuel Infrastructure Regulation (AFIR) classification[29]. That previous counting methodology did not differentiate between the different types of charging points and could have caused some overestimation of the results. Therefore, this new counting methodology, which was introduced in 2020, is based on the AFIR classification, and categorises charging points according to their power level and type of connector.

So, the data I'm presenting is the total data, that is, the data counting with the old methodology until 2019 and counting with the AFIR methodology from that year forward. This data, presented in the next figure, includes all AC and DC charging stations for the period 2013 to 2022.

[28] Available in www.ec.europa.eu/eurostat/
[29] See also www.alternative-fuels-observatory.ec.europa.eu/

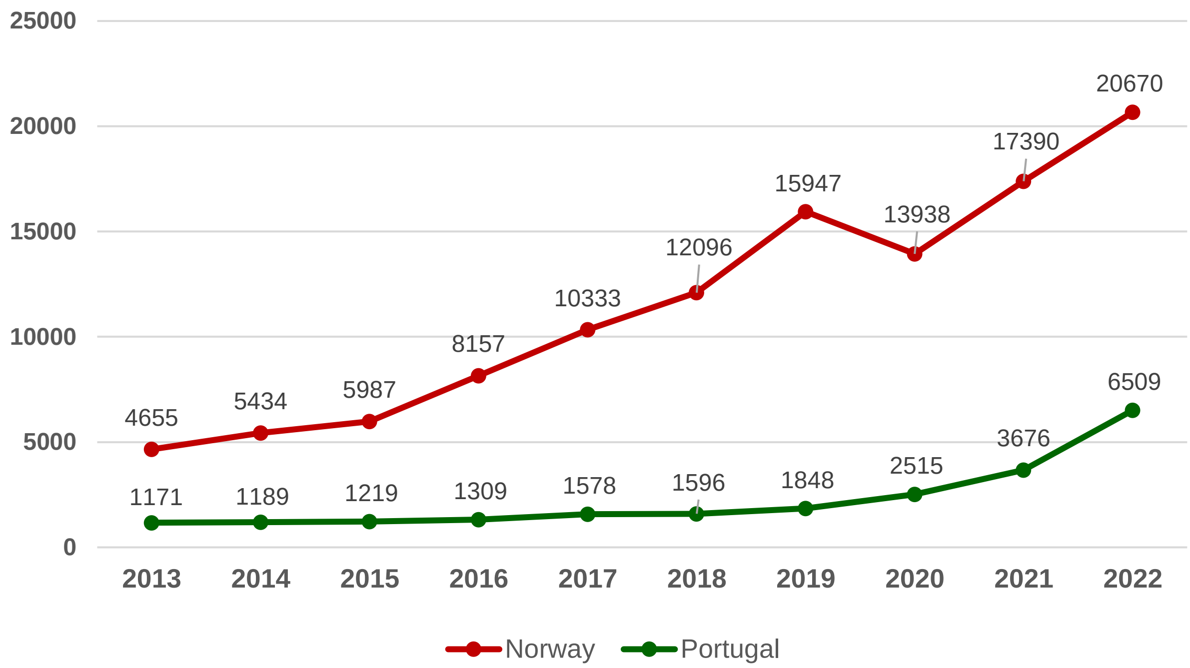


Figure 2.5 - Total number of recharging points

Source: EAFO www.alternative-fuels-observatory/ and www.alternative-fuels-observatory/

It is also important to remember that, as already mentioned, the dispersion and geographic accessibility of electrical charging stations is fundamental and, in the case of Norway and Portugal, these are two countries with different sizes and geographic land areas. Norway, an essentially mountainous country, has a total land mass area of 364.270 square meters[30], while Portugal, a less mountainous country, has a total area of only 91.606 square meters[31].

So, regarding the data on the number of recharging points for BEVs, once again Norway presents higher numbers than Portugal. However, in this case, the difference between these two countries is not as extensive as it was in the previous indicators. According to this data, in 2013 Norway had around 4655 charging points available, while Portugal had 1171. Over the course of 2013-2022, these figures increased for both countries, with Norway having 20670 charging points available in 2022, while Portugal had 6509 recharging points in the same year. In other words, in 2022, Norway achieved 3 times more recharging points than Portugal. The year in which there was the biggest difference between these countries in the number of recharging points was 2019, when Norway had 15947 recharging points and Portugal just only 1848, which is equivalent to a difference of 14099 recharging points, meaning, that year, Norway had almost 8 times more recharging points than Portugal. On the contrary, the year with the smallest difference was 2013, with a difference of only 3484 charging points between

[30] Available in www.data.worldbank.org/
[31] Available in www.data.worldbank.org/

these two countries. It should also be noted that the figure shows that, during the period analysed, in the case of Portugal, the values have always been higher year by year. This was also the case in Norway, however with the exception of 2020 (with 13938 recharging points), which shows a lower number than 2019 (15947 recharging points). The explanation for this is the adoption of the new counting methodology (AFIR classification), mentioned earlier, which meant that from then on, the accountability was more precise. In terms of the level of growth in each country, the figure shows that Norway has three distinct periods: from 2013 to 2015, from 2015 to 2019 and from 2020 to 2022, meaning that, only in this last period, the growth rate of recharging points in this country was 48%. On the other hand, in the Portuguese situation, 2 distinct periods are observed, which are from 2013 to 2019 and from 2019 to 2022, being also this last period the most notable, representing a 252% growth rate in recharging points.

Figure 2.6 - Example of charging station (with recharging points)
Source: UVE www.uve.pt/

Finally, to conclude this chapter, it remains to be said that all this data needs to be explained, or, in other words, finding the reasons for the differences that were encountered. Therefore, this justification of the differences founded will be the focus of my research, and that will be described and explained in the following chapters.

Chapter 3 - Norway *versus* Portugal - use of variables

In this chapter, an in-depth attempt will be made to explain the central question of this dissertation, which is, what are the reasons why Norway and Portugal have different sales figures for new electric cars during the period 2013-2022. To this purpose, and based on my personal knowledge of these two countries so far, I would like to propose the following statement as a possible explanatory hypothesis for this phenomenon*: The difference in the incomes of the citizens, the environmental (electric mobility) public policies respectively implemented and the cultural differences between these two countries, are the reasons for the difference in the number of sales of new electric cars between Norway and Portugal, during the period 2013-2022*.

So, with this dissertation, I intend to investigate whether this explanatory hypothesis is confirmed or not, or whether part of this explanatory hypothesis is confirmed or not. To operationalise this hypothesis, and with regard to the variables in question, I decided to allocate them as follows, simultaneously in Norway and Portugal, during the period 2013-2022:

- <u>Dependent Variable</u>:
  - ✓ The number of BEVs sales in Norway and Portugal, during the period 2013-2022.
- <u>Independent Variables</u>:
  - ✓ *The income of citizens* – by demonstrating the average salaries of Norwegian and Portuguese citizens. This will allow me to give an indication of the economic and financial possibilities for Norwegian and Portuguese citizens to purchase BEVs, when compared to an average or minimum price for an acquisition of a new BEV.
  - ✓ *Public Policies implemented* – by analysing the public environmental policies in effect during this period, targeted specifically at the support provided by the respective state for the purchase of BEVs by citizens. These can include financial incentives, network of charging stations or other facilities applied for implementation of electric mobility in each country. In this context, despite the fact that the continent of sales is the same (European) and that Norway does not belong to the European Union and Portugal does, an brief attempt will also be made to understand whether this fact could have repercussions and influence in these countries, for instance, on the ease of applying laws for electric mobility or on state support for the purchase of new BEVs.
  - ✓ *Cultural aspects* – by trying to understand whether cultural influence is also a reason to explain the differences in sales of BEVs between Norway and Portugal. These countries, despite both being European (although Norway doesn't belong to the European Union and Portugal does), have different cultural characteristics, which can be reflected in the consumers' interest and concerns.

- Control Variable:
  - ✓ *Battery recharging costs versus oil prices* - these aspects could be seen as a control variable, since the cost of charging the battery, compared to the cost of fill of the car with gasoline, can be a factor that influence the purchase and daily maintenance of BEV's.

Therefore, I will divide each of these variables described above into the next subchapters of this study, seeking to provide an explanation of them, a comparison between countries (Norway *versus* Portugal) and presenting the respective conclusions.

3.1. Income of citizens

Considered as one of the explanatory independent variables in this study, it is expected, as mentioned, to provide an indication of the financial ability of Norwegians and Portuguese to purchase new BEVs.

3.1.1. Income in Norway

As far as Norway is concerned, and according to the data provided by the OECD, the evolution of the average monthly gross salary of the Norwegian population (converted into euros, since the official Norwegian currency is the Norwegian krone - NOK), during the period 2013-2022, is shown in the table below. It should be noted that the figures presented below correspond to the division by 13 of the figures originally presented by the OECD (which only presents annual figures), explained by the fact that in Norway workers normally receive 12 monthly salaries per year and one month's extra salary as a holiday bonus (known as a "feriepenger"), which is usually paid in June or December, depending on the employer.

Table 3.1 - Norwegian average monthly gross salary

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Euros	3 265 €	3 354 €	3 449 €	3 497 €	3 558 €	3 659 €	3 811 €	3 881 €	4 102 €	4 283 €

Source: OECD statistics www.data-explorer.oecd.org/

As this table shows, in 2013, a Norwegian, on average, earned a gross monthly salary of around 3265 €, and in 2022, this value reached around 4283 €. In other words, in 10 years, the Norwegian population has increased its gross monthly income more than 1000 €, which represents, over this period of time, a growth of 31.2%. Although from 2014 to 2020 there was an average increase of 88 € per year compared to the corresponding previous year, 2021 and 2022 presented the largest increases, with a rise of 221 € in 2021 and 181 € in 2022.

Given that this is the average Norwegian salary, it's important to note that “there is no general minimum wage for all sectors and workers in Norway. Nevertheless, minimum wages has been introduced in certain sectors in general application of collective agreements. General application of collective agreements is one of a number of instruments to prevent foreign workers from being given poorer pay and working conditions than are usual in Norway”[32]. According to The Norwegian Labour Inspection Authority, the basic hourly salary varies depending on the sector, age and experience. These minimum rates of remuneration exist in certain sectors, such as construction sites, maritime construction industry, agriculture and horticulture sectors, fish processing enterprises, transportation and tourism[33]. Furthermore, most Norwegians have work contracts with a fixed monthly income and trade unions are institutions that strive to ensure fair wages for their workers, helping them maintain a good standard of living. The solid salary structure, paid in Norwegian kroner (NOK), is consistent with Norway's comprehensive welfare system and overall high quality of life.

However, in this context, it is important to emphasise the tax deductions, in other words, the monthly income tax paid by Norwegians. The Norwegian personal income tax system is modelled on a dual tax base: general income and personal income. General income is taxed at a fixed rate of 22% and the personal income is taxed through a bracket tax, consisting of a progressive tax on gross salary and other personal income, that starts at 1.7% and could rise to 17.4%, depending on which income bracket the person is in[34]. As far as social security contributions are concerned, the monthly amounts deducted are generally around 8% of personal salary and employees do not pay contributions if their income is less than NOK 64650 (or 5471 € per month)[35]. So, if added all these taxes described, it can be verified that in Norway, the tax rate on monthly salaries can reach a total of between 32% and 47%. Therefore, for example, in the year 2022, with an average gross monthly salary of 4283 €, applying a total minimum income tax rate of 32%, the net monthly salary becomes 2912 €, and 10 years earlier, in 2013, with an average gross monthly salary of 3265 € and with the same minimum tax rate, this monthly net salary would have been 2220 €. If, on the other hand, and placing the situation at the extreme, we apply the maximum tax rate of 47%, these monthly net salary figures, in 2013, change to an amount of just 1730 € and, in 2022, to 2270 €.

These overall salary figures that were presented are important for assessing the financial capacity of a Norwegian citizen to purchase a new BEV, being also displayed, in the following table, the values of the average cost of buying a new BEV in Norway, during the period from 2016 to 2022.

---

32 Available in www.arbeidstilsynet.no/
33 See also www.arbeidstilsynet.no/
34 See also www.skatteetaten.no/
35 See also www.lano.io/

Table 3.2 - Average price of one BEV in Norway

Year	2016	2017	2018	2019	2020	2021	2022
Euros	61 290 €	60 360 €	59 440 €	58 510 €	57 580 €	56 650 €	56 610 €

Source: Statista www.statista.com/

It should be emphasised firstly that, for reasons of data reliability, values from 2013 to 2015 have not been included in this table, being displayed only data from 2016 onwards (being also converted from US dollars to euros). It is also important to note that the figures shown are the average price of a new BEV (that is, including from the lowest to the highest price) and also includes all the brands available on the market during that year. So, as shown in the table, the average price of a new BEV, including taxes, was 61290 € in 2016, decreasing to 57580 € in 2020 and even to 56610 € in 2022. So, as it can be seen, in this country, occurred a gradual decrease in price of new BEVs over these years (almost in the order of 1000 € per year), having, however, a significant higher average purchase price when compared, for example, with the purchase price of a new car with an internal combustion engine.

The purchase of a new BEV can, indeed, be considered expensive. But if we look at it from the point of view of the minimum cost of purchase, that is, the cheapest BEVs, it becomes easier for any citizen, including Norwegians, to buy a 100% electric car. Owning a BEV doesn't necessarily have to be buying one with a medium or high price. It is sufficient to have one at the cheapest price, although the cheapest BEVs usually don't have the battery range or comfort of a higher-priced BEV, which can make people seriously reluctant to buy one. In Norway, prices for four-seater city BEVs, although in small in size, start at 13973 € or 163600 NOK (Peugeot iOn), 14060 € or 164620 NOK (Mitsubishi I-MiEV) and 15032 € or 176000 NOK (Skoda CITYGOe IV). If we want to step a little further up the car segment, to the lower mid-range, we can find the Nissan Leaf on the market from 16228 € (or 190000 NOK), the Fiat 500e from 18354 € (or 214900 NOK) and the Opel Corsa-e from 18782 € (or 219900 NOK)[36].

Figure 3.1 - Peugeot iOn

Source: Peugeot www.peugeot.com/

So, in short, looking at the figures presented, and in a generalised sense, it can be safely stated that a Norwegian with the net salary mentioned above (and even, if necessary, using today's normal credit or payment options), will certainly be able to buy a BEV that is cheap at least, or quite possibly, a middle-class car.

[36] See also www.naf.no/bilguiden/

3.1.2. Income in Portugal

Portugal, as a country belonging to the European Union and the eurozone, as we know, uses the euro as its currency. According to the data provided by the OECD, and similar to the way it was presented in the Norwegian case, the following table shows the average monthly gross salary in Portugal throughout the period 2013-2022. It should again be noted that in order to obtain these values, it was necessary to divide by 14 the values originally presented by the OECD (annual amounts), because, in Portugal, 14 salaries are paid per year (once a month, plus holidays and Christmas allowances, each of one normally corresponds to one gross monthly salary).

Table 3.3 - Portuguese average monthly gross salary

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Euros	1 187 €	1 169 €	1 176 €	1 182 €	1 206 €	1 245 €	1 304 €	1 321 €	1 373 €	1 452 €

Source: OECD statistics www.data-explorer.oecd.org/

Looking at this table, it shows that in 2013 the average gross monthly salary was around 1187 €, whereas in 2017 (already the period after the intervention of the financial assistance programme, commonly known as the "*troika*", which from 2011 to 2014 led to cuts in Portuguese salaries[37]) the average salary was only 1206 € and reaching, in 2022, around 1452 €. As such, the most significant increases in average monthly gross salaries in Portugal occurred after the year 2018, since, from that year onwards, there was an average salary gross increase of around 52 € per year. Nevertheless, and unlike Norway, if we estimate the gross salary growth rate from 2013 to 2022, it can be concluded that in Portugal there has only been an increase of 22,3% (that is, 265 €). Moreover, in Portugal, and unlike Norway, there is a national minimum wage applied to all sectors, being that values showed in the table below.

Table 3.4 - Portuguese minimum gross salary

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Euros	485 €	485 €	505 €	530 €	557 €	580 €	600 €	635 €	665 €	705 €

Source: Pordata www.prod2.pordata.pt/

With minimum gross salaries of around 485 € in 2013 and 705 € in 2022, it is evident that Portugal, in the span of 10 years, had an undeniably low salary for the less wealthy population and, with this minimum wage, it can be assumed that it hard to buy a new car, even of any kind. Plus, if the gross salaries described in the tables above are reduced by the IRS (personal income tax) and compulsory social security contributions, the average net salary of a

[37] See also www.bportugal.pt/

Portuguese citizen reduces considerably. In Portugal, the tax is computed based on categories of income, in which, for instance, in 2020, could range from exemption (0%, for minimum wages), to maximum 45.1%, for the most income wages[38]. Also, the monthly contribution by the worker to social security is 11% of gross pay[39].

Therefore, if we calculate the net salary in 2013, using the average gross monthly salary (1187 €), the respective withholding tax, for a single person without children, would be 14.5%, and, including the contribution to social security of 11%, it would have resulted in a monthly net salary of around of 884 €. Interestingly, 10 years later, in 2022, the net monthly salary would be even lower, since, despite having an increase in gross salary, the rate of IRS income tax, for example, for single individuals without children, has increased to around 16.2%, meaning, with 11% to social security included, an estimated net monthly salary of 792 €.

However, as it's related, it is also important to understand the average price of BEVs in Portugal during the period in analysis. As in Norway, for reasons of data reliability, only the data for the period 2016-2022 is presented.

Table 3.5 - Average price of one BEV in Portugal

Year	2016	2017	2018	2019	2020	2021	2022
Euros	52 440 €	51 510 €	50 580 €	49 660 €	48 720 €	47 800 €	47 750 €

Source: Statista www.statista.com/

In the case of Portugal, and it can be said throughout almost the entire world, there has also been a gradual decrease in the average price (including taxes) of BEVs. In 2016, the average price of a BEV in Portugal (meaning the average price of all BEVs available on the Portuguese market) was around 52500 €, in 2019 it was about 49500 € and in 2022 it was approximately 47500 €. So, as happened in the case of Norway, the price decrease has been gradual, despite the fact that it's not very significant, totalling, on average, nearly 900 to 1000 € per year. This also represents, in the period analysed (2016-2022), a decrease of only 8.94% in the average price of BEVs, noticing, therefore, the slow progression in the price decline.

Also in this context, and as in Norway, it is important to look at the financial possibilities for a Portuguese citizen to buy an electric car at the lowest possible price. So, in the Portuguese market, and until the end of 2022, the cheapest BEV possible was the Dacia Spring Electric (starting at 22200 €), followed by the Renault Twingo electric (26100 €) and the Fiat 500e Hatchback (around 30000 €). Once again, by uplifting the segment (and increasing, therefore, the comfort, power and battery autonomy), we would be able to find available on the Portuguese market the MG MG4 Electric for 33600 €, the Nissan Leaf for 34200 € or the MG

38 See also www.info.portaldasfinancas.gov.pt/
39 See also www.seg-social.pt/

Figure 3.2 - Dacia Spring Electric

Source: Dacia www.dacia.pt/

ZS EV for 34900 €[40]. Comparing these figures with the prices of the cheapest new gasoline four-seater cars (Dacia Sandero from 12505 € and Fiat Panda from 14902 €[41]), we can clearly see that the prices of BEVs in Portugal were significantly higher than the prices of cars with internal combustion engines. So, with this economic evidence in hand, it can be understood, almost at first glance, that was not always easy to buy a BEV in Portugal. However, a comparison, in this sense, is made with Norway, on the following pages.

3.1.3. Comparison of incomes

The following table shows a comparison of the average gross salaries in Norway and Portugal in the period 2013-2022. However, I have also decided to include the figures for the Nordic countries (Denmark, Finland, Iceland and Sweden) to demonstrate, in a more expressively way, the difference in salaries between the Nordic countries and Portugal (being this a southern European country).

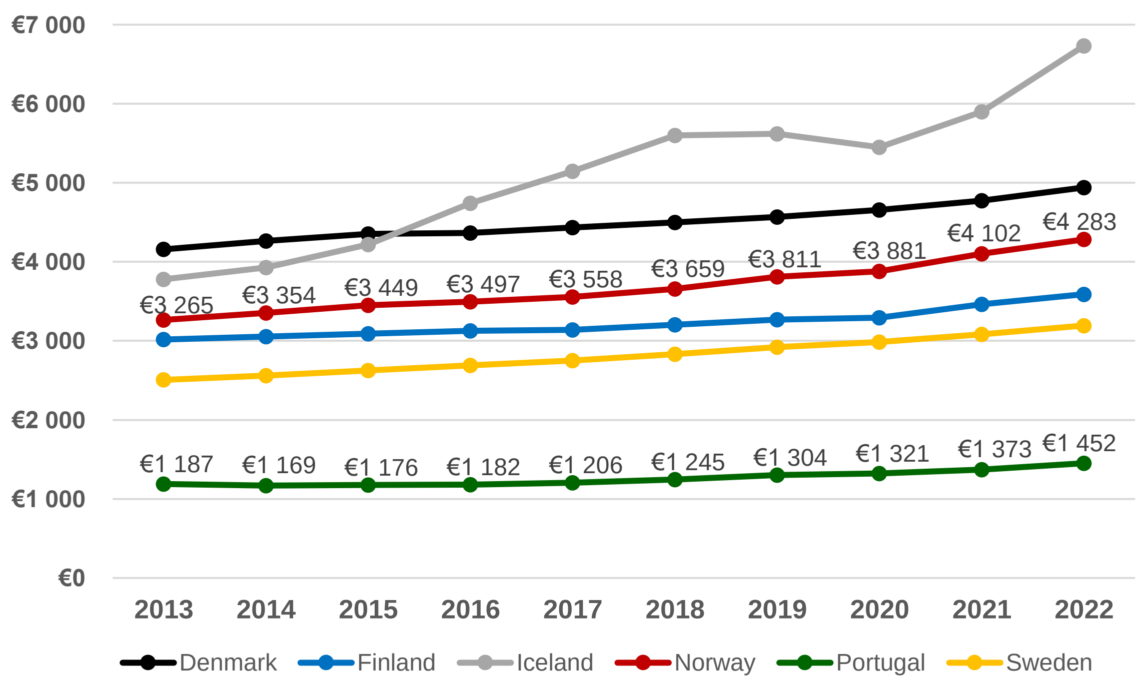


Figure 3.3 - Average monthly gross salaries in Norway and Portugal (including Nordic countries)

Source: OECD statistics www.data-explorer.oecd.org/

[40] See also www.alternative-fuels-observatory.ec.europa.eu/
[41] See also www.guiadoautomovel.pt/

As can be seen (also in a more detailed way in Appendix H), Norway, on average, had a gross salary 2.8 to 3 times higher than Portugal. This represented, during the years in review, an increased average salary of 192%, when compared to the Portuguese level. So, it can be concluded, in this case, that Norwegians citizens earn, per month, nearly 200% more than the Portuguese, being this not only true of Norway, but also for the other Nordic countries in general. With Iceland at the top, Denmark, Finland and Sweden, during the period in review, had considerably higher gross monthly salaries than Portugal, thus confirming the idea that salaries in northern Europe are significantly higher than in the Mediterranean countries.

It is also worth noting that, of the countries compared during the period 2013-2022, Portugal was the one with the lowest total increase of average gross salary (of only 265 €), followed by Finland (increase of 573 €), Sweden (688 €) and Denmark (783 €). Interestingly, the countries that showed the biggest rise on salaries were countries that are not part of the EU (meaning Norway and Iceland), with an increase of 1018 € and 2953 €, respectively, in the span of 10 years. Furthermore, and regarding the European Union average monthly gross salary shown in the next table (values divided by 13 months from original data), it can be seen that Portugal is below this average, while Norway is above it.

Table 3.6 - Average monthly gross salary in the EU

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Euros	2 568 €	2 593 €	2 628 €	2 664 €	2 722 €	2 789 €	2 859 €	2 857 €	2 983 €	3 126 €

Source: Pordata www.prod2.pordata.pt/

As a result, salaries in Portugal make it more difficult to acquire a BEV than the salaries practised in Norway (or even than the average salaries practised in the EU). Portugal is therefore behind these two players when it comes to the possibility of acquiring a BEV. Also, as shown earlier, from the perspective of the minimum wage, Portugal has one that permits only the subsistence of people (practically without any kind of personal vehicle), in contrast to Norway, where there is no general minimum wage, but where the agreed minimum wages allows for a greater economic quality of life.

It is therefore clear that the citizens of Norway, Portugal and the European Union on average have very different purchasing power. These conclusions are supported by the following graph, where is compared the purchasing power adjusted GDP per capita, being a measure used to compare the relative standards of living and economic well-being of different countries. Basic figures are expressed in purchasing power standards (PPS), which represents a common currency that eliminates the differences in price levels between countries to allow meaningful volume comparisons of GDP. Looking at the figures, during this period, it is evident that Norway had more than twice purchasing power adjusted GDP per capita than Portugal,

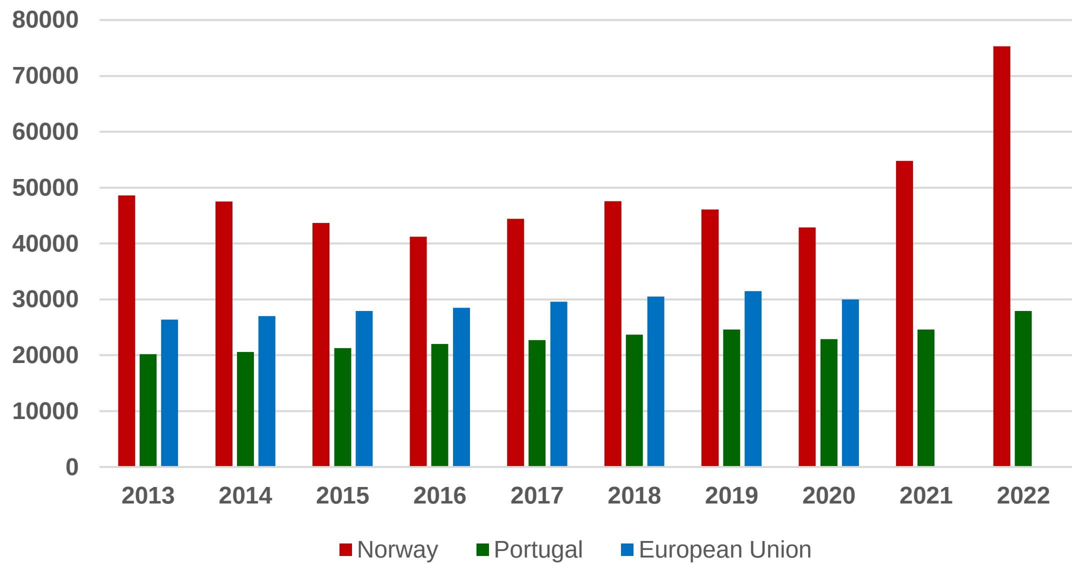


Figure 3.4 - Purchasing Power Adjusted GDP per capita (in Norway, Portugal and the EU)

Source: Eurostat www.ec.europa.eu/eurostat/

reaching almost three times as much in 2022. As far as the EU average purchasing power adjusted GDP per capita is concerned, again and as expected, it is above of Portugal, but below the Norwegian figures. Norwegian purchasing power ranks, therefore, amongst the highest on the European continent.

As far as the tax burden on salary is concerned, it can be synthesised in the table below, showing that Norway and Portugal have different percentages for income tax and social security contributions:

Table 3.7 - Tax deductions on salary

Tax deductions	Norway	Portugal
Income Tax	• 22% fixed rate • Plus, bracket tax from 1.7% to 17.4%	Bracket from 0% to a maximum of 45.1%
Social Security	8% fixed rate	11% fixed rate
Total	It could sum between 32% to 47%	It could sum between 11% to 56%

However, due to the large difference in average and minimum salaries between Norway and Portugal, in the case of Portugal, the average percentage of income tax deductions is between 15% and 20%, while in Norway it can be between 35% and 40%. So, in Portugal, there are very limited number of situations where the high and maximum rates of personal income tax are applied, whereas in Norway that number is considerably higher. Nevertheless, it is recognized that, in Portugal, despite having low salaries, taxes still take a considerable part of the gross salary, while in Norway, the elevated salaries practised, although having high taxes, still allow for a generous and large net salary. Also, even though the cost of living in Norway is higher than in Portugal (cost of living in Norway is, on the average of the main products, 66.4% higher than in Portugal[42]) the higher salaries offered by this Nordic country firmly compensate for that.

In all this, and as a result, Norway is generally considered a country with high purchasing power due to its high level of per capita income and relatively high cost of living. This is often attributed in part to its prosperous economy, high standard of living and comprehensive welfare system. On the other hand, Portugal is considered a country with more moderate purchasing power compared to many western European countries, and in general, the purchasing power for basic goods or services tend to be considerably lower than in Nordic countries.

By consequence, all these premisses have an impact on the purchasing capacity of BEVs for citizens of both countries. as this type of electric vehicle has a considerably higher purchase price than ICE vehicles. As seen in the table that follows, in Norway, the average price of BEVs in 2016 was 61290 €, whereas in Portugal it was 52440 €. Almost 10 years later, in 2022, the average price in Norway stood at 56610 €, while in Portugal it had fallen to around 47750 €. This leads to the fact that in both countries there has been a gradual (and similar), decrease in the average cost of new BEVs in recent years.

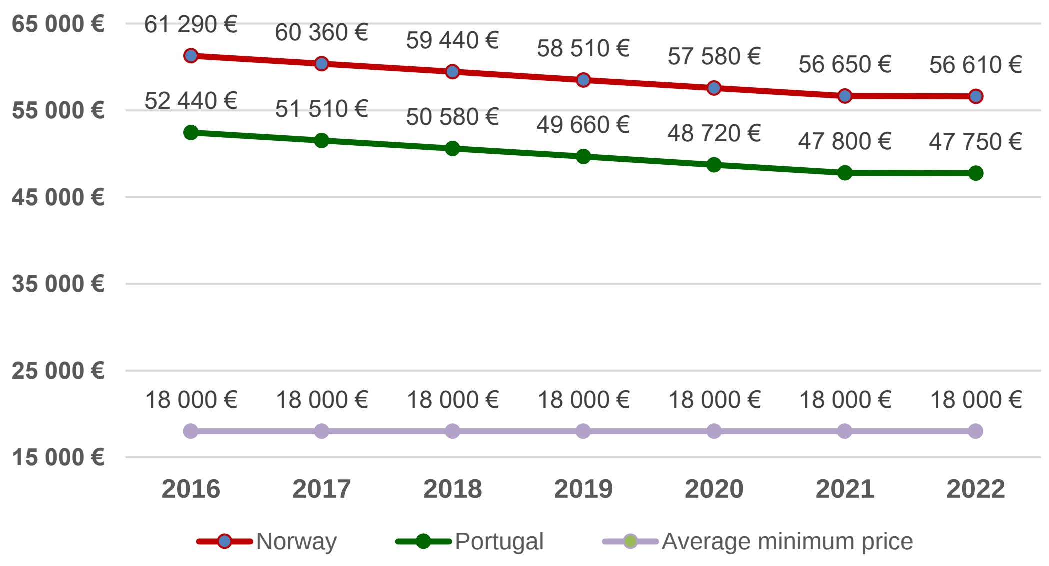


Figure 3.5 - Average price of one BEV (in Norway and Portugal) and average minimum price

Source: Statista www.statista.com/

This difference is even more noticeable when compared to the average minimum price of BEVs (the average minimum price of BEVs between Norway and Portugal is 18000 euros).

[42] See also www.numbeo.com/cost-of-living/

Therefore, it is clear that a Norwegian citizen will be able to more easily purchase a BEV at an average price, and even more so BEVs at a minimum price, since the cheapest BEV in Norway cost around 14000 € (Peugeot iOn), whereas in Portugal, the average Portuguese citizen will find it impossible to buy a medium-priced BEV, but with substantial financial effort and considerable payment facilities, he might be able to buy a minimal price BEV (Dacia Spring Electric at 22200 €).

Naturally, minimum-price BEVs offer a much more limited range than mid-price BEVs (as shown in the Appendix I). As stated, most of the utility BEVs available in Europe, with a cost of up to 50000 €, could offer, in some models, a range up to 450 km. However, there is a market of cheaper BEVs, whose batteries only provide around 200 km of autonomy, and therefore, being more city-orientated (urban BEVs). Without more rigorous planning for electric charging on highways for long distances, these BEVs are only recommended for everyday journeys (home to work) and hardly anything else. Nevertheless, there are BEVs at 100000 € or 150000 €, which also offer a range of up to 450 km, although, in that case, the price requested is mostly for the luxury of the car, the equipment and the respective brand and model segment (which can include sports cars), and not for the range of the battery.

So, in short, it can be concluded, that the salary conditions offered allow the Norwegian citizen to buy a BEV with a greater variety of choices (from the cheapest BEV, to a mid-priced or even high-priced one) than the Portuguese citizen, a fact that is more associated with the high gross salaries practised in this Nordic country, and less with the existing tax burden, since that also exists in Portugal.

3.2. Public Policies implemented

As mentioned above, another fundamental variable for this study is the influence of public environmental policies implemented in the last decade by Norway and Portugal respectively, specifically those related to the pace of implementation of e-mobility structures or public subsidies for the purchase of 100% electric vehicles for individual use. Therefore, a comparison of these public policies to support and facilitate the implementation of individual electric mobility is described on the following pages.

3.2.1. Electric mobility policy in Norway

"Norway has a long history of offering electric car incentives, dating back to 1990" (Haugneland *et.al*, 2017). As a country that tends to be politically stable, it is important to note that also has a strong political engagement in supporting the introduction and development of 100% electric vehicles. As it will be seen, these factors have played a crucial role in creating viable market conditions for the development of BEVs in the long term.

Starting, about the registration tax benefits, BEVs have been exempt from registration/importation tax since 1990 (this exemption exclusively applies to BEVs, and not another type of vehicle with some kind of electric propulsion). Only this fact is a determining factor in the much lower purchase price in general of BEVs, when compared, for example, with the purchase price of PHEVs or internal combustion cars. Furthermore, BEVs benefited from a 75% discount on the registration fee and buyers are exempt from purchase tax on car prices below 42000 € (above they pay only 25%). The drivers do not pay tax on CO_2, as well as no tax is required on Value-Added Tax (VAT) for the weight of the BEV's. Also, these exemptions have no budgetary limits[43][44].

Since 2001 and until 2022, BEVs did not pay VAT at the time of purchase (which was equivalent to 25% of the purchase price). This applied to new and used vehicles, although this practice will change from 2023, with VAT being paid at 25% on the purchase price from 500000 NOK and above. On the other hand, as far as property tax benefits are concerned, from 1996 to 2021 Norway offered BEVs buyers an annual road tax exemption, with this tax being reduced in 2021, and integrally paid from 2022 beyond (48 € per year), as well as a reduction in the dismantling tax of around 249 €. As this is also the type of fuel favoured by the Norwegian Government and for the purchase of BEVs by companies, there is a 30% reduction in car tax and a 25% VAT exemption on leasing. In addition, the benefit of private use of a company vehicle is only 60% of the list price of the vehicle in new condition[45][46].

At the level of Norwegian laws that enhanced the implementation of electric mobility in Norway, it can be mentioned the Norwegian VAT Act, 6-2 (introduced in 2001), refereeing to the exemption of electric vehicles from VAT; The Oslo Toll Ring Regulation[47], regarding to the exemption of electric vehicles from tolls on some Norwegian roads and bridges (launched in 2009), and The National Transport Plan, which is a strategic plan that is revised every four years the current plan covers the period 2018-2029[48].

As far as significant incentives for local infrastructure to support the use of BEVs are concerned, Norway's Ministry of Transport and Energy in 2016 created a regulation on the requirements for electric vehicle refuelling equipment in new buildings and car parks, in this case requiring that at least 6% of the spaces in car parks and parking areas in new buildings must be designated exclusively for electric cars. Plus, and related to the national infrastructure, being a country with a long mainland coastline stretching around 29.000 km, including fjords and bays, "the Norwegian government has already established fast-charging stations every 50

---

43 See also www.alternative-fuels-observatory.ec.europa.eu/
44 See also www.elbil.no/
45 See also www.alternative-fuels-observatory.ec.europa.eu/
46 See also www.elbil.no/
47 See also www.visitoslo.com/
48 See also www.regjeringen.no/

km on all main roads"[49] which facilitates long-distance travel and ensures that BEV drivers can easily and fast recharge their vehicles, minimizing also range anxiety. In total, Norway has a dense network of charging infrastructure, with over 10000 public charging points as of 2021, and a total (public and private) of over 20000 charging stations. As of end of 2022, "there were more than 5600 cars that can fast-charge at the same time"[50]. Collaboration between government, energy companies and other stakeholders (public-private partnerships) play an essential role in the funding, implementation and management of charging stations across the country. Advanced technologies are also incorporated to improve the efficiency of charging electric vehicles, such as adequate load charging of the individual BEVs or remote monitoring of charging station functioning.

It is also important to highlight these incentives (some even original) provided by the Norwegian government, such as:

- The existence of a special E-Number plate for electric vehicles, which simultaneously enables local authorities to implement and choose incentives for residents and users of BEVs, grants free municipal parking for electric vehicles in many areas in cities and access to the use of bus lanes by BEVs drivers.
- At a local level, the city of Oslo, for example, has its own budget allocated to housing associations for the installation of chargers (a policy called "a right to charge", applied for people living in apartment buildings), which has doubled since 2017 to 20 million Norwegian kroner (2.1 million euros). The Oslo City Council thus grants subsidies to the respective housing associations or co-owners for the improvement and dynamization of their charging stations. These subsidies can amount to a maximum of 20% of the investment costs, 5.000 NOK per charging point or 1.000.000 NOK per housing association or co-ownership. The same applies in the city of Bergen, while also in Oslo, but in the municipality of Bærum, there are subsidies for faster and more efficient charging of BEVs, intended for housing associations, co-owners, homeowner's associations or co-operatives, with the maximum subsidy per housing company being 50.000 Norwegian kroner.
- The city councils of each municipality also each have the authority to apply or change taxes or categories of exemption from payment, as they see fit. This possibility has been applied since 2016, leading to different parking fees in various cities, for example, where a BEV in Trondheim pays the same as a petrol car, but this amount is cut in half in Bergen. In Oslo, on the other hand, all parking spaces for BEVs were for free until 2019, and by that date there were also 1300 spaces dedicated to charging BEVs and

[49] Available in www.alternative-fuels-observatory.ec.europa.eu/
[50] Available in www.elbil.no/

equipped with chargers (3.6 kW), out of the 6500 parking spaces in municipal car parks (in other words, 20% of municipal parking spaces from, at least, 2013 to 2019, in addition to being free, already had charging stations available and incorporated).

- In this case, the existence of a charging chip provided by the Norwegian EV Association (Elbilforeningens) allows the Norwegian user of a BEV to access charging stations spread across the country with advantageous conditions and at a considerably reduced price.
- As far as tolls on Norway's roads are concerned, BEV users didn't have to pay them from 1997 to 2017 (tolls were 100% for free), but, from 2018, began charging maximum 50% of the price applied on fossil fuelled cars.
- Also, throughout the country, from 2009 to 2017, BEVs were exempt from paying a transport ticket when travelling by ferry boat within the national road network (although, from 2018, it began also to charge maximum 50% of ticket price). Due to Norway's mountainous and distinctive geographical features, this method of transport by water is vital for connecting the various populations. When travelling outside the national road network, each municipality decides whether, or not, to charge this transport fees for BEV users.
- Lastly, the Norwegian Parliament has decided to set, as national goal, that all new cars being sold by the year 2025 should be zero-emission (that is, electric or hydrogen-powered).

To conclude, and referenced by the OCDE, "Norway's success in promoting electric vehicles has mainly been driven by generous tax incentives. These fiscal incentives were essential for shifting demand towards zero emission vehicles and increasing their share in the car fleet"[51]. However, this policy has also contributed to a substantial decrease in tax revenues related to motor vehicles, since the associated tax revenue losses accounted for around a third of environmental tax revenues. These policies of taxes have thereby become the victims of their own success, as the tax expenditure resulting from the VAT exemption reached NOK 11.3 billion ($1.3 billion) in 2021. At the present time, "given the success of electric mobility, the government is now working towards building a sustainable vehicle taxation system"[52].

3.2.2. Electric mobility policy in Portugal

In Portugal, the laws for implementing electric mobility have been progressive, step by step, over the last decade. It was only in the year 2009 (through Resolution of the Council of

[51] Available in www.oecd.org/
[52] Available in www.oecd.org/

Ministers nº 20/2009, of 20th February) that the Portuguese government, for the first time, decided that “it was necessary to create the conditions for the mass introduction of electric vehicles, ensuring an adequate infrastructure for the evolution of the electric vehicle fleet and the development of a service model that allows any citizen or organisation to access all and any electric mobility solution provided by any electric vehicle manufacturer”[53]. In this resolution, it also decided to “create the Programme for Electric Mobility in Portugal, whose objective was to introduce and massify the use of electric vehicles”.

That same year, the Resolution of the Council of Ministers nº 81/2009, of 7th September, described the incentives, which included “5000 euros for the purchase of electric cars by private individuals, which could reach 6500 euros in the case of simultaneous disposal of an internal combustion vehicle. This subsidy will be granted for the purchase of the first 5000 electric cars and will be in effect until the end of 2012”[54]. This legislation was also intended to initiate the creation of a pilot infrastructure of public charging points (MOBI.E), present not only on the main national roads, but also in around 25 municipalities (through protocols with the respective town halls), in which it also incorporated tax and parking incentives for vehicles 100% electric. A year later, in 2010, with Law Decree nº 39/2010, of 26th April[55], which was amended the following year, in 2011 and in 2014 (with Law nº 64-B/2011, of 30th December[56], Law 82-D/2014, of 31st December[57], Law Decree nº 170/2012, of 1st August[58], and Law Decree nº 90/2014, of 11th June[59], respectively), came in existence regulations on the organisation, exercise and access to electric mobility activities, as well as the effective creation of the MOBI.E pilot network, resulting in the effective implementation of electric mobility in Portugal.

The year 2014 was particularly important, as Law Decree nº 90/2014, of 11th June, revised the model chosen for electric mobility, by defining rules for greater integration of charging points in private spaces with the MOBI.E electric mobility network. Two years later, in 2016, the 1st phase of the MOBI.E pilot network was completed (Resolution of the Council of Ministers, nº 49/2016, of 1st September[60]), giving rise to the 2nd phase of this pilot network, as well as increasing the number of municipalities that were not covered in the 1st phase.

Being Portugal a member of the European Union, in 2017, and in compliance with Directive 2014/94/EU of the European Parliament and the Council of 22 October (transposed into Portuguese law by Law Decree nº 60/2017, of 9th June[61]), the National Action Framework was

[53] Available in www.diariodarepublica.pt/
[54] Available in www.diariodarepublica.pt/
[55] Available in www.diariodarepublica.pt/
[56] Available in www.diariodarepublica.pt/
[57] Available in www.diariodarepublica.pt/
[58] Available in www.diariodarepublica.pt/
[59] Available in www.diariodarepublica.pt/
[60] Available in www.diariodarepublica.pt/
[61] Available in www.diariodarepublica.pt/

approved, which aimed to create an infrastructure for alternative fuels (Resolution of the Council of Ministers nº 88/2017, of 26th June[62]). This framework defined measures and objectives for the development of a refuelling infrastructure and the use of alternative fuels, with the goal by 2020 of establishing at least 2394 charging points for the public charging station infrastructure at national level, including the points in the pilot network.

Therefore, in terms of specific incentives for purchasing a new BEV in Portugal, the evolution from 2013 to 2022 is described in more detail in the following table:

Table 3.8 - Financial & taxes incentives for the purchase of BEVs in Portugal

Year	Financial incentive	Description	Tax incentive
2013-2014	--------------	• Financial incentives for the purchase of electric vehicles were suspended	• ISV exemption (on purchase) •IUC exemption (annual)
2015 - 2016	4500 €	• Until 2016, then replaced by the Fundo Ambiental (FA)	
2017-2018	2250 € (maximum of 1 BEV per person)	• Maximum of 1000 FA applications; • FA budget available: 2.300.000 € (2017) and 2.650.000 € (2018)	
2019	3000 €* (maximum of 1 BEV per person)	• Maximum of 1000 FA applications; • FA budget available: 3.000.000 €	
2020	3000 €* (maximum of 1 BEV per person)	• Maximum of 700 FA applications; • FA budget available: 4.000.000 €	
2021	3000 €* (maximum of 1 BEV per person)	• Maximum of 700 FA applications; • FA budget available: 2.100.000 €	
2022	4000 €* (maximum of 1 BEV per person)	• Maximum of 1300 FA applications; • FA budget available: 5.200.000 €	

Source: Fundo Ambiental (FA) www.fundoambiental.pt/

* Note: BEVs with a final purchase cost (including VAT) of more than 62500 € are not eligible.

It is important to highlight that as of 1 January 2017, the so-called Fundo Ambiental (FA) came into existence in Portugal, in which was intended to exclusively be responsible for the incentives to purchase of new BEVs "establishing the rules for their allocation, management, supervision and execution of the respective revenues and subsidies to be conceded"[63].

[62] Available in www.diariodarepublica.pt/
[63] Available in www.fundoambiental.pt/

So, as can be seen in the previous table, from 2013 to 2022 the Portuguese government chose to update the incentives for individual electric mobility every year. While at the beginning of the implementation of electric mobility in Portugal (2009 to 2012), there was an incentive of 5000 € for the purchase of a BEV (which could reach 6500 € in the case of decommissioning, for a total of 5000 vehicles), from 2015 to 2022, these incentives varied between 5000 € and 2250 € (per purchase and per person), and were also limited to the number of possible applications accepted (ranging between 700 and 1300) and the budget available from the FA. The procedure meant that a user of a new BEV, after purchasing it, had to apply to the FA by submitting personal documents and the documents related to the purchase of the BEV. As such, when this application was made, there was no guarantee that it would be elected (as an example, in 2018, the FA received 1596 applications for the incentive, and only 1170 were elected, which means that only 73.3% of the applications made received the respective incentive (2250 €) for the purchase of a new BEV. It should also be noted that in 2012 and 2014, these incentives were suspended by decision of the Portuguese government at the time of the intervention of the International Monetary Fund (commonly known as "*Troika*") in Portugal, which, as is well known, at the time led to severe constraints on the Portuguese economy, people's salaries, purchasing power and society in general.

On the other hand, as far as taxes are concerned, BEVs have been exempt from Registration tax benefits (in Portugal known as Vehicle Tax - ISV) and Ownership tax benefits (in Portugal known as Single Circulation Tax - IUC) since the beginning of the implementation of electric mobility in Portugal and throughout the 2013-2022 period. Both these taxes are calculated considering the engine's power and its environmental component. As the environmental component of a BEV is zero pollutant and zero greenhouse emissions, 100% electric vehicles are still fully exempt from this type of tax at the present time.

Regarding the parking of electric vehicles in municipalities, there have been free parking spaces available at a slow but progressive pace over the last decade, as well as parking discounts, green tariffs or dedicated BEV parking spaces in various Portuguese cities. In the capital (Lisbon) and some other cities in the country, car parking has become free (and even without a time limit) in some limited zones, or other places of limited duration. The criteria for awarding free or discounted parking tariffs are the responsibility of each city council. As far as tolls are concerned, there was no exemption from paying tolls for BEV users under Portuguese law. As mentioned by the Portuguese Association of Concessionaires of Motorways and Toll Bridges "Toll classes are not directly linked to vehicle pollution. Therefore, there is no exemption for this reason."[64]. However, on a limited number of bridges and motorways with automatic tolls, a 50% discount on the toll rate was possible if the motorway concessionaire

[64] Available in www.apcap.pt/

provided identification and information to the corresponding authorities[65]. Finally, with regard to charging stations, over the past decade, investments (both public and private) have been made, so that by 2022 there would be charging points throughout the country, although highly concentrated in the main cities. According to UVE, due to the investments made from 2015 to 2021, “"the number of charging stations for electric vehicles has increased by almost 400%, which refers to around 5000 charging points ("plugs") and this only in the public grid, as of 31 December 2021. If we add to this the charging points of the various private grids (which complement the public grid), this figure already exceeds 6000 charging points, including both AC and DC plugs.”[66]. However, by the end of 2022, there were significant problems in the distribution of charging stations across the country, as according to a study carried out by MOBI.E for consumers until 2023 on charging infrastructures to support the energy transition of mobility in Portugal, stated that "rural areas (24%) and small towns (32%) are the places where it is most difficult to recharge, and 73% of electric vehicle owners have already experienced difficulties in finding available charging stations (83% mentioned offline charging stations). With regard to municipalities outside the main cities, 70% still didn't have structured municipal plans defining the intended location of electric charging stations”[67].

3.2.3. Comparison of policies

To compare the public policies for implementing individual electric mobility in both countries, the following table was produced. In his way, the public policy to promote electric mobility in the period 2013-2022 is divided into around 10 criteria and is compared in both countries in terms of their main features. In the last column, based on this comparison, the country that offers the most attractive result for each criterion is identified (“Winner”).

Table 3.9 - Comparison of electric mobility policy (Norway *vs* Portugal)

Criteria of electric mobility policy (2013-2022)	**Norway**	**Portugal**	**Results** (“Winner”)
Start of Implementation of policy	Year 1990.	Late 2009 / beginning 2010.	**Norway**
Financial incentives to the acquisition of new BEVs	No incentives.	Through a personal application: • Between 2250 € and 5000 €, depending on the year. • Limited to 1 incentive per person. • Dependent on state budget allocation. • Maximum BEV value of 62500 €.	**Portugal**

65 See also www.viaverde.pt/
66 Available in www.uve.pt/
67 Available in www.mobie.pt/

Criteria of electric mobility policy (2013-2022)	**Norway**	**Portugal**	**Results** ("Winner")
Fiscal incentives (Taxes)	• Exemption registration/importation tax. • Exemption purchase tax (above 42000 € pay only 25%). • Exemption ownership tax. • Exemption VAT in purchase.	• Exemption registration tax (ISV). • Exemption ownership tax (IUC). • No exemption on VAT.	**Norway**
Charging stations	• Dense network of charging infrastructure (more than 4000 stations in 2012 and 20000 in 2022). • Public-private partnerships manage charging stations across the country. • Modern charging stations and advanced technologies to remotely monitoring charging station.	• More than 1000 stations in 2012 and 6000 in 2022. • Public-private partnerships manage charging stations. • Significant number of stations not working (83% of users have already found offline stations).	**Norway**
Distribution of charging stations	Fast-charging stations every 50 km on all main roads, leading to more than 5600 cars that can fast-charge at the same time.	• Mostly located in the major cities, outskirts or main motorways. • Few in the smaller towns or in the rural areas, being the most difficult places to recharge.	**Norway**
Parking	• Free municipal parking in many areas (1999-2017) and dedicated parking places for BEVs. • The granting criteria are the responsibility of each town council.	• Free parking spots, parking discounts, green tariffs or dedicated parking spaces are available. • The granting criteria are the responsibility of each town council.	**draw**
Road Tolls	• Free of charge (1997-2017). • From 2018, maximum 50% of the price ticket.	Normal payment as other cars (although occasionally it can reach 50% discount).	**Norway**
Circulation	• No annual road tax. (1996-2021) • Ferries free of charge (2009-2017, from 2018 maximum 50% of the price ticket). • Free access to bus lanes.	Only in some cities, free access to some exclusive areas.	**Norway**
Financial support to residential areas	Municipal budget ("right to charge") allocated to housing associations and co-owners for installation and improvement of charging stations.	No financial support.	**Norway**
Information availability to citizens	Information available on specific websites, especially those of BEV user associations.	Information available on specific websites, especially those of BEV user associations.	**draw**

Beginning with the 1st criterion (*Start of Implementation of policy*), it is appropriate to emphasise the difference in the antiquity of the implementation of electric mobility in these countries. In Norway, this public policy began in the early 1990s, while in Portugal the first steps in this direction were only taken in 2009/2010. In other words, there is a difference of almost 20 years between these countries in terms of experience and practices in this area of policies and incentives associated with electric mobility, which is definitely a plus in Norway's favour.

Regarding the 2nd criterion (*Financial incentives to the acquisition of new BEV's*) in the period under analysis (2013-2022), Norway didn't practise these incentives, while Portugal did. Therefore, this is a point won by Portugal, as it helped to motivate and financially stimulate the initial purchase of new BEVs by the Portuguese citizens (although it was not a determining factor for the purchases, mainly due to the high purchase price of BEVs in Portugal and the limited number of incentives available). This suggests the idea that, in the last decade, it has been part of Portuguese public policy to incentivise the purchase of BEVs in Portugal in an introductory way, and eventually leading to a competition between users to try their luck at getting back some of the money invested in the purchase of their new BEV.

However, another significant difference is in *Fiscal incentives (Taxes)*, since Norway has exempted practically all the main taxes, namely registration/importation tax, purchase tax, ownership tax and VAT (which considerably lowers the final purchase price of a new BEV). On the other hand, Portugal, in accordance with its tax laws, has also exempted BEVs from paying registration tax (ISV) and ownership tax (IUC), which is a measure to be congratulated, though it does require the payment of VAT in full, which considerably increased the final purchase price of a new BEV (and for that reason, many users still have the practice of buying BEVs in foreign countries and transporting them to Portugal after). Therefore, because they are more extensive, Norway's generous tax incentives have become a key point in the success of its policy to increase the number of electric vehicles in circulation, since the taxation (VAT at 25%) represents a considerable portion of the final purchase price.

A similar result occurred in relation to *Charging stations* (4th and 5th criteria), since Norway, despite being a large country, has a dense network of charging stations. Expanded by public-private partnerships and equipped with modern technology, these charging stations have a very low rate of service failures. Throughout its long country, the implementation of a substantial number of fast and ultra-fast charging stations on motorways and other roads demonstrates the policy's strong commitment to the adoption of BEVs, providing battery charges of up to 80% in just 30 minutes. In residential areas, whether large or small, it is common to find exclusive charging stations for electric cars, having even converted petrol stations that originally used fossil fuels, to only provide fast charging for BEVs. Moreover, their public principle of "right to charge" is innovative, displaying their accumulated experience and awareness, for more than 20 years, of the importance of accessible electric charging in mobility issues. In Portugal, although there has been a significant increase in the number of charging stations (more than 6000 by 2022) many of the charging points are slow AC, DC or medium, with fast AC available almost exclusively on motorways. On the other hand, although in the Portuguese case there are also public-private partnerships for managing and expanding the charging network, the quality of service is not as high, with complaints about the number of stations that are out of order or not working (offline). In Portugal also, despite having more charging stations than Norway in proportion to the size of its geographical area, the public investment made was mostly in the main cities and much less in smaller towns. So, considering all these cumulative reasons, as far as electric charging stations are concerned, Norway comes on top in this electric mobility policy criteria.

As for the *Municipalities*, in both Norway and Portugal, each municipality is free to adopt the strategies and measures it considers appropriate. And these measures can include free or reduced-rate parking, the possibility of bus lanes, exemption from paying tolls or reduced rates, exemption from road taxes, exemption from paying ferry tickets and whether there are municipal budgets for improving and upgrading electric charging stations in residential neighbourhoods. In this regard, Norway has a (slight) advantage over Portugal, as road tolls and ferry use in Norwegian municipalities were free for BEVs until 2017, whereas in Portugal they are still paid at the same price as those used by an ICE. In Norway as well, BEV users can use all the lanes reserved for buses, while in Portugal in only a few municipalities there are lanes reserved for electric vehicles, and in certain Norwegian municipalities, there is a municipal budget for BEV-using residents, while in Portugal this does not yet exist. It should be noted that, as far as parking is concerned, these countries are tied, since both municipalities offer free spots, reduced parking fees or public parking for BEVs.

Finally, an *Information availability* criterion was added, defined as the government's communication and ease of access to information on electric mobility policies by the citizens. In this respect, these points are similar in both countries (resulting in a tie), although with the help of websites run by BEV user associations, which centralise and simplify that kind of information. In Portugal, even though in the study carried out by MOBI.E 37% reported difficulty in accessing information[68], with a little research it was possible to obtain the desired information regarding incentives and policies.

So, as a result of the comparative analysis of the 10 criteria of electric mobility policy (2013-2022), there are 7 criteria that are won by Norway, 2 criteria are draws and only 1 criterion is won by Portugal.

[68] See also www.mobie.pt/

Finally, it is important to reiterate that Portugal is a member of the EU, while Norway is not. As such, "the duties resulting from the primacy of European Union law bind all public entities, including the entire public administration and national courts. The Court of Justice of the European Union has maintained that all European Union law takes precedence over all national law, including the respective constitutional rules"[69]. In this way, the EU exercises influence by defining guidelines and regulations that member countries must follow to promote the adoption of BEVs and achieve environmental goals. These guidelines can include specific emissions standards, financial support for charging infrastructure and related regulations, encouragement of tax incentives and the definition of targets for the promotion of renewable energies. All of this, therefore, has an impact on policies related to the implementation of electric vehicles in Portugal. Norway, for its part, although not formally a member of the EU, is part of the European Economic Area, meaning that it adopts various EU regulations and policies to ensure economic integration and cooperation, and, in this case, in matters concerning to the implementation of BEVs. Therefore, although Norway is not directly bound or obliged by EU legislation and directives, the collaborative nature and alignment of environmental objectives contribute to a convergence of approaches between the two, in which the Norwegian country can choose to adopt EU policies that are aligned with its own objectives and values[70].

3.3. Cultural aspects

In this chapter, which seeks to determine whether cultural aspects of each country have influenced the difference in the pace of implementation of electric mobility, respectively, in Norway and Portugal, it is important to begin by making a brief bibliographical reference to materialism and post-materialism concepts, as they may have a significant influence on this particular subject.

3.3.1. Materialism and Post-Materialism

According to Ronald Inglehart's Theory of Intergenerational Value Change, it was suggested "that people from developed countries have become more reflexive, less traditional, and more interested in values related to freedom, quality of life, and self-expression" (Nieto *et*. *al*, 2013:672). Also, according to these authors, "this theory predicts a change in values in the younger generations, while the older generations are expected to maintain a modernist profile of personal values" (Nieto *et.al*, 2013:672). So, in general, it can be said that "the term 'materialism' incorporates both economic materialist values such as 'economic growth' and

[69] Available in www.diariodarepublica.pt/
[70] See also www.regjeringen.no/

'economic stability' and authoritarian and conformity values, while the term 'post-materialism' incorporates typical 'green or non-material values', such as 'environmental protection' and puts less emphasis on money and economic rewards, and libertarian values related to broader, more direct forms of participation, equal rights for all cultural and racial groups, openness to new forms of morality, and so on" (Knutsen, 1989:223). In accordance and more recently, materialistic values continued to be "defined as social values that emphasize economic and physical security, whereas postmaterialist values are defined as social values that prioritize the need for belonging as well as aesthetic and intellectual needs" (Sudo, 2022:2). Also, for this author, "generally, Northern European countries, such as Norway, Finland, and Denmark, tend to experience high average life satisfaction, whereas Eastern European countries, such as Russia, Bulgaria, and Georgia, tend to have a low life satisfaction average. Moreover, the average life satisfaction in Western and Southern European countries was found to be between the average life satisfaction of Northern and Eastern European countries" (Sudo, 2022:2). Finally, comparing the Liberal Democracy Index, GDP per capita and Average Life Satisfaction per country, of the list of 34 countries presented, Norway emerges in 2nd place, with an average life satisfaction of 8.048 (only behind Iceland, ranked 1st, with 8.094). Portugal, on the other hand, ranks below the middle of the list, only in 22nd place, with an average life satisfaction of 7.267 (Sudo, 2022:12-13).

However, as still referenced by the same author, "social values in Western European countries, which have realized high levels of economic and physical security, have been changing from materialist to postmaterialist ones since the late twentieth century" (Sudo, 2022:2). In other words, it was predicted that other countries, not only Western European countries, will realize a shift from materialistic to postmaterialist values by achieving economic prosperity and political stability. This predicted 'silent revolution' consisted in "the process behind the transition from 'Old Politics' values of economic growth, public order, national security, and traditional lifestyle to 'New Politics' values of environmental concern, individual freedom, and social equality" (Dalton, Beck & Flanagan, 1984, *apud* Knutsen, 1989:223).

Furthermore, this growing importance of post-materialism can be justified by scarcity and socialisation, being the scarcity "based on the recognition that people value and prioritise their most pressing needs. When their level of income is sufficiently high to not have to worry about survival and physical security, non-materialistic priorities such as quality of life, personal freedom and social equality become more important" (Joordan & Dima, 2019:444), which leads to the growth of post-materialism. On the other hand, the socialisation "explains why the rise of post materialism materialises as a long term and structural process" (Joordan & Dima, 2019:444), meaning "that citizens that hold post materialistic values in their adult lives grew up under economic conditions that allowed for such values to become important. As such, the growing importance of post materialism can be seen as a process of intergenerational change

“(Joordan & Dima, 2019:444), successively passing on to the following generations. Moreover, it can also be seen that the growing importance of post-materialist values and priorities is capable of producing significant repercussions on economic activity and outcomes, since there is a “significant and positive association between post materialism and GDP per capita, an association that appears robust to sample composition, time frame, choice of post materialism indicator and choice of instrumental variable” (Joordan & Dima, 2019:462).

Also, this influence is felt at the institutional and political level, since “Inglehart (1971) understood values as forming a framework for social priorities and argued that in more post-materialist societies, economic welfare plays an important role in legitimizing democratic institutions, so that when people are dissatisfied with policies, they elect new leaders” (Inglehart, 1971, *apud* Lima *et.al*, 2021:209). Therefore, “the reasoning concerning materialist and post-materialist values has made a substantial contribution to understanding how economic fluctuations produce changes in political attitudes” (Kaase & Newton, 1995, *apud* Lima *et.al*, 2021:209). In result, “citizens with post materialistic values are socially active and are likely to put pressure on governments to change and improve institutional settings, in order to advance their values and priorities” (Joordan & Dima, 2019:453), meaning that institutions operates as an intermediate channel for the post-materialism, since “this pressure on institutions generates positive effects on economic development, effects that are larger than the direct negative economic effect caused by the growing prominence of societal goals that are less motivated by income and profit maximisation” (Joordan & Dima, 2019:468).

In resume, it can be deduced that the cultural aspects of a country are reflected in its economy and politics, but also largely extend beyond that, embodying a particular society's way of living or thinking and its concerns about a particular issue. These cultural concerns and ways of thinking about climate issues, particularly related to the implementation of electric mobility, are described and compared, in both Norway and Portugal, in the following sections.

3.3.2. Environmental culture in Norway

Scandinavian cultures, known for their environmental awareness, were the first to adopt the purchase and usage of electric vehicles. In these cultures, in general, a deep level of commitment to environmental sustainability was evident from an early stage. In Norway, its capital city Oslo, is surrounded by lakes and forests, many of them untouched, which are home to wolves, moose, salmons, foxes and other species of wildlife. Its natural landscapes are unquestionably beautiful and world-renowned (being the fiords its best-known tourist attraction). In fact, the bond with nature is so intrinsic to Norwegian culture that there's a specific term for it: *friluftsliv*, which literally means *outdoor life*. Although there are several approximate equivalents in English (such as *outdoorsy, crunchy, woodsy*) there is no word like *friluftsliv* that so well describes the natural, daily, regular, healthy and even sporty connection that Norwegian people have with nature[71]. Being developed during childhood, this *friluftsliv* is also the reason why city centers are often so much quieter on the weekends, with younger children joining their parents on camping trips and hikes, leading to Norwegians usually spending their free time in the fjords, in the mountains, or by the sea. Plus, there are other cultural practices, such as:

- The right to roam (*allemannsretten* in Norwegian), which legally guarantees that nature (mountains, forests, beaches and lakes) is open to public use;
- The *Dugnad* (or the importance of the collective). Through *Dugnad*, people gather to fix, clean, paint or arrange things. It usually takes place in the open air, involving schools, housing blocks or social neighbourhoods, and involves some kind of manual labour;
- *Janteloven*, that describes the way Norwegians (and Scandinavians in general) behave, by placing society ahead of the individual, not being jealous of each other, and individuals not bragging about their individual achievements. Being this a social norm, this *Janteloven* it is closely related to the post-materialistic principles and values mentioned earlier, that are typically present in the Nordic societies.

Also, as a country with a mainland coastline of around 29000 km, the sea is deeply imprinted in Norway's cultural identity. Perhaps even the most noticeable aspect of Norway's culture is its historical dependence on the sea for its livelihood and commerce, resulting in a multifaceted tapestry, fused with maritime traditions firmly embedded in the nation. Even nowadays, the Norwegian television usually devotes long reports and live broadcasts to common maritime events on the Norwegian coast. However, this was not always the case, since, in Norway, "from 1860 to 1970, economic concerns took precedence over environmental issues" (Schwach, 2012:1). For this author, "Norwegians were late to acknowledge that fishing resources were limited. In the 1970s, environmental concerns were integrated in the existing knowledge system, but economic concerns still took precedence over environmental issues" (Schwach, 2012:1).

Figure 3.6 - Location of Norway in Europe

Source: www.mapsland.com/

Still, to firmly oppose this outdated fact, there is a concept called the *Nordic Ideology*. Developed in Hanzi Freinacht's book[72], the concept of *Nordic Ideology* is linked to the economic and social policies of countries such as Norway, Sweden, Denmark, Finland and Iceland. With an emphasis on a combined free market capitalism and a robust

[71] See also www.lifeinnorway.net/norwegian-culture/

[72] See also www.amazon.com/Nordic-Ideology-Metamodern-Politics-Guides/

welfare state, the *Nordic Ideology* favours extended social benefits, universal healthcare, and a cost-free education, while at the same time prioritising social justice, equality, and a higher level of social trust. Based on historical and contemporary manifestations, this Nordic identity takes its cue from the cultural heredity of the Nordic communities, being even reflected in the design of products and solutions, which includes a minimalist aesthetic, functionality, sustainability, and an emphasis on natural materials and craftsmanship. As a result, and already on an environmental level, the Nordic countries are typically at the forefront of environmental protection efforts, with a usually strong commitment to renewable energies, preservation of natural resources, circular economy and ecological responsibility.

Norway's cultural heritage is therefore considered rich and diverse, as it includes a wide variety of places, landmarks and artefacts that represent different historical periods and areas of society. Traditionally, cultural heritage conservation has been focused on the protection of ancient monuments and buildings with a significant historical value. However, nowadays, the importance of protecting cultural environments, monuments and places (including rivers and lakes) where everyday people live and work, is also considered[73].

So, being recognized that "climate change is a threat to cultural heritage", one of the aims of the Norwegian Government and other Scandinavian countries is "to mobilize the cultural heritage sector to action"[74]. To do this, Norway has a dynamic cultural environmental policy - which is part of Norway's climate and environmental policy – and has been redefined, in 2020, to a new set of goals. These goals include: "1) Everyone shall have the opportunity to get involved in and assume responsibility for the cultural environment; 2) the cultural environment shall contribute to sustainable development through integrated land use and social planning, and 3) a diversity of cultural environments shall be preserved as a basis for knowledge, experience and use"[75].

In this respect, it is also important to note the views of the Norwegian people, since "individuals tend to search for information that fits with their cultural predispositions, such as values" (Schulz-Hardt, Frey, Luthgens, & Moscovici, 2000, *apud* Aansen, 2017:216). Also, "the public's value orientations may lead them to perceive this politically contentious issue of mitigating climate change quite differently, because they take cues from favoured ideological elites that reinforce their pre-existing views on what policy solutions are best" (Aansen, 2017:224). In a previous survey, measuring outdoor recreation interests and environmental attitudes in Norway, respondents agree that "the balance of nature is delicate, that humans severely abuse the environment and that plants and animals have as much right as humans to exist" (Bjerke *et.al*, 2006:125). Plus, "it is noteworthy that 75% of the sampled Norwegian

[73] See also www.environment.no/topics/cultural-heritage/
[74] Available in www.osloforum2021/baltic-heritage/
[75] Available in www.regjeringen.no/

public acknowledged that loss of biodiversity is real and 50% saw it as a considerable environmental problem; these percentages are well above those reported for other European countries" (TNS Political & Social, 2013, *apud* Kaltenborn *et.al,* 2016:58).

Regarding to electric vehicles, it can therefore be assumed that with this awareness and strong environmental commitment has nourished the success of BEVs. In fact, owning an electric vehicle is not just a decision driven by economic or environmental reasons; it has even evolved into a status symbol. The social influence of family, friends and even national celebrities who have adopted electric mobility, has played a major role in standardising BEVs ownership. Norway is proud to lead the world in the adoption of BEVs per capita, and this cultural pride reinforces the social acceptance and normalisation of electric vehicles, as Norwegians see them as part of their national identity and achievements.

As proven by Anfinsen *et.al* (2019:39) and shown in the figure below, the cultural aspect of the EV domestication process is made up of 3 dimensions: *Cognitive* (to learn about the object or acquire new understanding); *Practical* (the development of a set of practices related to an object) and *Symbolic* (the connection between meaning, identity and the appearance of the self in public). In the case of Norwegians, it was noted that beyond economics or the passion for technology, "the qualities attracting users to EVs in Norway are numerous and extend further than the usual representations of EV users environmental concern or the potential for financial savings" (Anfinsen *et.al*, 2019:45), and that "both men and women EV users stressed the good feeling and experience of driving with an environmentally clear conscience" (Anfinsen *et.al*, 2019:44).

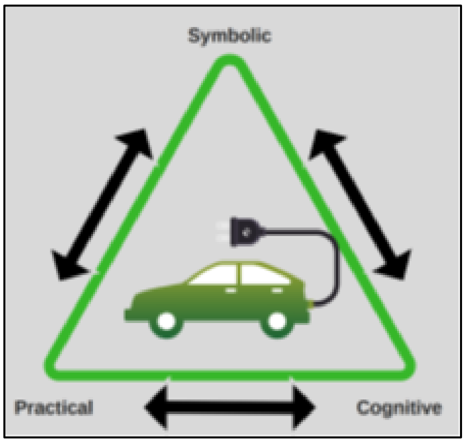


Figure 3.7 - EV domestication process
Source: Anfinsen *et.al* (2019:39)

3.3.3. Environmental culture in Portugal

Historically, the Portuguese environmental perspective has developed from the attribution of a central role to water, air and forests. Over the last decades, catastrophic fires, floods, hydroelectric dams and atmospheric pollution have become recurrent topics on the Portuguese environmental scene[76]. Furthermore, with the ocean playing a key geographical importance in Portugal, concerns in this area have been also known, having the need "to deepen the long-term relationship between the specificity of maritime and coastal resources (fauna, flora, salt) and their exploitation (fishing and aquaculture, salt farming, forestry and rice farming), in a

[76] See also www.ics.ulisboa.pt/

dynamic of interactions between the environment and social, economic and technological processes" (Guimarães & Amorim,2016:53).

In Portugal, the first administrative measures to protect the environment appeared at the beginning of the 1970s, although they were involved in important cultural factors. At the time, the country was still essentially rural and its countryside "meant hunger, misery and cold; the sea was still the place where fishermen died" (Schmidt, 2008:287). Despite the fact that there was already a National Environmental Commission since 1971, "Portugal, which had important public policies in terms of nature conservation - especially with the creation of the National Service for Parks, Reserves and Landscape Heritage in 1975, as well as the creation of the National Agricultural Reserve (RAN, 1982) and the National Ecological Reserve (REN, 1983) - received a strong stimulus from European environmental policies when it joined the Economic European Community on 1st of January 1986. Membership brought the country not only financial resources and a legislative framework, but also the obligation to improve environmental quality indicators at various levels" (Schmidt & Delicado, 2014:33).

Figure 3.8 - Location of Portugal in Europe

Source: www.mapsland.com/

Turning to the environmental education in Portugal, although this concern already exists in the curricula of the most diverse school levels since late 1990´s, only in 2017, "following a participatory process, the National Environmental Education Strategy was adopted, which aimed to establish a collaborative, strategic and cohesive commitment to building environmental literacy in Portugal, through inclusive and visionary citizenship that leads to a paradigm shift in civilization, translated into sustainable models of conduct in all dimensions of human activity"[77]. As a result, on the level of public opinion and environmental concerns of the Portuguese people, from 1986 to 1997, "it was industrial pollution that emerged as the main damage with an impact on the environment (more specifically the release of dangerous chemicals into the air and water), a trend that worsened as we moved into the 1990s" (Schmidt & Delicado, 2014:46), being also "noteworthy the increased awareness of various global problems - the greenhouse effect, the ozone layer, the loss of tropical forests - due to the influence of ECO92, the signing of the Kyoto Protocol (1997) and the media coverage of these issues from the early 1990s onwards" (Schmidt 2003, *apud* Schmidt & Delicado, 2014:46). Plus, from the 2000s upwards, there was a change in the Portuguese population's traditional concept of *environmental damage*, moving more to using a concept of *environmental concern*,

[77] Available in www.apambiente.pt/apa/educacao-ambiental

particularly in relation to water pollution, anthropogenic disasters, climate change, air pollution, the increase of garbage and the depletion of natural resources.

With this context, and specifically regarding to climate change in a comparative European context, it is surprising to note that “since the beginning of the surveys addressing this issue, Portugal has registered slightly higher levels of concern than the European average” (Schmidt & Delicado, 2014:118), as shown in the following figure. Concern showed an upward trend until 1995, coinciding with the publication of the IPCC's second report that same year. From

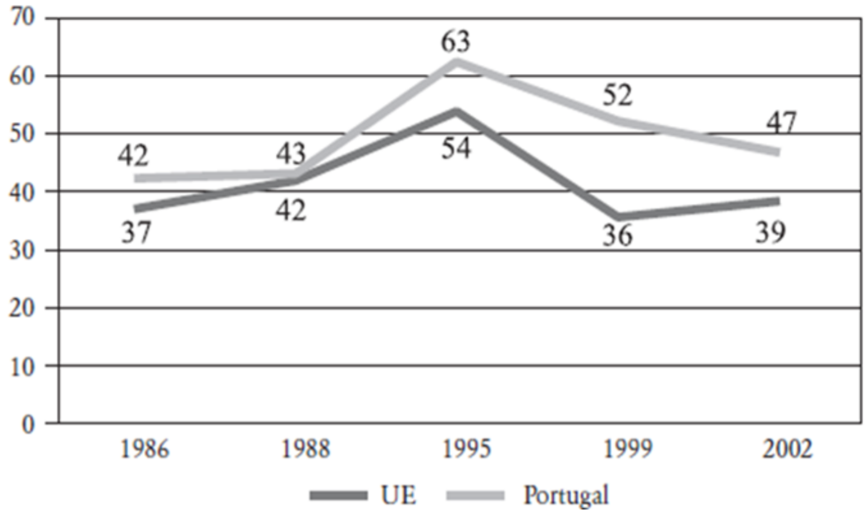


Figure 3.9 - Respondents who declare to be very concerned about climate change 1986-2002 (%)

Source: Schmidt & Delicado (2014:119)

then on and until 2002 (in Portugal, and even in Europe), there was a decline in concern about the climate theme, partly explained by the new global problems that emerged at the end of the 1990s and the beginning of the 21st century (such as terrorist attacks or armed conflicts), which displaced climate change from the top of people's concerns. Moreover, until 2005, can be slightly appointed some "environmental illiteracy, disinformation without planning, lack of culture of nature and the landscape, ignorance of biodiversity, fragility of the environmental movement itself, which has a visibility far greater than its effective social implementation" (Schmidt, 2008:305).

However, as early as 2020, a study carried out by Sociedade Ponto Verde states that the Portuguese have identified 3 major environmental problems that concern them: pollution, marine protection and global warming, with the recycling of waste being considered by 2/3 of the Portuguese as their greatest contribution to a better environment and that 89% of the Portuguese admitting to being more concerned about environmental problems than they were 10 years ago[78]. Same, two years later, in 2022, in the III Great National Sustainability Survey

[78] See also www.ambientemagazine.com/

conducted in partnership with the Institute of Social Sciences of the University of Lisbon, which surveyed 1.520 Portuguese over the age of 18, forest fires, drought, climate change and food waste were the main environmental concerns expressed, adding that the general concern with environmental problems is cemented and only the urgency of serious socio-economic issues, such as hunger and poverty, diverts the focus of the Portuguese from that issue[79].

Also, and regarding to the BEVs, since the end of the last decade, it can be said that there has been a cultural shift in Portugal, since a study carried in 2019 across 15 European countries (including Portugal) and also the United States, revealed that when "asked about their attitude towards electric cars, 87% of Portuguese respondents said that it was positive or very positive. For 8% of the respondents the attitude is neutral and only 5% consider these vehicles negatively or very negatively"[80]. Thus, in relation to the attitude towards electric cars 3 years prior, 72% of the Portuguese consider that it has become more positive.

In short, it can be recognised that the increase in environmental awareness has changed Portugal's environmental cultural values in the last decade (2013-2022). The promotion of electric vehicles as a cleaner alternative has become increasingly aligned with this new cultural value. However, even in this 2013-2022 period, the emotional attachment to traditional petrol or diesel vehicles still has a sentimental symbolism, status and even nostalgia, and some people may consider electric vehicles inconvenient due to concerns about range limitations, availability of charging infrastructure and charging times. This perception can dissuade them from considering electric vehicles as viable alternatives to conventional cars. Also, if owning a traditional vehicle is seen as the norm in certain social circles (notably the political class or higher classes), individuals may hesitate to deviate from this expectation by opting for electric vehicles. This is considered the power of social norms and peer influence. Therefore, creating confidence in the technology and expansion of electric vehicles through testimonials and examples, especially from the higher and political classes, can help alleviate these concerns.

3.3.4. Comparison of environmental cultures

Norway and Portugal, in terms of geographical features, share some similarities. Both are surrounded by ocean along their coastline and the populations of these territories, throughout their history, have always depended on the sea for their survival (curiously, perhaps the most striking example of this is *cod*, where in Norway and Portugal, this fish is typically associated with their gastronomy and appreciated by both cultures). In addition, both countries have forests and mountains along their territory, being the last, in Norway, called a *fjord* - large sea entrance between high rocky mountains, usually created by the erosion of ice from ancient

[79] See also www.observador.pt/2022/
[80] Available in www.sabado.pt/

glaciers over thousands of years - although Portugal, in proportion to its geographical size, it is considered to have almost 36% more forests than Norway[81].

However, even though Norway has approximately half the population that Portugal has, the attitude of both countries towards nature varies considerably. In Norway, experiencing and respecting nature is something intrinsic, it comes "naturally" and It's embedded in the very roots of the people. For Norwegians, nature is seen as something almost sacred, strongly anchored in their daily practices, forming part of the cultural matrix of an entire community. Also, the need to survive the frequently severe Norwegian climate has shaped an entire Nordic mindset as a collective over the centuries. In the case of Portugal, although environmental awareness has increased in recent decades, it doesn't exist as vividly in the culture of its people. In fact, it's more due to legislation, campaigns, news and politics that environmental issues have become increasingly important in Portugal. Therefore, this issue is not emphasized as it is in Norway, but rather can be somewhat perceived as having been imposed on Portuguese by government policies. Furthermore, in the middle of the last decade “as far as the environment is concerned, the Portuguese are keeping pace with the growing concern of the average European citizen, but they differ in the greater emphasis they place on 'classic' or 'first generation' environmental problems, such as water and air pollution, while the rest of Europeans, especially in the Centre and North, are more concerned about 'second generation' problems, such as natural resources and consumption habits” (Schmidt & Delicado, 2014:26).

In addition, in this next comparative table, some cultural differences between Norway and Portugal in terms of environmental aspects can also be referenced:

Table 3.10 - Cultural differences between Norway and Portugal

	Norway	**Portugal**
Awareness and Concerns	• “Their citizens possess a high degree of global environmental awareness and characterized by high levels of environmental concern in their peoples’ cultures, along with their governments having a political culture that is 'rule-deferential' emphasizing cooperation and 'consensus'“(Reyes, 2021:1); • “As such, there is the impetus for understanding environmental actions and the congruency to their values that could allow for early adoption and lifestyle changes” (Reyes, 2021:1); • “Highest levels of support for protecting the environment, which has been attributed to the fact that they have 'relatively high proportions of post-materialists in their population'” (Reyes, 2021:2).	• “The Portuguese emphasise the association of the concept of the environment mainly with the protection of nature and urban pollution, followed by natural and man-made disasters and climate change, which have a greater media impact” (Schmidt & Delicado, 2014:69). • “In terms of problems, concerns about the country's environment are centred on first generation issues - water pollution, air pollution and waste. However, more recently, issues such as energy and climate change have come to prominence” (Schmidt & Delicado, 2014:69). • “It is the younger people - those who correspond to the most educated in Portugal - who show higher levels of concern about issues such as biodiversity, climate change, as well as greater present and future adherence to renewable energies and more ecological consumption” (Schmidt & Delicado, 2014:27).

[81] Available in www.versus.com/en/norway-vs-portugal

	Norway	Portugal
Cost Sacrifices	• "Willingness to make economic sacrifices for the environment among the Nordics is high, particularly in answering questions such as how willing they are towards 'paying much higher taxes' and 'accepting cuts in standards of living' (Reyes, 2021:2); • "Citizens' willingness to make economic sacrifices had significant relationships to consumer behaviours and public behaviours" (Reyes, 2021:17).	• "Portugal is in the group of countries with the lowest level of environmental information and is also the least willing to pay more for environmentally friendly products" (Schmidt & Delicado, 2014:59).
Comparison EU	• "Significantly higher levels in most substantive survey items dealing with willingness to make economic sacrifices for the environment, pro-environmental attitudes, behaviours and preferences—as compared to other Western European countries, other EU members, and third countries" (Reyes, 2021:17).	• "Convergence with European standards and, at the same time, a generational break on a national scale, which brings young Portuguese much closer to their European peers than the older generations to and with each other" (Schmidt & Delicado, 2014:27).

Also, in relation to the table above, it is important to highlight the degree of sacrifice that citizens are willing to make in favour of environmental issues, being this a practical measure of the importance that environmental issues have for citizens. As shown in the Appendix J, it can be clearly seen that, at the beginning of the last decade, the Nordic countries already distinguished for their amount of information and awareness on environmental issues, being directly related to the willingness to pay for environmentally friendly products. On the other side, at the time, countries such as Portugal, Spain, the Czech Republic or Bulgaria were on the opposite side of the chart, which meant that there was less information and awareness of environmental issues, resulting in a lower will to sacrifice the economic side in favour of buying environmentally friendly products.

The same is recognised regarding climate change in particular, as shown in the Appendix K. In the beginning of the last decade there were "countries with high levels of information and concern (Nordic countries), countries with well-informed populations but moderate levels of concern (United Kingdom, Netherlands) and countries with low rates of information but high levels of concern, denoting a 'fear effect' (Southern and Eastern Europe) or moderate (Baltic countries, Poland, Germany). Portugal registers the lowest levels of information in Europe, for a concern identical to the European average" (Schmidt & Delicado, 2014:128). Yet, more recently, in 2020, and still on the economic front between Norway and Portugal, it appears that "irrespective of the socio-economic differences of the two countries, the companies of both seek to create and use circular economy strategies, as well as sustainable strategies. This demonstrates a growing concern for the environment and future generations" (Paixão *et.al*, 2020:1).

Plus, according to Hofstede's cultural dimensions theory, intended to show the effects of a society's culture on the values of its members and how these values relate to behaviour, using a scale from 0 to approximately 100 in six cultural dimensions, a comparison between Norway and Portugal revealed the following results:

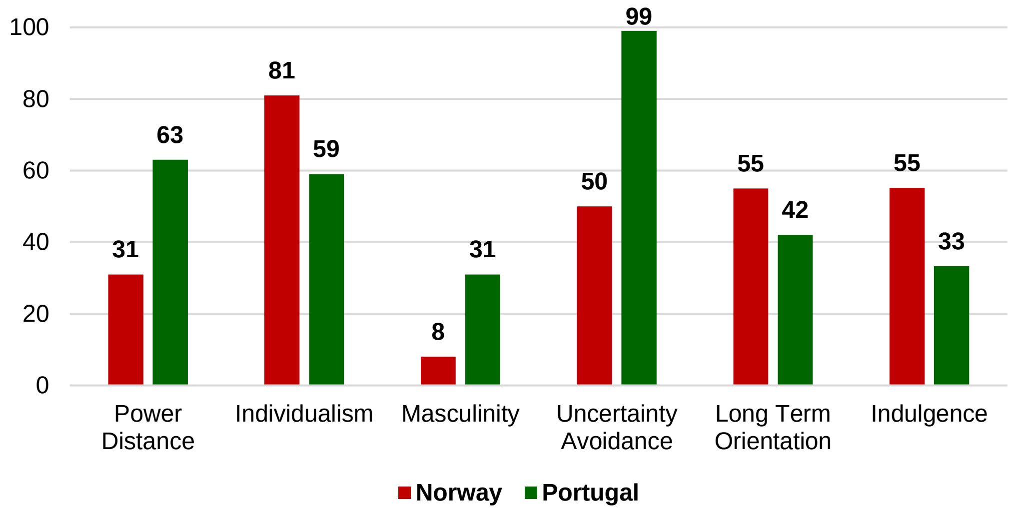


Figure 3.10 - Hofstede Cultural Dimensions comparison

Source: www.hofstede-insights.com/

In this graph, the following dimensions are worth highlighting:

- *Masculinity* (society's preference for achievement, heroism, assertiveness and material rewards. *Femininity*, on the other hand, represents a preference for cooperation, relationships, modesty and quality of life). Norway scored only 8 for masculinity, while Portugal scored 31, meaning that Norwegian culture has more feminine characteristics than Portuguese culture, which, in terms of climate and environmental protection, means a greater propensity for green practices associated in this Nordic country;
- *Uncertainty avoidance*, in which society accept or avoid the event of something unexpected or unknown. Societies with a high score on uncertainty avoidance have strict codes, laws or guidelines and a greater fear of uncertainty of the future. A lower score shows greater acceptance of different ideas and less fear of ambiguity or uncertainty. Norway has 50 points and Portugal 99, which means that Norway may tend to be more accepting of innovative or open-minded solutions to combat future problems caused by climate change.
- *Long Term Orientation*, meaning societies that values current or future challenges. A lower score on this index indicates that the culture is essentially traditionalist and actions are based on the past or present. Societies with a high score on this dimension represent forward-looking societies that see adaptation and pragmatic problem-solving as a necessity. Norway scored 55 and Portugal 42, which means that the countries have similar visions for the future, although Norway is slightly more focused on this.

Although Norway scored higher than Portugal in the dimension *individualism* (degree to which people in a society are integrated into groups, with *collectivism* being the opposite, “Culture significantly influences BEV sales, which are more pronounced in countries where cultural values are more conforming to the functional, innovative, and environmental benefits of purchasing and using electric cars” (Novotny *et.al*, 2022:10). For these authors, “in addition to higher per capita wealth, societies characterised by lower uncertainty avoidance (lower stress when facing the future), collectivism (prioritizing the needs of the group), femininity (more modest and caring), long-term orientation (focusing on the future), and restraint (control of desires) are more likely to adopt BEVs” (Novotny *et.al*, 2022:10).

To summarise, it can be said that in Norway, over the last decade (2013-2022), the cultural commitment to sustainability and the reduction of carbon emissions has aligned well with its adoption of BEVs, while, on the other hand, Portugal had to undergo some cultural change in order to achieve true environmental awareness, being reflected, in fact, although not as pronounced as in Norway, in the genuine growing cultural interest of Portuguese consumers in buying BEVs. Cultural aspects such as attitudes toward technology, status and symbolism, played significant roles in shaping the adoption of BEVs in both Norway and Portugal. Norwegian culture values innovation and technological progress and BEVs are seen as a symbol of progress and technological advancement, while Portugal, despite also having a growing technology industry and a culture that embraces innovation, still doesn't have the same level of emphasis on technological advancements as Norway. In conclusion, while Norway's cultural emphasis on sustainability led to a faster adoption of BEVs, Portugal's evolving cultural landscape and growing awareness of environmental issues are still driving a smoother transition to electric mobility today.

3.4. Battery recharging costs *versus* oil prices

As a control variable, it was decided to compare the charging costs of a BEV with the fuel costs of an ICE vehicle. To illustrate this, the costs of electricity at home, the costs of charging away from home and the price of gasoline over the last decade (2013-2022) are explained, in brief, in both Norway and Portugal. Starting with the cost of electricity at home, as shown in the following figure (by kWh) and in Appendix L, it can be noticed that during the period in question, Norway had slightly and consistently lower prices than Portugal and the average EU.

In Norway, until 2020, the average kWh price was always below 0.20€/kWh (even falling to 0.13 €/kWh that year), before rising to 0.21€/kWh in 2022. In the case of Portugal, kWh prices followed the average prices in the EU (although with a slight ascent in the 2013-2018 period), and, from 2021 onwards, remained below the EU average price, while approaching those of Norway. Also, as a note, the rise in electricity prices from 2021 onwards was seen

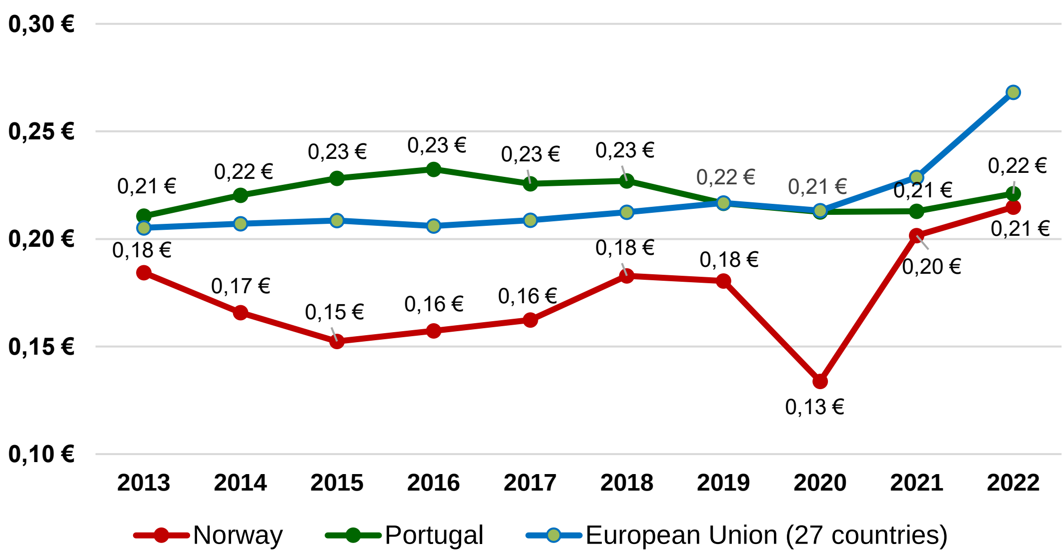


Figure 3.11 - Electricity prices (Euro/kWh) for household consumers

Source: Eurostat www.ec.europa.eu/eurostat/

across the whole of the European continent (which includes Norway and Portugal), a trend that was already underway and was probably aggravated by Russia's invasion of Ukraine at the beginning of 2022, which increased energy costs on the European continent from then on. So, in sum, and contrary to what happened in Norway, in Portugal the average price of electricity at home has never been below 0.20€/kWh (starting at 0.21€/kWh in 2013 and reaching 0.22€/kWh in 2022) thereby demonstrating that, at least at home, it is cheaper to charge the BEV in Norway than it is in Portugal. This, therefore, represents a stronger incentive for Norwegian citizens to buy a BEV, but not so strong for Portuguese citizens, since this price difference certainly means, per year, a considerable reduction in charging costs in Norway, given that "charging at the home parking space is promising and enables untroubled parking and charging. Observations in several European countries and during relevant projects show that charging to more than 85% takes place at home or at work" (Ramsebner *et.al*, 2023:1).

Outside the residence, at charging stations (that is, when it's usually not possible to charge the BEV at home), the prices offered are quite different. In this respect, I also decided to compare the prices for two segments: the Dacia Spring Electric (being the lowest segment), and the Nissan Leaf (being a slightly higher segment).

However, it is important to clarify the definition of MSP (Mobility Service Provider), in which is a subscription service where BEV users use cards to make their electric charging on a charging station. These MSPs set their own €/kWh price and usually offer solutions based on the customer's consumption or even propose kWh package subscriptions. Therefore, in this graph, MSP Min means the cost of charging (when done with the cheapest MSP in the country), MSP Max (the cost of charging, when done with the most expensive MSP in the country) and Adhoc (the average cost of charging, when done without an MSP subscription).

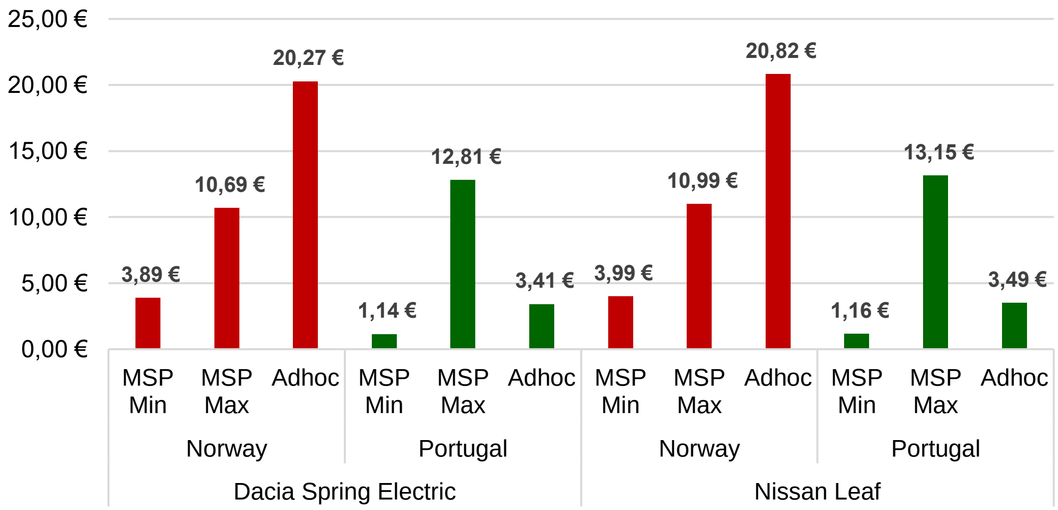


Figure 3.12 - MSP and Adhoc electricity prices

Source: EAFO www.alternative-fuels-observatory.ec.europa.eu/

So, in the case of the Dacia Spring Electric, the MSP Min is lower in Portugal (1.14 € per 100 km), while when using the MSP max occurs the opposite, that is, in Portugal is practised a higher price than Norway (12.81 € per 100 km). However, it is in the Adhoc charging method that there is a major difference, since Norway has an average charging cost of 20.27 € per 100 km, while Portugal only practises an average of 3.41 €, meaning that is practically 6 times lower than the price charged in Norway. Approximately the same thing happens with the Nissan Leaf, although with slightly differences, where again Norway practises an even higher MSP min (of 3.99 € per 100 km), Portugal a MSP max also higher than that practised in Norway, and again a very pronounced Adhoc price difference between these two countries. It is then clear, given the prices charged away from home or on charging stations, how important it is to subscribe to, at least, an MSP min service (due to its extensive service, such customer support, etc.), while Adhoc charging method should be reserved for punctual situations.

On the other hand, and now with regard to fossil fuels aspects, according to OECD data[82], Norway and Portugal, from 2013 to 2022, followed the European trend and average in terms of the price of crude oil (see Appendix M), being those figures also confirmed in the following figure. It can thus be seen that, during 2013-2022, the price of gasoline per litre remained almost always higher in Norway when compared to the price practised in Portugal. The only period in which it remained the same price was from 2020 to 2021. This chart also highlights the most important years, such as 2013, when gasoline per litre in Norway was on average 0.4 USD more expensive than in Portugal, 2018 (0.1 USD more expensive) and again in 2022, when Norway had an average gasoline price per litre 0.3 USD more expensive than the price practised in Portugal.

[82] See also www.data-explorer.oecd.org/

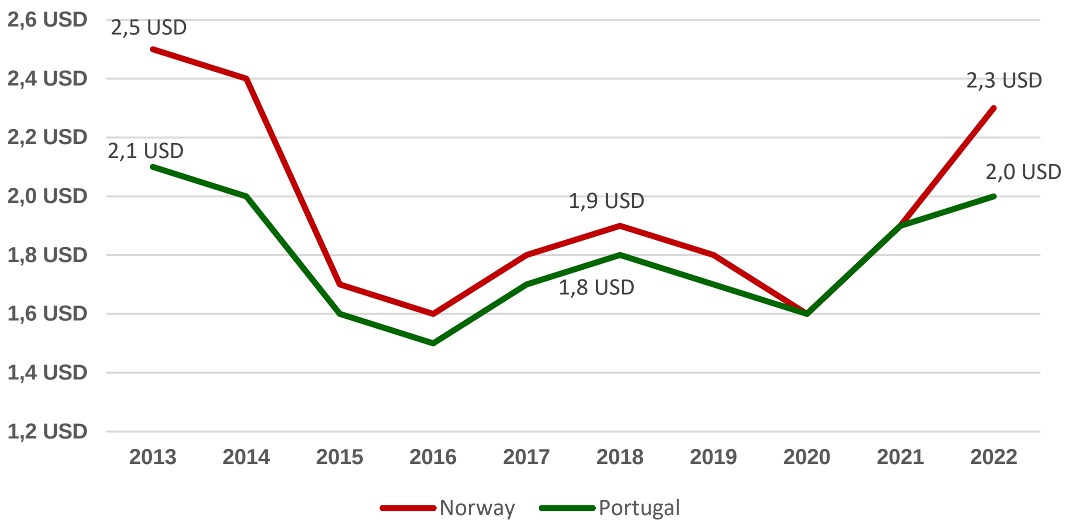


Figure 3.13 - Gasoline prices (USD) per litre in a mid-grade motor gasoline
Source: International Energy Agency www.iea.org/ and www.iea.org/

As an explanation for the falls and rises of prices of gasoline in both countries, I should be noted that there was a European recession until 2015, followed by a period of greater stability in gasoline price from 2015 to 2020, although rising again from then on in both countries and throughout Europe, aggravated by Russia's invasion of Ukraine from 2022 onwards. So, the fact that gasoline prices are higher in Norway than in Portugal is also an incentive for Norwegian citizens to buy electric cars. Norway is, therefore, also trying to discourage the use of gasoline through a pricing policy that is, on average, higher than the price of electricity.

Plus, confirmed by Transport and Environment (T&E), a European reference organisation for non-governmental organisations working in the domain of transport and the environment, “electric cars still cheaper to drive than petrol and diesel” and more specifically “recharging an EV at home or at the office is still much cheaper than refuelling at the pump”[83]. For T&E "while purchase prices for most EV models are currently still higher than comparable diesel and petrol cars, electric cars are expected to reach parity with conventional models in the mid-2020s. However, the total costs of ownership is already lower for most EVs when taking into account how much it costs to fuel, maintain and insure the car"[84].

Chapter 4 - Conclusions

One of the first conclusions that can be drawn from this research is the different approach that the countries in question have towards nature and the environment. In Norway, nature is seen

[83] Available in www.euronews.com/
[84] Available in www.transportenvironment.org/

as something special, strongly embedded in Norwegian culture as well in its practices, and it must be heavily protected. Norwegian culture itself is a culture of outdoors and mountains, related to fresh air and cold temperatures. As for Portugal, the perspective on environmental issues is based on legislation that seeks to regulate them. Although there were indeed environmental concerns, for many years and during the early 21st century, these were mainly centred on the issues of recycling, air pollution, water pollution, urban sanitation or controlling waste disposal. This means that the environmental culture depended more on existing laws and regulations issued by the Portuguese government, and not so much on a genuine environmental culture rooted in the Portuguese people's way of thinking. Also, this difference is further emphasised by the fact that Nordic countries are essentially post-materialist, meaning that instead of traditionally focusing exclusively on economic growth, they actively incorporate 'green' values, even exerting pressure on governments to maintain this environmental concern, and thereby promoting the interests of the collective over the individual. Linked in the practice of renewable energies, the *Nordic Ideology* and cultural heritage are also reflected in this way of being and behaving, being this behaviour something that deeply does not exist in Portugal.

Although it was considered a poor country at the beginning of the 20th century and invaded by Nazi Germany in World War II, after the discovery of oil on its coast in the 1960´s, Norway became a country considered with one of the highest standards of living in the world, becoming also a country with open arms for the future. In turn, Portugal has tried to follow European trends since it joined the EU in 1986. Although the Portuguese younger generations are more informed and concerned about climate change (even approaching to the Norwegian level), they have only recently reached that level of concern. In fact, when it comes to environmental topics, Portugal is more culturally linked to its closest European peers, or even to the average of the entire EU, than it is to Norway. So, although both countries are part of the European continent, Portugal is a member of the European Union, while Norway is not, and this too is reflected culturally, specifically in the consumers' interest or concerns.

As such, it is natural that culturally there is an older and more natural concern about BEVs in Norway than there is in Portugal. In Portugal, BEVs are still viewed with some scepticism, whether due to the autonomy of the batteries, the number of charging stations available, the quality of the cars or the fear of making a misguided purchase (being this related to *uncertainty avoidance*). In this Iberian country, over the last decade, there has been a considerable absence of technical familiarity on the part of citizens about BEVs aspects, which combined with historical and cultural issues (status and brand name, owning a good diesel or petrol car - related to *masculinity*) has resulted in a culture that is not very conducive to the rapid implementation of BEVs on the market. On the other hand, in Norway, owning a BEV means owning a status (or at least, the proper status - *femininity* values), since, under a strong influence from social peers and the government, owning an internal combustion car is beginning to be perceived negatively. As a result, although both countries are increasingly open to a *long-term orientation* when it comes to implementing BEVs on the respective market, there is still a greater emphasis on the Norwegian side.

Also supported by their respective public policies, even in this area the logic is different in both countries, with almost two decades of public policies separating the two in terms of the adoption of BEVs. Norway focussed early on electrifying its car fleet, that is, instead of exhausting its oil resources, knowing that it would eventually end, it decided to electrify and invest in renewable energies from the 1990´s onwards. Not being considered a country with major economic difficulties since 1970 (currently considered a wealthy country, reflected also on the quality of life scale), it has decided not to invest in financial incentives for the purchase of BEVs (because the Norwegian consumers it doesn't need them), but rather in tax incentives, as well as, due to its large and dispersed geography, in free tolls, car parks for BEVs, ferries discounts and other facilities for the circulation of BEVs on the roads. It has also been careful to create an extensive, efficient and modern charging station policy, both throughout the country and in local communities and social neighbourhoods. Therefore, “the total package of incentives represent a highly visible, concerted national policy in support of BEVs. This has resulted in a dual effect. On the one hand, incentives provide instrumental motives to buy a BEV. On the other hand, they represent a symbolic certification of BEVs and clearly identifies this technology as a preferred alternative towards sustainable mobility in Norway” (Ingeborgrud & Ryghaug, 2019:514). In this country, public policy, mixed with information and social awareness, was thereby combined with a thoughtful and concerned environmental culture.

Portugal, on the other hand, has mainly followed the pattern and timing of the EU (which has been slower, with a real boost in this subject for this country only beginning in 2009). The focus was mainly on experiments and incentives to raise awareness of the environmental importance of buying electric cars. Knowing how difficult it was for the Portuguese to buy BEVs, the Portuguese public policy was based primarily on financial incentives that people could apply for (however, to a limited number, and with a restricted value), as well as tax and car parking cuts (although it could have gone further with discounts on tolls and priority lanes on the roads). The charging station policy has not been the most efficient, focussing mainly on the major cities, in a slow and even discouraging process, offering no other support and in a need of a better communication strategy to the population. In Portugal, even though some people can afford it, many people still refuse to buy a BEV for fear of running out of battery on the road and not being able to return to their starting location (usually home). In this country, for a long time, in order to have confidence in driving a BEV, it was essential previously to plan carefully the route involved, something that normally isn't necessary in Norway.

In addition to this, Norway has an average gross salary almost 3 times higher than Portugal and double (or almost triple) the purchasing power adjusted for GDP per capita. Even though the cost of living in Norway is higher than in Portugal, the higher salaries offered by this Nordic country firmly compensate, impacting therefore on the ability to purchase BEVs. Although there has been a gradual decrease in the average price of BEVs over the last decade and in all across the Europe, this type of vehicle still has a considerably higher purchase price than ICE vehicles, meaning, in this case, that Norwegians can buy BEVs of practically any segment, while in Portugal the purchasing power usually offers only access to the lower or lower-middle segments, at most. However, unfortunately, lower segment cars, due to the short battery range, are mainly for city purposes, and in order to have a car with a longer range in Portugal, it would be necessary to pay at least 35000 € to get one that provides a range of around 400 kilometres, allowing, therefore, to travel from the Portuguese capital to the furthest places in the country, on a single full charge, without worrying about charging stations along the way.

Furthermore, electricity costs at home are cheaper in Norway than in Portugal, yet they are more expensive away from home, when compared to prices practised in Portugal. As most BEV charging is carried at owner's property, this shouldn't be an issue, as only in emergency or standby situations should these charges be carried out outside home (for instance, in shopping centres, BEV parking's, or charging stations at petrol stations). Nevertheless, an important fact is that in Portugal there are many houses that don't have a garage or internal parking space, which makes it difficult to charge at home, as it requires a cable running from inside the house directly to the BEV. In Norway, this is not a concern, as many Norwegian houses are villas with a garage and many apartments have internal parking.

In this context, it is also worth mentioning that a BEV, when compared to an ICE, although the purchase costs are higher, it saves on maintenance costs (price of electric charging *versus* price of petrol), and not only that, the cost of overhauling a BEV is significantly lower, as it has fewer moving parts than a ICE. In a BEV, although batteries need to be replaced, costing a significant amount of money, they are now covered by a guarantee of perfect performance for 8 to 10 years, with replacement being recommended after that period of time.

So, as a final conclusion to this research, I can say that *the 3 variables under study have been confirmed, that is, the income of the citizens, the public policies implemented and the cultural aspects of these two countries are the main (if not the only) reasons why there is a much higher quantity of BEVs sold in Norway than there is in Portugal*.

It is expected that, over time, the price of BEVs will continue to fall and their battery autonomy will also increase, thus better corresponding to the law of supply and demand, and even reaching an optimum price point for possible purchase by citizens with the lowest incomes. However, until then and in an attempt to reduce these disparities between Norway and Portugal and as a Portuguese citizen, I would like to make the following recommendations for the Portuguese government to adopt:

- *Increasing the number of financial incentives available and the amount allocated (Fundo Ambiental) for the purchase of new BEV's* - this is a considerable factor in the purchase, since the income of a Portuguese citizen is usually low for the purchase of a BEV and the salary of the Portuguese population is unlikely to rise in the near future.
- *Keeping the tax exemption (ISV and IUC)* - this is also an important factor, but it is considered more of a psychological motivating factor for buying new BEVs, due to the lower values involved.
- *Continuing the discounts on parking and tolls* - also considered more of a motivational factor, to positively differentiate a BEV user from an ICE user.
- *Improve the existing network of charging stations across the country, making them more modern, better distributed and varied* - the implementation of this suggestion is extremely important, as it will give both present and future BEV users the confidence that their vehicle will not be left on the road for lack of charging stations (minimising the prospect of *range anxiety*).
- *Creating a public policy for the recycling and replacement of BEV batteries* - important, not only to protect the environment due to the harmful metals present in the batteries, but also to expand the normal functioning of BEVs after the batteries lifespan.
- *Creating price for home BEV charging that differs from the normal price* - making it even lower than it already is, though, for example, subsidised tariffs, so that the price of home electricity doesn't increase much.
- *Continuing to reduce the price of Adhoc charging outside home* - through, for example, promotions, special tariffs and other discounts, so that will be always cheaper to charge Adhoc an BEV outside home than it is to fill up an ICE's fuel tank.
- *Investing in information campaigns on BEV for citizens* - to promote even more cultural change in the population.

These suggestions are therefore intended to encourage a more effective implementation of individual electric mobility in Portugal (namely through the use of BEVs), which, ultimately, is expected to contribute to tackling the rise in global temperatures and reducing the recognised effects of climate change.

Sources

Legislation

European Union (EU), *Regulation of the European Parliament and of the Council on the deployment of alternative fuels infrastructure, and repealing directive 2014/94/EU*, consulted on 18-10-2023. Available at https://data.consilium.europa.eu/doc/document/PE-25-2023-INIT/en/pdf

Eur-Lex, *Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure Text with EEA relevance*, consulted on 15-11-2023. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0094

Eur-Lex, *European Green Deal*, consulted on 09-10-2023. Available at https://eur-lex.europa.eu/EN/legal-content/summary/european-green-deal.html

Eur-Lex, "*Fit for 55*", consulted on 09-10-2023. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0550

Eur-Lex, *Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019*, consulted on 20-10-2023. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0631

Eur-Lex, *Sustainable and Smart Mobility Strategy - putting European transport on track for the future*, consulted on 09-10-2023. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0789

Diário da República, *Resolution of the Council of Ministers nº 20/2009, of 20 February*, consulted on 03-04-2024. Available at https://files.diariodarepublica.pt/1s/2009/02/03600/0116501165.pdf

Diário da República, *Resolution of the Council of Ministers nº 81/2009, of 7 September*, consulted on 03-04-2024. Available at https://files.diariodarepublica.pt/1s/2009/09/17300/0600306006.pdf

Diário da República, *Decreto-Lei n.º 39/2010, de 26 de abril*, consulted on 03-04-2024. Available at https://files.diariodarepublica.pt/1s/2010/04/08000/0137101386.pdf

Diário da República, *Lei n.º 64-B/2011, de 30 de dezembro*, consulted on 03-04-2024. Available at https://files.diariodarepublica.pt/1s/2011/12/25001/0004800244.pdf

Diário da República, *Decreto-Lei n.º 170/2012, de 1 de agosto*, consulted on 03-04-2024. Available at https://files.diariodarepublica.pt/1s/2012/08/14800/0400704025.pdf

Diário da República, *Lei n.º 82-D/2014*, consulted on 03-04-2024. Available at https://diariodarepublica.pt/dr/legislacao-consolidada/lei/2014-66624400

Diário da República, *Decreto-Lei n.º 90/2014, de 11 de junho*, consulted on 03-04-2024. Available at https://files.diariodarepublica.pt/1s/2014/06/11100/0309603121.pdf

Diário da República, *Resolution of the Council of Ministers, nº 49/2016, of 1 September*, consulted on 03-04-2024. Available at https://files.diariodarepublica.pt/1s/2016/09/16800/0311103114.pdf

Diário da República, *Law Decree nº 60/2017, of 9 June*, consulted on 03-04-2024. Available at https://files.diariodarepublica.pt/1s/2017/06/11200/0291802922.pdf

Diário da República, *Resolution of the Council of Ministers nº 88/2017, of 26 June*, consulted on 03-04-2024. Available at https://files.diariodarepublica.pt/1s/2017/06/12100/0319003228.pdf

Diário da República, *Princípio do primado do Direito da União Europeia*, consulted on 23-03-2024. Available at https://diariodarepublica.pt/dr/lexionario/termo/principio-primado-direito-uniao-europeia

Norwegian VAT Act, 6-2, *exemption of electric vehicles from VAT,* consulted on 05-03-2024. Available at https://www.skatteetaten.no/globalassets/bedrift-og-organisasjon/voec/norwegian-vat-act-112020.pdf

Other sources

Agência Portuguesa do Ambiente, *Educação Ambiental*, consulted on 22-04-2024. Available at https://www.apambiente.pt/apa/educacao-ambiental

Amazon, *Nordic Ideology: A Metamodern Guide to Politics, Book Two (Metamodern Guides),* consulted on 30-03-2024, Available at https://www.amazon.com/Nordic-Ideology-Metamodern-Politics-Guides/dp/8799973928

Ambiente Magazine, *Inquérito revela que portugueses estão mais preocupados com problemas ambientais*, consulted on 23-04-2024, Available at https://www.ambientemagazine.com/inquerito-revela-que-portugueses-estao-mais-preocupados-com-problemas-ambientais/

APCAP, *Carro com portagem Classe Zero é publicidade enganosa*, Consulted on 21-04-2024. Available at https://apcap.pt/carro-com-portagem-classe-zero-e-publicidade-enganosa/

Autoridade Tributária e Aduaneira, *Tabelas de Retenção do IRS*, consulted on 15-02-2024. Available at https://info.portaldasfinancas.gov.pt/pt/apoio_contribuinte/tabela_ret_doclib/Pages/default.aspx

Banco de Portugal, *The Financial Assistance Programme*, consulted on 12-02-2024. Available at https://www.bportugal.pt/en/page/financial-assistance-programme

Climate.gov, *Climate Change: Global Temperature*, consulted on 10-10-2023. Available at https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature

Climate.nasa.gov, *Global Temperature*, consulted on 12-10-2023. Available at https://climate.nasa.gov/vital-signs/global-temperature/

Electric Vehicle Users' Association (UVE), *A UVE e o crescimento da mobilidade elétrica em Portugal. 6 anos de atividade – 6 anos de crescimento*, consulted on 20-03-2024, Available at https://www.uve.pt/page/blueauto-54-uve-e-o-crescimento-da-mobilidade-eletrica/

Electric Vehicle Users' Association (UVE), *Estado da arte da Mobilidade Elétrica em Portugal*, consulted on 28-04-2024, Available at https://www.uve.pt/page/fleet-magazine-estado-da-arte-da-mobilidade-eletrica-em-portugal/

Electric Vehicle Users' Association (UVE), *Parabéns! Comprou um veículo elétrico. E agora?*, consulted on 25-11-2023, Available at https://www.uve.pt/page/wp-content/uploads/2023/05/Manual_ME_05-2023.pdf

Electric Vehicle Users' Association (UVE), *Protocolo UVE Ampera*, consulted on 12-12-2023, Available at https://www.uve.pt/page/protocolo-uve-ampera/

Electric Vehicle Users' Association (UVE), *10 Razões para Mudar*, consulted on 03-10-2023, Available at https://www.uve.pt/page/10-razoes-para-mudar/

Environment.no*, A rich and diverse cultural heritage*, consulted on 02-04-2023. Available at https://www.environment.no/topics/cultural-heritage/

Euronews, *Are electric cars still cheaper to run than petrol and diesel?*, consulted on 10-05-2023. Available at https://www.euronews.com/2023/07/24/electric-cars-are-still-cheaper-to-run-than-petrol-and-diesel

European Commission (EC), *European Alternative Fuels Observatory*. Available at https://alternative-fuels-observatory.ec.europa.eu/

European Commission (EC), *European Alternative Fuels Observatory - Available electric vehicle models,* consulted on 24-02-2024. Available at https://alternative-fuels-observatory.ec.europa.eu/consumer-portal/available-electric-vehicle-models

European Commission (EC), *European Alternative Fuels Observatory - Frequently asked questions,* consulted on 15-01-2024. Available at https://alternative-fuels-observatory.ec.europa.eu/general-information/frequently-asked-questions

European Commission (EC), *European Alternative Fuels Observatory - Norway - Vehicles and fleet*. Available at https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/norway/vehicles-and-fleet

European Commission (EC), *European Alternative Fuels Observatory - Norway - Infrastructure* Available at https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/norway/infrastructure

European Commission (EC), *European Alternative Fuels Observatory - Portugal - Vehicles and fleet*. Available at https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/portugal/vehicles-and-fleet

European Commission (EC), *European Alternative Fuels Observatory - Portugal - Infrastructure*. Available at https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/portugal/infrastructure

European Commission (EC), *European Alternative Fuels Observatory - Recharging systems*, consulted on 07-11-2023. Available at https://alternative-fuels-observatory.ec.europa.eu/general-information/recharging-systems

European Commission (EC), *Climate Action*, consulted on 01-10-2023. Available at https://climate.ec.europa.eu/eu-action/transport/overview_en

European Environment Agency (EEA), *Electric Vehicles*, consulted on 06-10-2023. Available at https://www.eea.europa.eu/en/topics/in-depth/electric-vehicles

European Environment Agency (EEA), *The changing context of European environmental policy*, consulted on 08-10-2023. Available at https://www.eea.europa.eu/soer/2015/synthesis/report/1-changingcontext

European Environment Agency (EEA), *Transport and Mobility*, consulted on 01-10-2023. Available at https://www.eea.europa.eu/en/topics/in-depth/transport-and-mobility?activeTab=07e50b68-8bf2-4641-ba6b-eda1afd544be

European Union (EU), *Environment - Towards a greener and more sustainable Europe,* consulted on 12-10-2023. Available at https://european-union.europa.eu/priorities-and-actions/actions-topic/environment_en

Eurostat, consulted on 12-10-2023. Available at https://ec.europa.eu/eurostat

Eurostat, *Electricity prices for household consumers - bi-annual data*, consulted on 01-06-2024. Available at https://ec.europa.eu/eurostat/databrowser/view/nrg_pc_204__custom_10542050/default/table?lang=en

Eurostat, *Passenger cars, by type of motor energy*, consulted on 03-01-2024. Available at https://ec.europa.eu/eurostat/databrowser/view/road_eqs_carpda__custom_9417750/default/table?lang=en

Eurostat, *Population on 1 January - Portugal, Norway*, consulted on 20-12-2023. Available at https://ec.europa.eu/eurostat/databrowser/view/tps00001__custom_9400212/default/table?lang=en

Eurostat, *Population on 1 January - Germany, France, Norway*, consulted on 20-12-2023. Available at https://ec.europa.eu/eurostat/databrowser/view/tps00001__custom_9330662/default/table?lang=en

Eurostat, *Purchasing power adjusted GDP per capita*, consulted on 01-02-2024. Available at https://ec.europa.eu/eurostat/databrowser/view/sdg_10_10__custom_11321065/default/table?lang=en

Fundo Ambiental, consulted on 10-03-2024. Available at https://www.fundoambiental.pt/quem-somos/quem-somos/fundo-ambiental.aspx

Fundo Ambiental, consulted on 20-04-2024. Available at https://www.fundoambiental.pt/avisos-anteriores/avisos-2017/incentivo-veiculos-de-baixas-emissoes-2017.aspx

Governement.no, *European policy*, consulted on 25-03-2024 Available at https://www.regjeringen.no/en/topics/european-policy/id1151/

Guia do Automóvel, *Pesquisar Carros*, consulted on 27-02-2024. Available at https://www.guiadoautomovel.pt/pesquisa

Hofstede Insights, *Country Comparison Tool*, consulted on 25-05-2024. Available at https://www.hofstede-insights.com/country-comparison-tool?countries=norway%2Cportugal

Iano.io, *Running payroll in Norway*, consulted on 20-01-2024, Available at https://www.lano.io/global-payroll-guide/norway

International Council on Clean Transportation (ICCT), *A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars*, consulted on 30-09-2023. Available at https://theicct.org/wp-content/uploads/2021/07/Global-Vehicle-LCA-White-Paper-A4-revised-v2.pdf

International Energy Agency IEA), *Energy Statistics Data Browser – Gasoline Price Norway*, consulted on 02-06-2024. Available at https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser?country=NORWAY&fuel=Prices&indicator=GasPrice

International Energy Agency IEA), *Energy Statistics Data Browser – Gasoline Price Portugal*, consulted on 02-06-2024. Available at https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser?country=PORTUGAL&fuel=Prices&indicator=GasPrice

Instituto Ciências Sociais - Universidade Lisboa, *História Ambiental do Século XX Português*, consulted on 06-04-2023. Available at https://www.ics.ulisboa.pt/projeto/historia-ambiental-do-seculo-xx-portugues

Life in Norway, *Norwegian Culture: 21 Must-Know Traditions In Norway*, consulted on 26-03-2024. Available at https://www.lifeinnorway.net/norwegian-culture/

Mapsland, consulted on 28-05-2024. Available at https://www.mapsland.com/

MOBI.E, *Estudo sobre infraestruturas de carregamento de apoio à transição energética da mobilidade em Portugal*, consulted on 22-03-2024. Available at https://www.mobie.pt/documents/42032/140624/Estudo_Mobilidade_Portugal.pdf/8852d349-9500-886c-10c1-3b28889f6cfc?t=1698139704575

Naf.no, *bilguiden*, consulted on 10-02-2024. Available at https://www.naf.no/bilguiden/elbiler-i-norge?filter%5BpriceGroup%5D%5B0%5D=0.0-400000.0&sortBy=3

National Aeronautics and Space Administration (NASA), *What is the greenhouse effect?*, consulted on 22-09-2023. Available at https://science.nasa.gov/climate-change/faq/what-is-the-greenhouse-effect/

Norwegian EV Association (Ebil.no), *Norwegian EV policy*, consulted on 09-03-2024. Available at https://elbil.no/english/norwegian-ev-policy/

Numbeo, *Cost of Living*, consulted on 01-03-2024. Available at https://www.numbeo.com/cost-of-living/country_result.jsp?country=Norway

Observador, *Incêndios e seca são as principais preocupações ambientais dos portugueses,* consulted on 25-04-2024. Available at https://observador.pt/2022/10/19/incendios-e-seca-sao-as-principais-preocupacoes-ambientais-dos-portugueses/

Organisation for Economic Cooperation and Development (OECD), *Crude oil import prices*, consulted on 04-05-2024. Available at https://data.oecd.org/energy/crude-oil-import-prices.htm

Organisation for Economic Cooperation and Development (OECD), *Data Explorer*, Consulted on 20-02-2024. Available at https://data-explorer.oecd.org/

Organisation for Economic Cooperation and Development (OECD), *Data Explorer - Average annual wages - Norway*, Consulted on 20-01-2024. Available at www.data-explorer.oecd.org/

Organisation for Economic Cooperation and Development (OECD), *Norway's evolving incentives for zero-emission vehicles*, consulted on 05-03-2024. Available at https://www.oecd.org/climate-action/ipac/practices/norway-s-evolving-incentives-for-zero-emission-vehicles-22d2485b/

Organisation for Economic Cooperation and Development (OECD), *Portugal*, consulted on 23-02-2024. Available at https://www.oecd-ilibrary.org/sites/d875bda7-en/index.html?itemId=/content/component/d875bda7-en#section-d1e65235-642485b5ad

Oslo Forum 2021, *Cultural Heritage in a Changing Climate*, consulted on 02-04-2024. Available at https://cbss.org/baltic-heritage/wp-content/uploads/sites/2/2023/06/Cultural-Heritage-in-a-Changing-Climate-single-page.pdf

Peugeot, consulted in 07-02-2024. Available at https://www.peugeot.com/en/

Pordata, *Salário Minimo Nacional*, consulted in 01-03-2024. Available at https://prod2.pordata.pt/db/portugal/ambiente+de+consulta/tabela

Pordata, *Remuneração média de trabalhadores por conta de outrem - Europa*, consulted in 01-03-2024. Available at https://prod2.pordata.pt/db/europa/ambiente+de+consulta/tabela

Portuguese Association of Concessionaires of Motorways and Toll Bridges (APCAP), *Carro com portagem Classe Zero é publicidade enganosa*, consulted on 11-03-2024. Available at https://apcap.pt/carro-com-portagem-classe-zero-e-publicidade-enganosa/

Sábado, *Portugueses são os mais entusiastas com carros elétricos*, consulted on 26-04-2024. Available at https://www.sabado.pt/dinheiro/detalhe/portugueses-sao-os-mais-entusiastas-com-carros-eletricos

Segurança Social, *Payment of social contributions*, consulted in 01-02-2024. Available at https://en.seg-social.pt/payment-of-social-contributions-rights-duties-and-penalties

Statista, *Electric Vehicles Norway*, consulted on 10-02-2024, available at https://www.statista.com/outlook/mmo/electric-vehicles/norway

Statista, *Electric Vehicles Portugal*, consulted on 25-02-2024, available at https://www.statista.com/outlook/mmo/electric-vehicles/portugal#revenue

Statista, *Electric Vehicles Norway versus Portugal*, consulted on 7-03-2024, available at www.statista.com/outlook/

The Norwegian Labour Inspection Authority (Arbeidstilsynet), *Minimum wage*, consulted on 25-01-2024. Available at https://www.arbeidstilsynet.no/en/working-conditions/pay-and-minimum-rates-of-pay/minimum-wage/

The Norwegian Ministry of Climate and Environment, *New goals for Norway's cultural environment policy*, consulted on 05-04-2024. Available at https://www.regjeringen.no/contentassets/35b42a6383f442b4b501de0665ec8fcf/en-gb/pdfs/stm201920200016000engpdfs.pdf

The Norwegian Ministry of Transport and Communications, *National Transport Plan 2018-2029*, consulted on 20-03-2024. Available at https://www.regjeringen.no/contentassets/7c52fd2938ca42209e4286fe86bb28bd/en-gb/pdfs/stm201620170033000engpdfs.pdf

The Norwegian Tax Administration, *Bracket Tax*, consulted on 02-02-2024. Available at https://www.skatteetaten.no/en/rates/bracket-tax/?year=2022#rateShowYear

Transport and Environment, *Cost of electric cars*, consulted on 11-05-2024. Available at https://www.transportenvironment.org/topics/cars

United Nations (UN), *Sustainable Development Goals*, consulted on 15-09-2023. Available at https://www.un.org/sustainabledevelopment/climate-change/

United Nations (UN), *what is climate change?*, consulted on 15-09-2023. Available at https://www.un.org/en/climatechange/what-is-climate-change

United Nations Climate Change (UNFCCC), *The Paris Agreement*, consulted on 16-09-2023. Available at https://unfccc.int/process-and-meetings/the-paris-agreement

Versus.com, *Norway vs Portugal*, consulted on 29-04-2024. Available at https://versus.com/en/norway-vs-portugal

Via Verde, consulted on 15-03-2024, Available at https://www.viaverde.pt/particulares

Visit Oslo, *Oslo toll rings & AutoPASS*, consulted in 12-03-2024. Available at https://www.visitoslo.com/en/transport/by-car/toll-ring/

World Bank Group, *Land area (sq. km) - Norway*, consulted on 10-01-2024. Available at https://data.worldbank.org/indicator/AG.LND.TOTL.K2?locations=NO

World Bank Group, *Land area (sq. km) - Portugal*, consulted on 10-01-2024. Available at https://data.worldbank.org/indicator/AG.LND.TOTL.K2?locations=PT

Bibliographical references

Aasen, Marianne (2017), “The polarization of public concern about climate change in Norway”, *Climate Policy*, 17, pp. 213-230.

Anfinsen, M., Lagesen, V. and Marianne Ryghaug (2019), “Green and gendered? Cultural perspectives on the road towards electric vehicles in Norway”, *Transportation Research Part D*, 71, pp. 37-46.

Berger, B. (2009), “Political theory, political science and the End of civic engagement”, *Perspectives on Politics*, 7(2), pp. 335–350, *apud* Kumpu, Ville (2022), “What is Public Engagement and How Does it Help to Address Climate Change? A Review of Climate Communication Research”, *Environmental Communication*, Vol. 16, 3, pp. 304-316.

Bieker, Georg (2021), “A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars”, *The International Council on Clean Transportation*, White Paper, pp.1-91

Bjerke, T., Thrane, C. and Jo Kleiven (2006), “Outdoor recreation interests and environmental attitudes in Norway”, *Managing Leisure*, 11, 2, pp. 116-128.

Carvalho, A., van Wessel, M., & Maeseele, P. (2017), “Communication practices and political engagement with climate change: A research agenda”. *Environmental Communication*, 11(1), pp. 122-135, *apud* Kumpu, Ville (2022), “What is Public Engagement and How Does it Help to Address Climate Change? A Review of Climate Communication Research”, *Environmental Communication*, Vol. 16, 3, pp. 304-316.

Clarke, J., Webster, R., & Corner, A. (2020), *Theory of change: Creating a social mandate for climate action*. Climate Outreach, *apud* Kumpu, Ville (2022), “What is Public Engagement and How Does it Help to Address Climate Change? A Review of Climate Communication Research”, *Environmental Communication*, Vol. 16, 3, pp. 304-316.

Dalton, R., Beck, P. & Flanagan, S. (1984). “Electoral Change in Advanced Industrial Societies”, *Princeton University Press,* ch.1, *apud* Knutsen, Oddbjørn (1989), “The Priorities of Materialist and Post-Materialist Values in the Nordic Countries - a Five-Nation Comparison”, *Scandinavian Political Studies*, Bind 12 (New Series), 3, pp. 221-243.

Degraeuwea, B., Thunisa, P., Clappierb, A., Weissc, M., Lefebvred, W., Janssend, S., Vranckxd, S. (2017), “Impact of passenger car NOX emissions on urban NO2 pollution – Scenario analysis for 8 European cities”, *Science of the Total Environment*, 171, pp.330-337.

Delhey, Jan (2009), “From Materialist to Postmaterialist Happiness? National Affluence and Determinants of Life Satisfaction in Cross-national Perspective”, *World Values Research*, Vol. 2, 2, pp. 30-54.

Dietz, T., Rachael L. Shwom and Cameron T. Whitley (2020), “Climate Change and Society”, *Annual Review of Sociology*, Annual Reviews, pp. 135-158.

EAFO, *Vehicles and fleet*, *apud* Martins, H., Henriques, C.O., Figueira, J.R., Silva, C.S., Costa, A.S. (2023), “Assessing policy interventions to stimulate the transition of electric vehicle technology in the European Union”, *Socio-Economic Planning Sciences*, 87, Elsevier.

Falvo, M., Sbordone, D., Bayram, I., Devetsikiotis, M. (2014), “EV Charging Stations and Modes: International Standards”, *International Symposium on Power Electronics, Electrical Drives, Automation and Motion*, pp. 1134-1139.

Gedik, A., Uslu, O. and Abdullah Hilmi Lav (2022), “A prospective study to evaluate CO2 emission mitigation strategies for highway transportation”, *Environ Monit Assess*, 703, Springer.

Gelmanova, Z.S., Zhabalova, G.G., Sivyakova, G.A., Lelikova, O.N., Onishchenko, O.N., Smailova, A.A., Kamarova S.N. (2018), “Electric cars. Advantages and disadvantages”, *Journal of Physics*, Conference Series 1015, IOP Publishing Ltd.

Guimarães, Paulo and Inês Amorim (2016), “A História Ambiental em Portugal: A emergência de um novo campo historiográfico”, *Instituto Ciências Sociais*, Universidade de Lisboa.

Haugneland, P., Lorentzen, E., Bu, C., Hauge, E. (2017), “Put a price on carbon to fund EV incentives – Norwegian EV policy success”, *EVS30 Symposium*, Stuttgart, Germany, pp. 9-11.

Helmers, Eckard and Patrick Marx (2012), “Electric cars: technical characteristics and environmental impacts”, *Environmental Sciences Europe*, 24, Springer.

Helmus, J.R. and Wolbertus, R. (2023), “Cooperative behaviour at public electric vehicle charging stations”, *Travel Behaviour and Society*, 32, Elsevier.

Hulme, Mike (2021), *Climate change*, London, Routledge (1st edition).

Hung, C.R., Voller, S., Agez, M., Majeau-Bettez, G., Strømman. A. (2021), “Regionalized climate footprints of battery electric vehicles in Europe”, *Journal of Cleaner Production*, 322, Elsevier.

Ingeborgrud, Lina and Marianne Ryghaug (2019), “The role of practical, cognitive and symbolic factors in the successful implementation of battery electric vehicles in Norway”, *Transportation Research Part A*, 130, pp. 507-516.

Inglehart, Ronald (1971), “The silent revolution in Europe: Intergenerational change in post-industrial societies”. *American Political Science Review*, 65, pp. 991-1017.

Inglehart, Ronald (1971), “The silent revolution in Europe: Intergenerational change in post-industrial societies”. *American Political Science Review*, 65, pp. 991-1017, *apud* Lima, M., França, D., Jetten, J., Pereira, C., Wohl, M., Jasinskaja-Lahti, I., Hong, Y., Torres, A., Lopes, R., Ariyanto, A., *et al*. (2021), “Materialist and post-materialist concerns and the wish for a strong leader in 27countries”, *Journal of Social and Political Psychology*, 9, pp. 207-220.

Johnston, K. A. (2018). “Toward a theory of social engagement”, in K. A. Johnston, & M. Taylor (Eds.), *The Handbook of Communication engagement*, John Wiley & Sons, Inc, pp.17-32, *apud* Kumpu, Ville (2022), “What is Public Engagement and How Does it Help to Address Climate Change? A Review of Climate Communication Research”, *Environmental Communication*, Vol. 16, 3, pp. 304-316.

Jordaan, Jacob and Bogdan Dima (2019), “Post Materialism and Comparative Economic Development: Do Institutions Act as Transmission Channel?”, *Social Indicators Research*, 148, Springer, pp. 441-472.

Kaase, M., & Newton, K. (1995), *Beliefs in government*, Oxford University Press, United Kingdom, *apud* Lima, M., França, D., Jetten, J., Pereira, C., Wohl, M., Jasinskaja-Lahti, I., Hong, Y., Torres, A., Lopes, R., Ariyanto, A., *et al*. (2021), “Materialist and post-materialist concerns and the wish for a strong leader in 27countries”, *Journal of Social and Political Psychology*, 9, pp. 207-220.

Kaltenborn, B., Gundersen, V., Stange, E., Hagen, D., Skogen, K. (2016), “Public perceptions of biodiversity in Norway: From recognition to stewardship?”, *Norwegian Journal of Geography*, 70, 1, pp. 54-61.

Kellogg, William W. and Robert Schware (1981), *Climate Change and Society - Consequences of Increasing Atmospheric Carbon Dioxide*, New York, Routledge.

Knutsen, Oddbjørn (1989), “The Priorities of Materialist and Post-Materialist Values in the Nordic Countries - a Five-Nation Comparison”, *Scandinavian Political Studies*, Bind 12 (New Series), 3, pp. 221-243.

Kumar, P., Hama, S., Nogueira, T., Abbass, R., Brand, V., Andrade, M., Asfawe, A., Aziz, K., Cao, S., El-Gendy, A., Islam, S., Jeba, F., Khare, M., Mamuya, S., Martinez, J., Meng, M., Morawska, L., Muula, A., Nagendra, S., Ngowi, A., Omerf, K., Olaya, Y., Osano, P., Salam, A. (2021), "In-car particulate matter exposure across ten global cities", *Science of the Total Environment*, 750.

Kumar, P. and Imam, B. (2013), "Footprints of air pollution and changing environment on the sustainability of built infrastructure". *Sci. Total Environ*. 444, pp.85-101, *apud* Kumar *et.al*, (2021), "In-car particulate matter exposure across ten global cities", *Science of the Total Environment*, 750.

Kumpu, Ville (2022), "What is Public Engagement and How Does it Help to Address Climate Change? A Review of Climate Communication Research", *Environmental Communication*, Vol. 16, 3, pp. 304-316.

Landrigan *et.al* (2018), "The Lancet Commission on pollution and health", *Lancet 391*, pp. 462-512, *apud* Kumar *et.al*, (2021), "In-car particulate matter exposure across ten global cities", *Science of the Total Environment*, 750.

Lelieveld, J., Pozzer, A., Pöschl, U., Fnais, M., Haines, A., Münzel, T., (2020), "Loss of life expectancy from air pollution compared to other risk factors: a worldwide perspective", *Cardiovasc. Res.*, *apud* Kumar *et.al*, (2021), "In-car particulate matter exposure across ten global cities", *Science of the Total Environment*, 750.

Lima, M., França, D., Jetten, J., Pereira, C., Wohl, M., Jasinskaja-Lahti, I., Hong, Y., Torres, A., Lopes, R., Ariyanto, A., *et al*. (2021), "Materialist and post-materialist concerns and the wish for a strong leader in 27countries", *Journal of Social and Political Psychology*, 9, pp. 207-220.

Martins, H., Henriques, C.O., Figueira, J.R., Silva, C.S., Costa, A.S. (2023), "Assessing policy interventions to stimulate the transition of electric vehicle technology in the European Union", *Socio-Economic Planning Sciences*, 87, Elsevier.

Masson-Delmotte, V., Pörtner, H.O., Calvo Buendia, E., Skea, J., Shukla, P., Roberts, D. C., Zhai, P., Slade, R., Connors, S., Van Diemen, R., Ferrat, M., Haughey, E., Luz, S., Neogi, S., Pathak, M., Petzold, J., Portugal Pereira, J., Vyas, P., Huntley, E., Kissick, K., Belkacemi, M., Malley, J. (2019), *Climate Change and Land*, Intergovernmental Panel on Climate Change, Special Report.

Melendez, M., Milbrandt, A. (2006), *Geographically Based Hydrogen Consumer Demand and Infrastructure Analysis*, National Renewable Energy Laboratory, Department of Energy, United States, *apud* Sun, Z., Gao, W., Li, B., Wang, L. (2020), "Locating charging stations for electric vehicles", *Transport Policy*, Vol. 98, pp. 48-54.

Melendez, M., Milbrandt, A. (2006), *Transitioning to a Hydrogen Future: Learning from the Alternative Fuels Experience*. National Renewable Energy Laboratory, Department of Energy, United States *apud* Sun, Z., Gao, W., Li, B., Wang, L. (2020), "Locating charging stations for electric vehicles", *Transport Policy*, Vol. 98, pp. 48-54.

Melendez, M., Theis, K., Johnson, C. (2007), *Lessons Learned from the Alternative Fuels Experience and How They Apply to the Development of a Hydrogen-fueled Transportation System*. National Renewable Energy Laboratory, Department of Energy, United States, *apud* Sun, Z., Gao, W., Li, B., Wang, L. (2020), "Locating charging stations for electric vehicles", *Transport Policy*, Vol. 98, pp. 48-54.

Mersky, A. Sprei, F., Samaras, C., Qian, Z. (2016), "Effectiveness of incentives on electric vehicle adoption in Norway", *Transportation Research Part D*, 46, pp.56-68.

Meyn, Jan-Peter (2015), “The kinematic advantage of electric cars”, *European Journal of Physics*, 36, IOP Publishing Ltd.

Nieto, J., López, F., O’Neill, B., Preciado, J., Malespín, J. (2013), “Intergenerational Differences in Materialist and Post-materialist Values in a Sample of Hispanic New York City Residents”, *Universitas Psychologica*, Vol. 12, 3, pp. 671-683.

Novotny, A., Szeberin, I., Kovács, S., Máté D. (2022), “National Culture and the Market Development of Battery Electric Vehicles in 21 Countries”, *Energies*, 15.

Oliveira, M., Slezakova, K., Delerue-Matos, C., Pereira, M.C., Morais, S. (2019), “Children environmental exposure to particulate matter and polycyclic aromatic hydrocarbons and biomonitoring in school environments: a review on indoor and outdoor exposure levels, major sources and health impacts”, *Environ. Int*., 124, pp. 180-204, *apud* Kumar *et.al*, (2021), “In-car particulate matter exposure across ten global cities”, *Science of the Total Environment*, 750.

Ortar, Nathalie and Marianne Ryghaug (2019), “Should All Cars Be Electric by 2025? The Electric Car Debate in Europe”, *Sustainability*, 11, MDPI.

Paixão, S., Marques, N., Ferreira, A., Carvalho R. (2020), “Sustainability and Circular Economy, a comparison between Portugal and Norway”*, Conference of the International Society for the Circular Economy*, University of Exeter.

Porter, Libby (2020), “Thinking Climate Justice: Introduction to the Interface”, in Libby Porter, Lauren Rickards, Blanche Verlie, Karyn Bosomworth, Susie Moloney, Bronwyn Lay, Ben Latham, Isabelle Anguelovski & David Pellow, *Climate Justice in a Climate Changed World*, Planning Theory & Practice, Routledge, Vol. 21, 2, pp. 293–321.

Ramsebner, J., Hiesl, A., Haas, R., Auer, H., Ajanovic, A., Mayrhofer, G., Reinhardt, A., Wimmer, A., Ferchhumer, E., Mitterndorfer, B., Mühlberger, M., Mühlberger-Habiger, K. (2023), “Smart charging infrastructure for battery electric vehicles in multi apartment buildings”, *Smart Energy*, Elsevier, pp. 1-13.

Razmjoo, A., Ghazanfari, A., Jahangiri, M., Franklin, E., Denai, M., Marzband, M., Garcia, D. Maheri, A. (2022), “A Comprehensive Study on the Expansion of Electric Vehicles in Europe”, *Applied Sciences*, 12.

Reyes, Joseph (2021), “How Different Are the Nordics? Unravelling theWillingness to Make Economic Sacrifices for the Environment”, *Sustainability*, 13, 1294, pp. 2-31.

Rickards, Lauren (2020), “Using and Interrogating Privilege to Progress Climate Justice”, in Libby Porter, Lauren Rickards, Blanche Verlie, Karyn Bosomworth, Susie Moloney, Bronwyn Lay, Ben Latham, Isabelle Anguelovski & David Pellow, *Climate Justice in a Climate Changed World*, Planning Theory & Practice, Routledge, Vol. 21, 2, pp. 293–321.

Schmidt, Luísa (2008), “Ambiente e Políticas Ambientais: Escalas e Desajustes*”, Universidade de Lisboa*, 14, pp. 285-314.

Schmidt, Luísa (2003). *O Ambiente no Ecrã - Emissões e Demissões no Serviço Público Televisivo*, ICS - Imprensa de Ciências Sociais, Lisboa.

Schmidt, Luísa and Ana Delicado (2014), *Ambiente, Alterações Climáticas, Alimentação e Energia - A Opinião dos Portugueses*, ICS - Imprensa de Ciências Sociais, Lisboa.

Schulz-Hardt, S., Frey, D., Luthgens, C., & Moscovici, S. (2000). “Biased information search in group decision making”. *Journal of Personality and Social Psychology*, 78, pp. 655–669, *apud* Aasen, Marianne (2017), “The polarization of public concern about climate change in Norway”, Climate Policy, 17, pp. 213-230.

Schwach, Vera (2012), “The Sea Around Norway: Science, Resource Management, and Environmental Concerns, 1860-1970”, *Environmental History*, pp.1-10.

Stilgoe, J., Lock, S. J., & Wilsdon, J. (2014), “Why should we promote public engagement with science?” *Public Understanding of Science*, 23(1), pp. 4-15, *apud* Kumpu, Ville (2022), “What is Public Engagement and How Does it Help to Address Climate Change? A Review of Climate Communication Research”, *Environmental Communication*, Vol. 16, 3, pp. 304-316.

Sudo, Naoki (2022), “The Effects of Postmaterialist Values on Average Life Satisfaction at the Country Level: What Generates Differences in Subjective Well-Being among European Countries?”, *Socius: Sociological Research for a Dynamic World*, Vol.8, pp.1-15.

Sun, Z., Gao, W., Li, B., Wang, L. (2020), “Locating charging stations for electric vehicles”, *Transport Policy*, Vol. 98, pp. 48-54.

Thøgersen, John (2021), “Consumer behavior and climate change: consumers need considerable assistance”, *Current Opinion in Behavioral Sciences*, 42, pp. 9-14.

Vilchez, Jonatan and Christian Thiel (2019), “The Effect of Reducing Electric Car Purchase Incentives in the European Union”, *World Electric Vehicle Journal*, 10, MDPI.

Intergovernmental Panel on Climate Change (2014), “Synthesis Report”, *Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Geneva, Switzerland, *apud* Whitmarsh, L., Wouter Poortinga and Stuart Capstick (2021), “Behaviour change to address climate change”, *Current Opinion in Psychology*, 42, pp. 76-81.

TNS Political & Social (2013), “Attitudes towards Biodiversity”, *Flash Eurobarometer Report*, 379, European Commission *apud* Kaltenborn, B., Gundersen, V., Stange, E., Hagen, D., Skogen, K. (2016), “Public perceptions of biodiversity in Norway: From recognition to stewardship?”, Norwegian Journal of Geography, 70, 1, pp. 54-61.

UK Climate Change Committee (2019), *Net Zero: the UK’s Contribution to Stopping Global Warming*, Committee on Climate Change, London, UK, *apud* Whitmarsh, L., Wouter Poortinga and Stuart Capstick (2021), “Behaviour change to address climate change”, *Current Opinion in Psychology*, 42, pp. 76-81.

Whitmarsh, L., Wouter Poortinga and Stuart Capstick (2021), “Behaviour change to address climate change”, *Current Opinion in Psychology*, 42, pp. 76-81.

WHO (2006), “Health Risks of ParticulateMatter from Long-range Transboundary Air Pollution”. *European Centre for Environment and Health*, Bonn, Germany, *apud* Kumar *et.al*, (2021), “In-car particulate matter exposure across ten global cities”, *Science of the Total Environment*, 750.

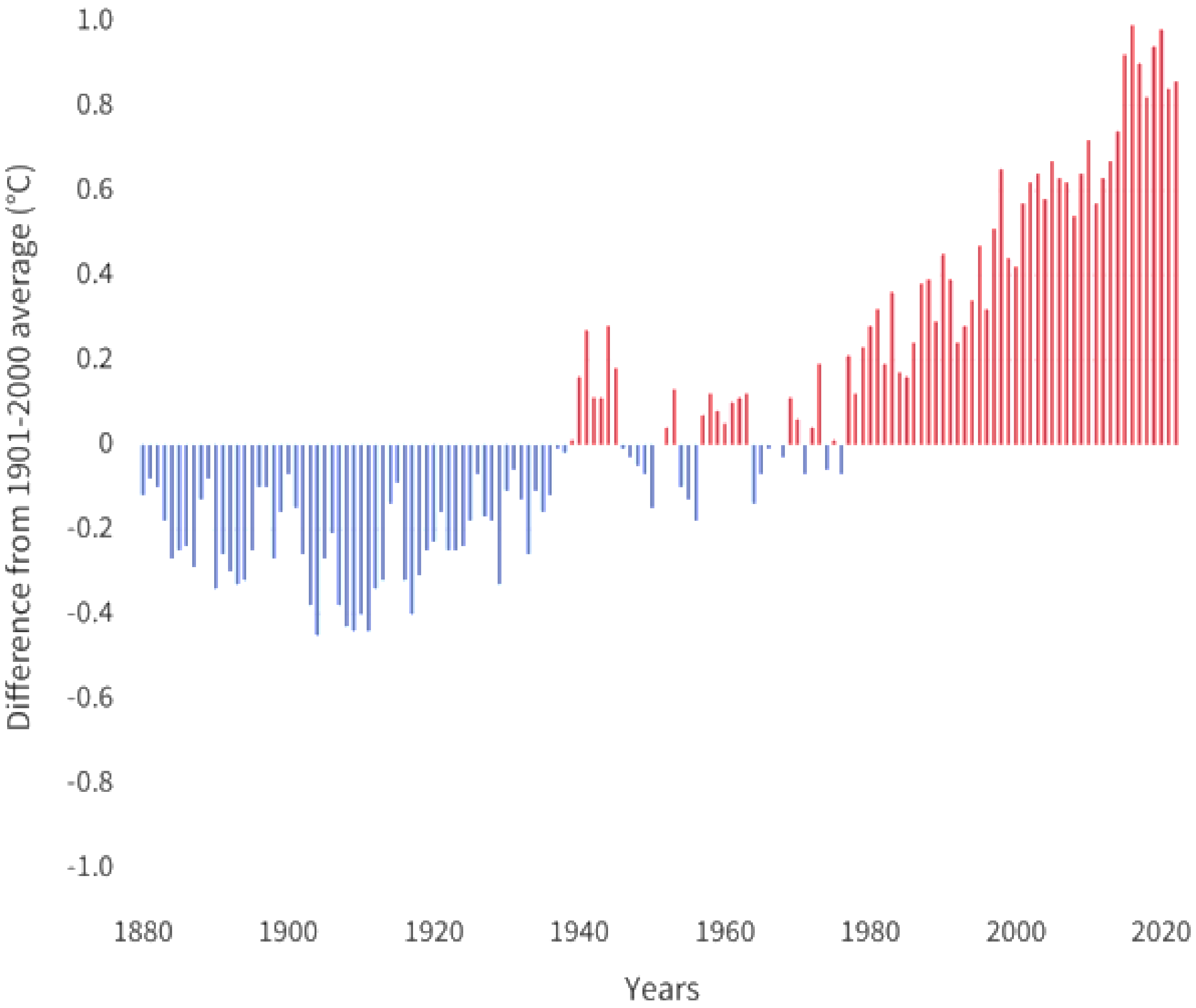
Wolbertus, R., Kroesen, M., Hoed, R., Chorus, C. (2018), “Fully charged: An empirical study into the factors that influence connection times at EV-charging stations”, *Energy Policy*, Vol.123, pp. 1-7.

Wolfram, Paul and Nicholas P. Lutsey (2016), "Electric vehicles: Literature review of technology costs and carbon emissions", *The International Council on Clean Transportation*, working paper 14.

Zhang, Zhengming and Renran Tian (2021), "Studying Battery Range and Range Anxiety for Electric Vehicles based on Real Travel Demands", *Proceedings of the 2021 HFES 65th International Annual Meeting*, Human Factors and Ergonomics Society, pp. 332-336.

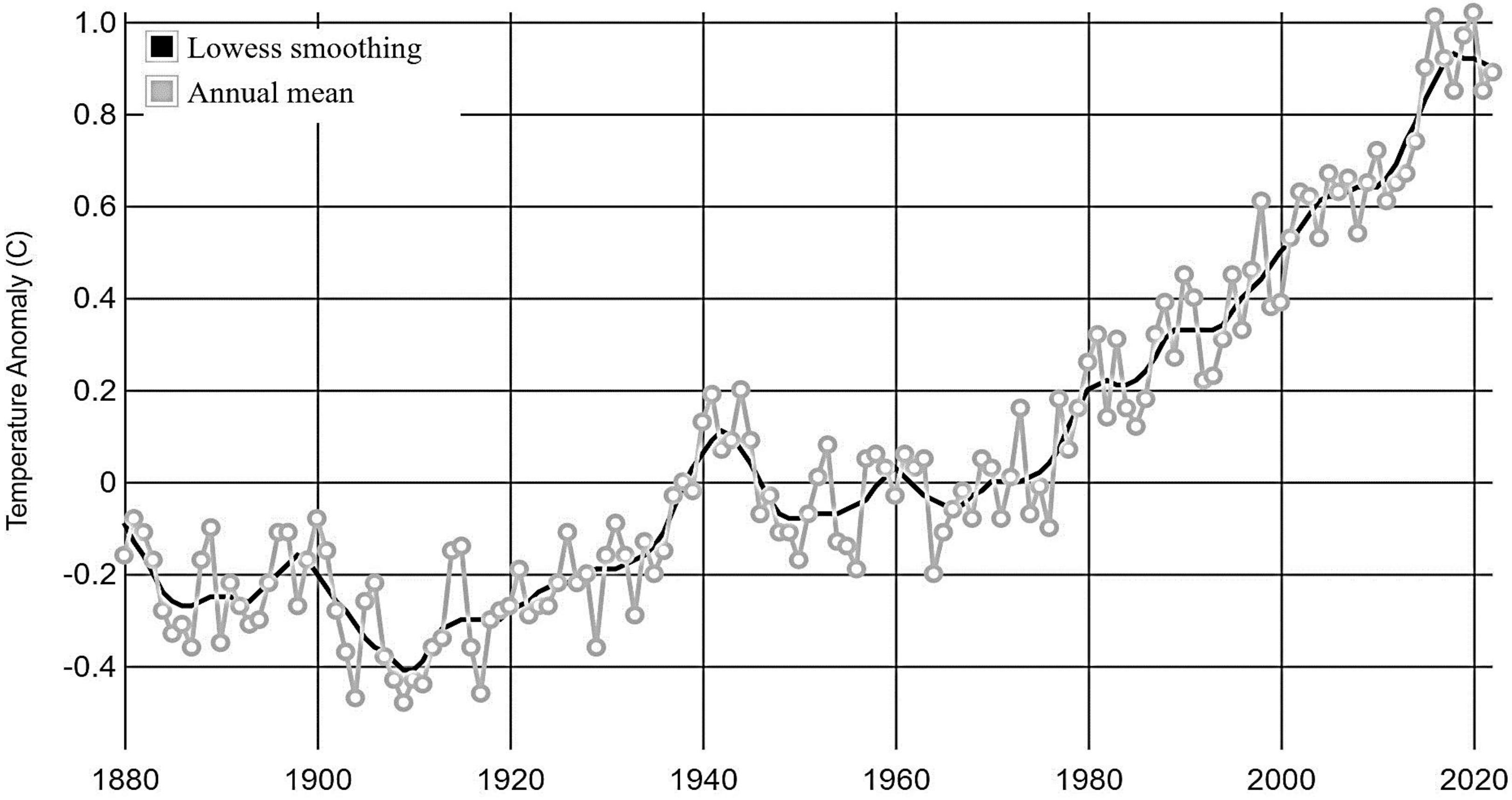
APPENDICES

Appendix A - NOAA Climate chart average Earth´s temperature



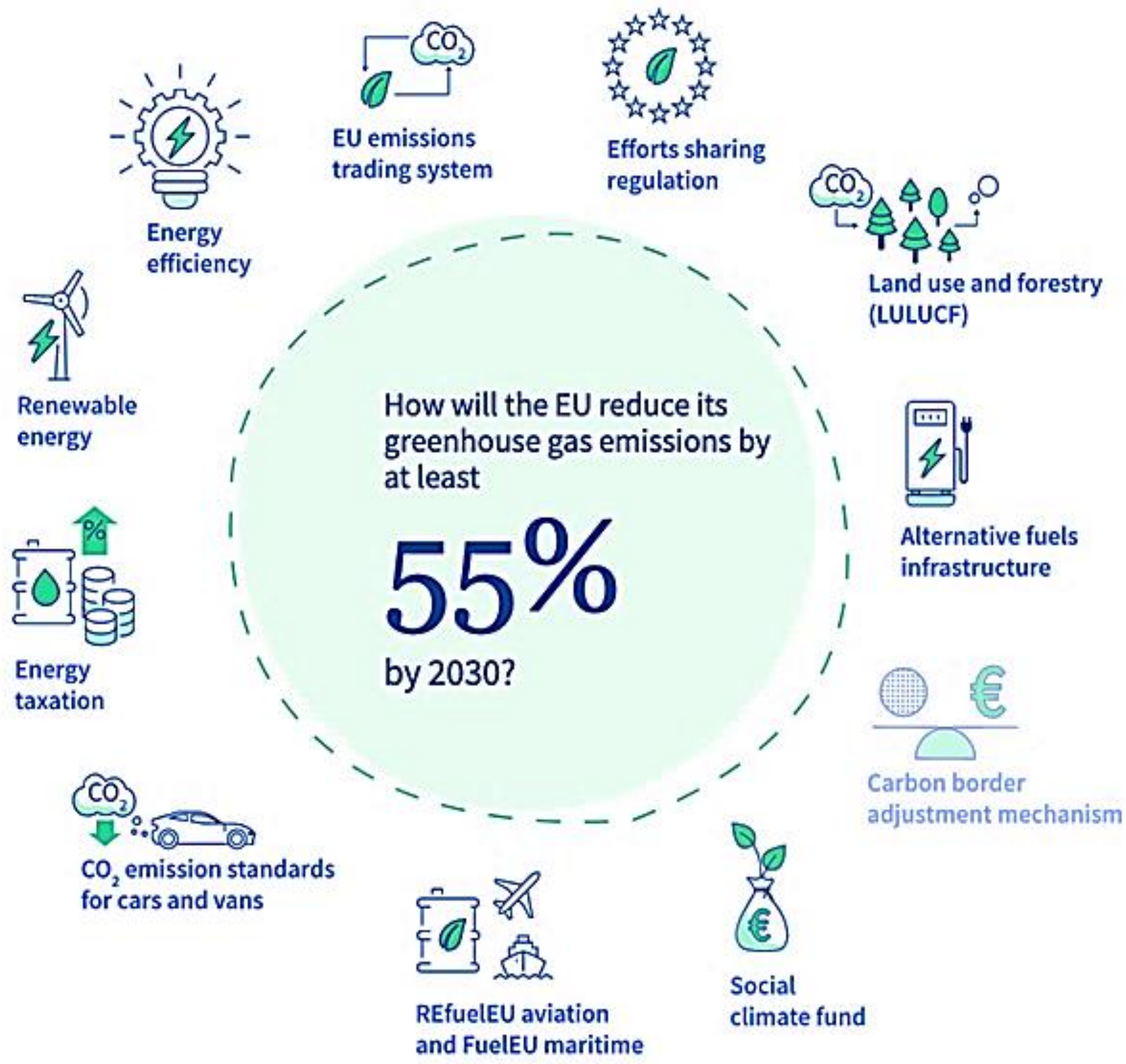
Source: Climate.gov (NOAA), available at www.climate.gov/

Appendix B - NASA´s Earth's global average surface temperature



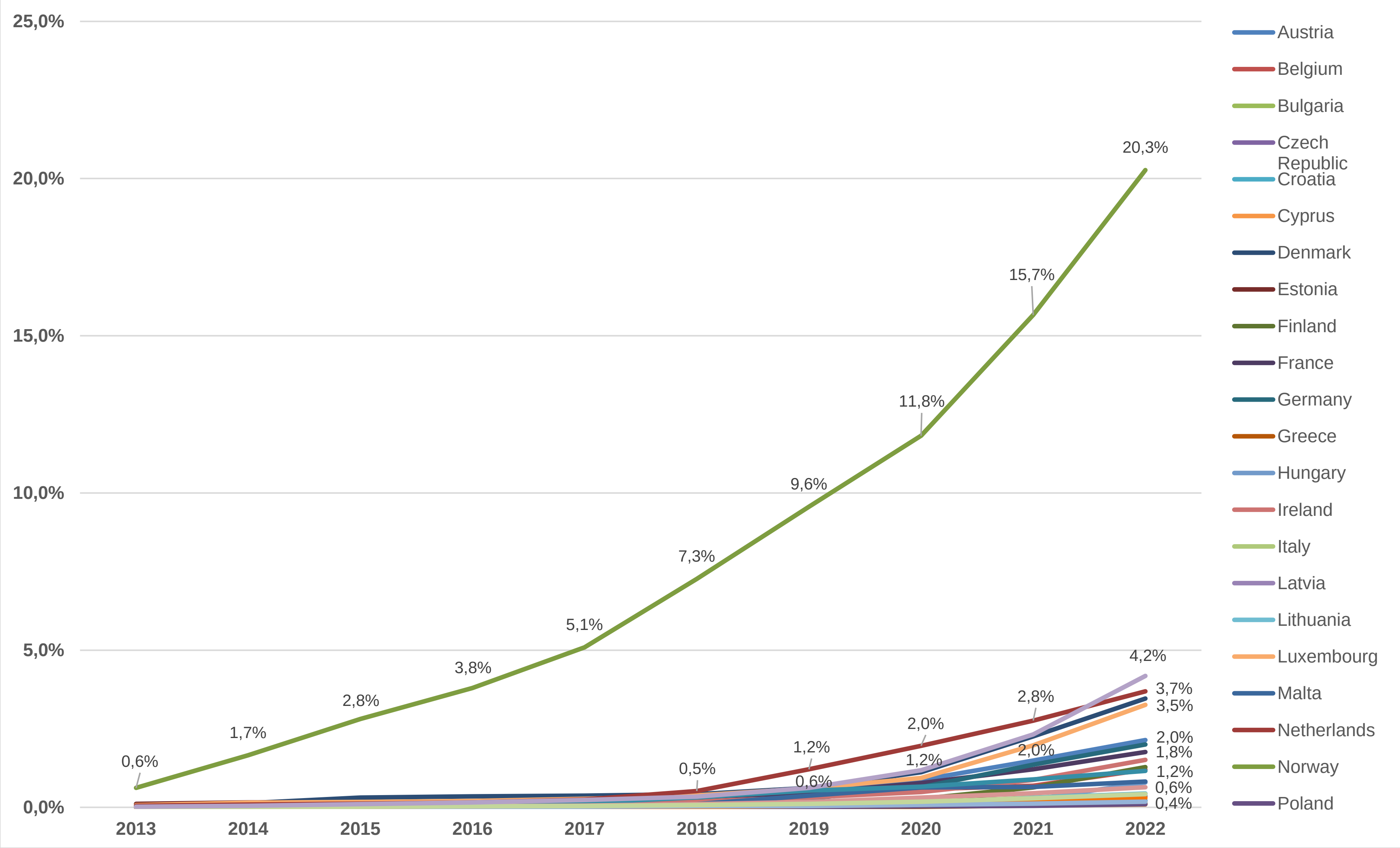
Source: Climate.nasa.gov, available at www.climate.nasa.gov/

Appendix C - "Fit for 55" infographic



Source: European Council, available at www.consilium.europa.eu/

Appendix D - Fleet of BEVs as a % of the total fleet (*graphic*)



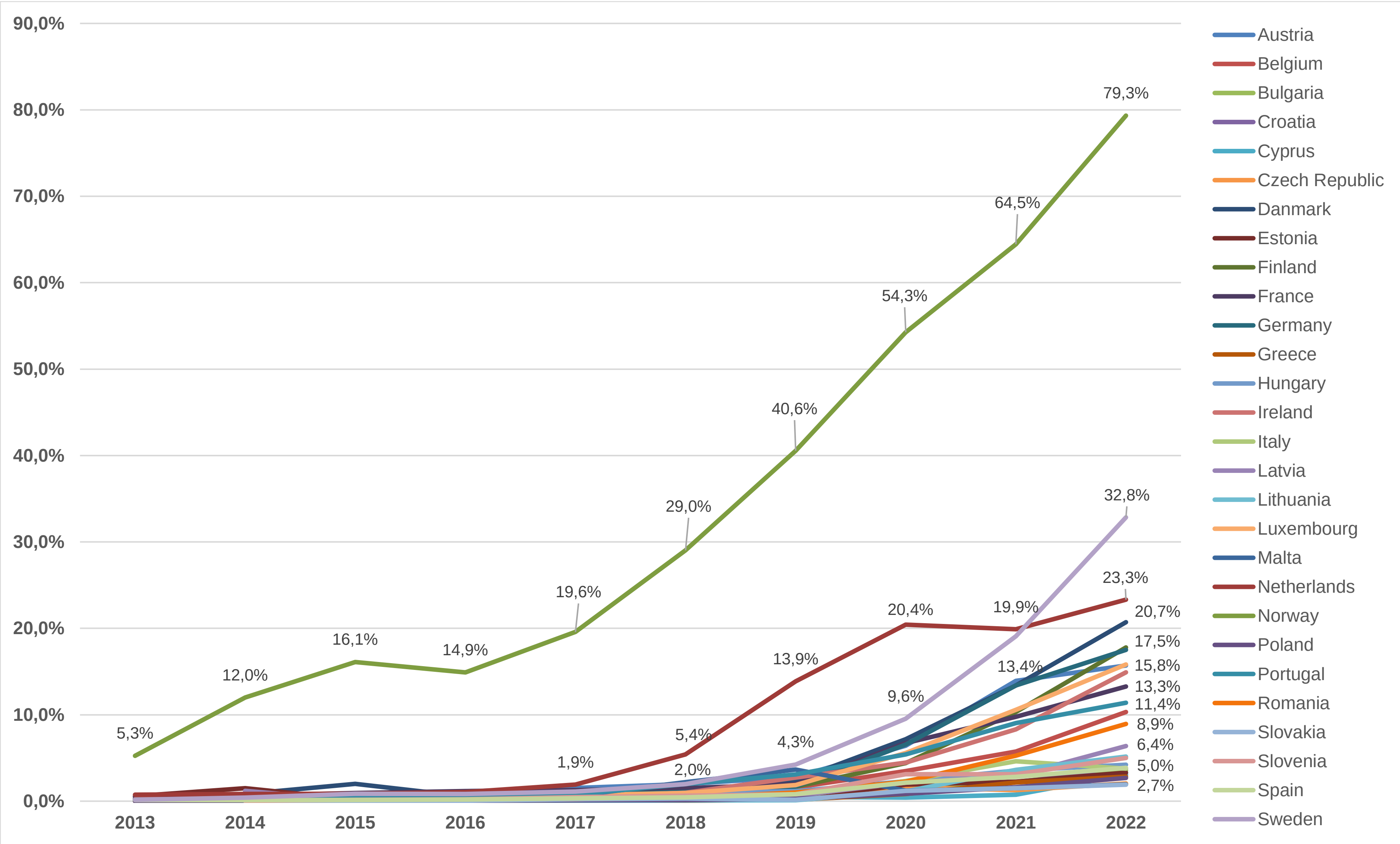
Source: EAFO, available at www.alternative-fuels-observatory.ec.europa.eu/

Appendix E - Fleet of BEVs as a % of the total fleet (*data*)

Year	Austria	Belgium	Bulgaria	Czech Republic	Croatia	Cyprus	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Latvia	Lithuania	Luxembourg	Malta	Netherlands	Norway	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	Sweden
2013	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,1%	0,1%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,1%	0,0%	0,1%	0,6%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
2014	0,1%	0,0%	0,0%	0,0%	0,0%	0,0%	0,1%	0,2%	0,0%	0,1%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,2%	0,0%	0,1%	1,7%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,1%
2015	0,1%	0,1%	0,0%	0,0%	0,0%	0,0%	0,3%	0,2%	0,0%	0,1%	0,1%	0,0%	0,0%	0,1%	0,0%	0,0%	0,0%	0,2%	0,0%	0,1%	2,8%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,1%
2016	0,2%	0,1%	0,0%	0,0%	0,0%	0,0%	0,4%	0,2%	0,0%	0,2%	0,1%	0,0%	0,0%	0,1%	0,0%	0,0%	0,0%	0,2%	0,1%	0,2%	3,8%	0,0%	0,1%	0,0%	0,0%	0,0%	0,0%	0,2%
2017	0,3%	0,1%	0,0%	0,0%	0,0%	0,0%	0,4%	0,2%	0,0%	0,2%	0,1%	0,0%	0,0%	0,1%	0,0%	0,0%	0,1%	0,3%	0,1%	0,3%	5,1%	0,0%	0,2%	0,0%	0,0%	0,1%	0,0%	0,2%
2018	0,4%	0,2%	0,0%	0,1%	0,0%	0,0%	0,4%	0,2%	0,1%	0,3%	0,2%	0,0%	0,1%	0,2%	0,0%	0,1%	0,1%	0,4%	0,1%	0,5%	7,3%	0,0%	0,3%	0,0%	0,0%	0,1%	0,1%	0,3%
2019	0,6%	0,3%	0,0%	0,1%	0,0%	0,0%	0,6%	0,2%	0,1%	0,5%	0,3%	0,0%	0,1%	0,3%	0,1%	0,1%	0,1%	0,6%	0,4%	1,2%	9,6%	0,0%	0,5%	0,0%	0,0%	0,2%	0,1%	0,6%
2020	0,9%	0,6%	0,1%	0,1%	0,1%	0,0%	1,1%	0,2%	0,3%	0,8%	0,6%	0,0%	0,2%	0,5%	0,1%	0,1%	0,1%	0,9%	0,6%	2,0%	11,8%	0,0%	0,7%	0,1%	0,1%	0,3%	0,2%	1,2%
2021	1,5%	0,7%	0,1%	0,2%	0,2%	0,1%	2,3%	0,3%	0,6%	1,2%	1,4%	0,1%	0,3%	0,9%	0,3%	0,2%	0,3%	2,0%	0,7%	2,8%	15,7%	0,1%	0,9%	0,2%	0,1%	0,5%	0,3%	2,3%
2022	2,1%	1,2%	0,2%	0,2%	0,2%	0,1%	3,5%	0,4%	1,3%	1,8%	2,0%	0,1%	0,8%	1,5%	0,4%	0,4%	0,4%	3,3%	0,8%	3,7%	20,3%	0,1%	1,2%	0,3%	0,2%	0,6%	0,4%	4,2%

Source: EAFO, available at www.alternative-fuels-observatory.ec.europa.eu/

Appendix F - Newly registered BEVs as a % of the total number of registrations (*graphic*)



Source: EAFO, available at www.alternative-fuels-observatory.ec.europa.eu/

Appendix G - Newly registered BEVs as a % of the total number of registrations (*data*)

Year	Austria	Belgium	Bulgaria	Croatia	Cyprus	Czech Republic	Danmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Latvia	Lithuania	Luxemburg	Malta	Netherlands	Norway	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	Sweden
2013	0,2%	0,1%				0,0%	0,3%	0,6%	0,1%	0,5%	0,2%	0,0%	0,0%	0,2%	0,1%					0,8%	5,3%	0,0%	0,2%	0,1%			0,1%	0,2%
2014	0,4%	0,3%		0,0%		0,0%	0,8%	1,5%	0,2%	0,6%	0,3%	0,1%	0,0%	0,3%	0,1%	1,2%		0,1%		0,8%	12,0%	0,0%	0,1%		0,0%	0,0%	0,1%	0,4%
2015	0,6%	0,3%	0,1%	0,1%		0,1%	2,0%	0,2%	0,2%	0,9%	0,4%	0,1%	0,3%	0,4%	0,1%	0,1%	0,0%	0,1%		0,9%	16,1%	0,0%	0,4%	0,1%	0,0%	0,2%	0,1%	0,9%
2016	1,2%	0,4%	0,1%	0,1%	0,2%	0,1%	0,6%	0,2%	0,2%	1,2%	0,4%	0,1%	0,2%	0,3%	0,1%	0,1%	0,0%	0,3%		1,1%	14,9%	0,0%	0,4%	0,1%	0,1%	0,2%	0,2%	0,8%
2017	1,5%	0,5%	0,1%	0,0%	0,4%	0,1%	0,3%	0,1%	0,4%	1,3%	0,8%	0,1%	0,6%	0,5%	0,1%	0,4%	0,0%	0,7%	0,6%	1,9%	19,6%	0,1%	0,8%	0,2%	0,2%	0,5%	0,3%	1,1%
2018	2,0%	0,7%	0,5%	0,1%	0,3%	0,3%	0,7%	0,4%	0,7%	1,5%	1,1%	0,1%	0,9%	1,0%	0,3%	0,8%	0,1%	0,9%	2,2%	5,4%	29,0%	0,1%	2,0%	0,4%	0,3%	0,6%	0,5%	2,0%
2019	2,8%	1,6%	0,6%	0,2%	0,5%	0,3%	2,4%	0,3%	1,7%	2,0%	1,7%	0,2%	1,2%	2,7%	0,6%	0,6%	0,1%	1,9%	3,7%	13,9%	40,6%	0,3%	3,1%	1,0%	0,2%	0,8%	0,8%	4,3%
2020	6,4%	3,5%	1,2%	1,5%	0,4%	1,6%	7,2%	1,9%	4,4%	6,7%	6,6%	0,8%	2,3%	4,5%	2,4%	2,1%	1,1%	5,6%	1,2%	20,4%	54,3%	0,9%	5,4%	2,3%	1,2%	3,1%	2,1%	9,6%
2021	13,9%	5,7%	2,2%	3,0%	0,8%	1,3%	13,4%	2,3%	10,3%	9,8%	13,4%	2,2%	3,5%	8,3%	4,6%	2,9%	3,6%	10,6%	1,5%	19,9%	64,5%	1,6%	9,0%	5,3%	1,5%	3,1%	2,8%	19,1%
2022	15,7%	10,3%	3,6%	3,0%	3,1%	2,1%	20,7%	3,3%	17,8%	13,3%	17,5%	2,8%	4,2%	14,9%	3,8%	6,4%	5,2%	15,8%	1,9%	23,3%	79,3%	2,7%	11,4%	8,9%	1,9%	5,0%	3,9%	32,8%

Source: EAFO, available at www.alternative-fuels-observatory.ec.europa.eu/

Appendix H - Average monthly gross salaries in (including Nordic countries) (*data*)

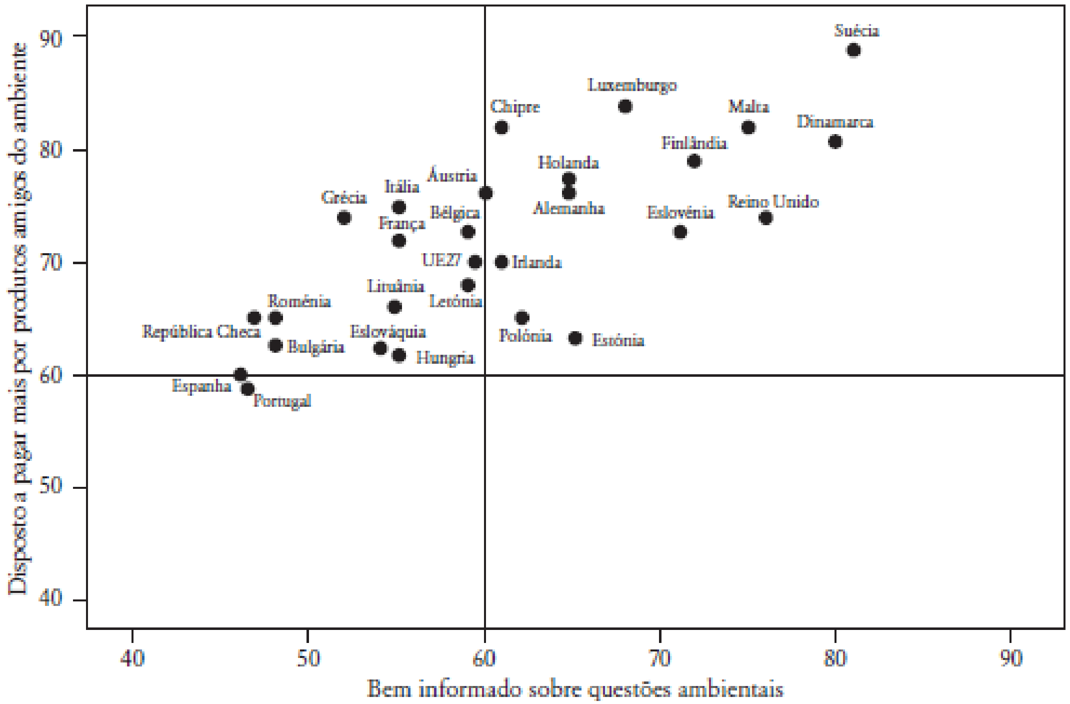
Country	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Denmark	4 158 €	4 263 €	4 354 €	4 364 €	4 436 €	4 497 €	4 569 €	4 655 €	4 773 €	4 940 €
Finland	3 017 €	3 054 €	3 092 €	3 126 €	3 140 €	3 204 €	3 269 €	3 294 €	3 464 €	3 590 €
Iceland	3 779 €	3 930 €	4 220 €	4 743 €	5 145 €	5 599 €	5 619 €	5 451 €	5 898 €	6 732 €
Norway	3 265 €	3 354 €	3 449 €	3 497 €	3 558 €	3 659 €	3 811 €	3 881 €	4 102 €	4 283 €
Portugal	1 187 €	1 169 €	1 176 €	1 182 €	1 206 €	1 245 €	1 304 €	1 321 €	1 373 €	1 452 €
Sweden	2 506 €	2 561 €	2 625 €	2 689 €	2 752 €	2 833 €	2 923 €	2 987 €	3 083 €	3 194 €

Source: OECD statistics, available at www.data-explorer.oecd.org/

Appendix I - Purchase price (€) to real range (Km) of BEV models

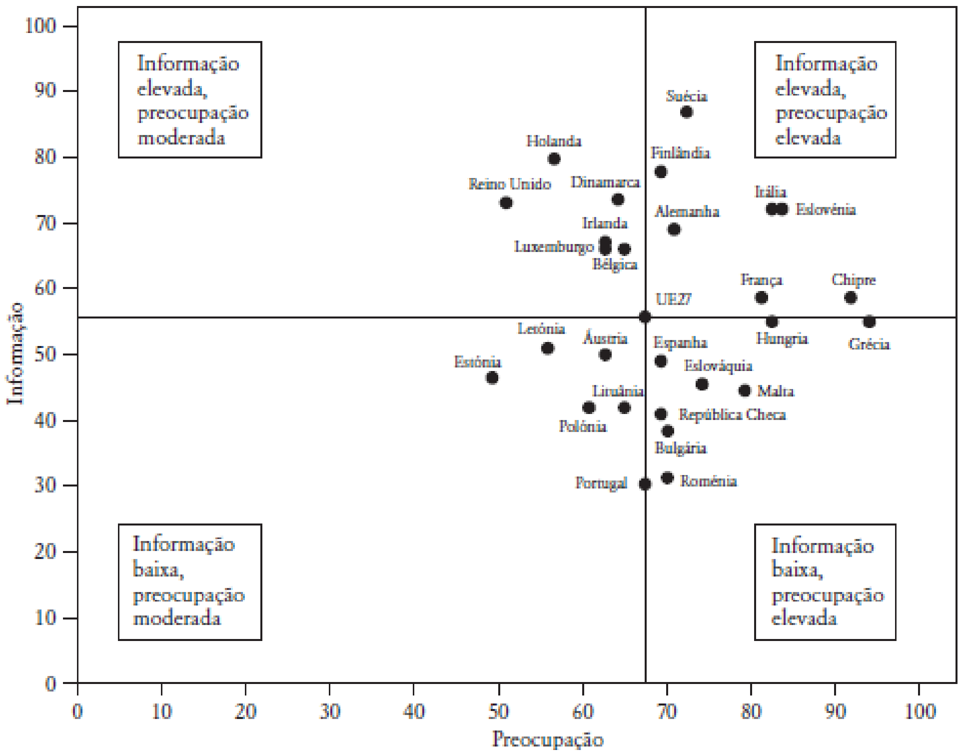
Source: EAFO, available at www.alternative-fuels-observatory.ec.europa.eu/

Appendix J - Relationship between being well informed about environmental issues and willingness to pay more for environmentally friendly products, 2011 (%)



Source: Schmidt & Delicado (2014:60)

Appendix K - Cross-referencing between rates of concern and information on climate change, 2009 (%)



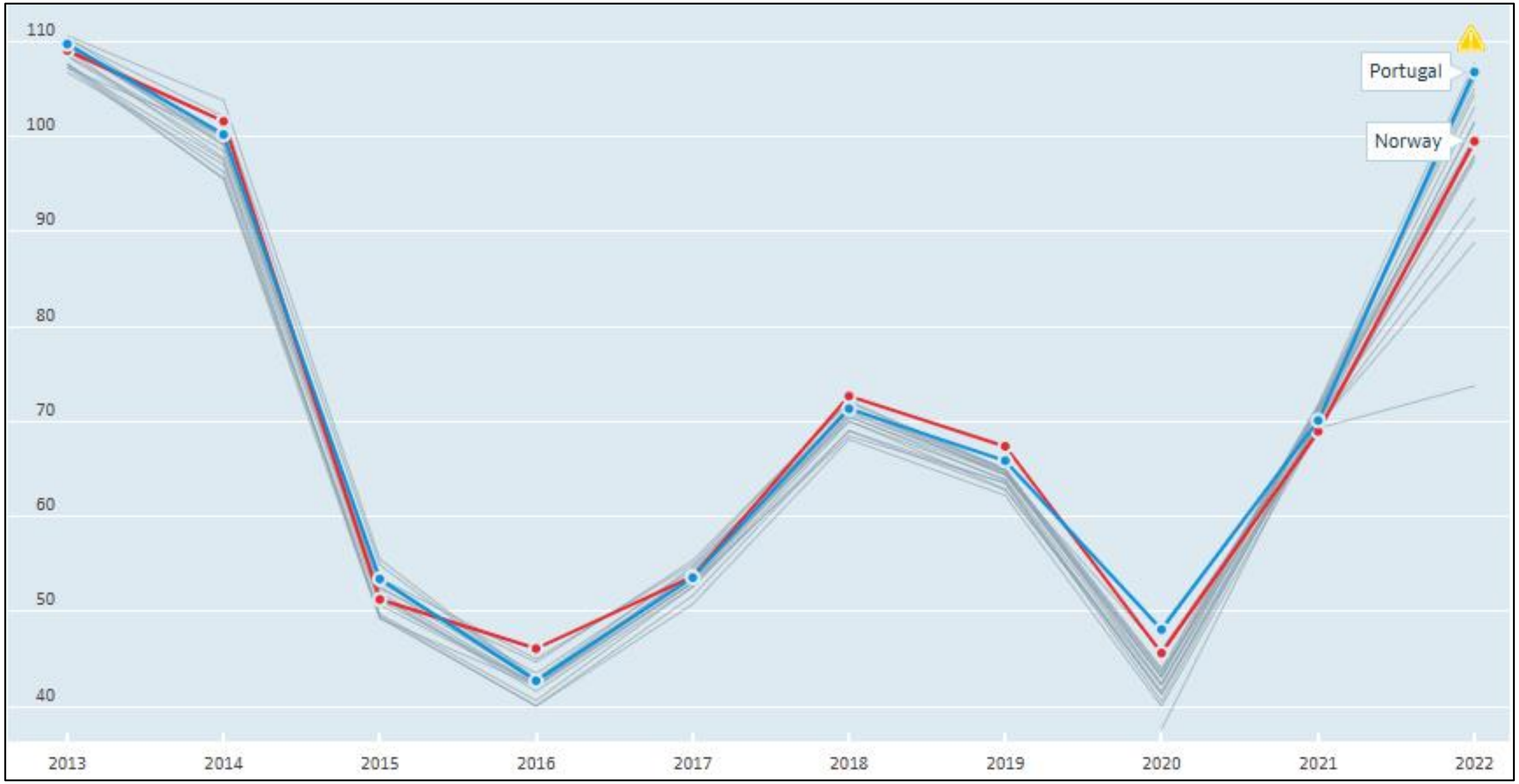
Source: Schmidt & Delicado (2014:130)

Appendix L - Electricity prices (Euro/kWh) for household consumers (bi-annual data)

Year (semester)	2013-S1	2013-S2	2014-S1	2014-S2	2015-S1	2015-S2	2016-S1	2016-S2	2017-S1	2017-S2	2018-S1	2018-S2	2019-S1	2019-S2	2020-S1	2020-S2	2021-S1	2021-S2	2022-S1	2022-S2
European Union - 27 countries (from 2020)	0,2042	0,2062	0,2058	0,2084	0,2083	0,2089	0,2051	0,2069	0,2086	0,2087	0,2100	0,2149	0,2168	0,2168	0,2131	0,2132	0,2203	0,2369	0,2525	0,2840
Portugal	0,2081	0,2131	0,2175	0,2231	0,2279	0,2285	0,235	0,2298	0,2284	0,223	0,2246	0,2293	0,2150	0,2181	0,2120	0,2133	0,2089	0,2170	0,2199	0,2222
Norway	0,1909	0,1778	0,1653	0,1661	0,1614	0,1434	0,1515	0,1631	0,1642	0,1605	0,1751	0,1907	0,1867	0,1744	0,1355	0,1322	0,1826	0,2206	0,1994	0,2302

Source: Eurostat, available at www.ec.europa.eu/eurostat/databrowser/

Appendix M - Crude oil import prices



Source: OECD statistics, available at www.data-explorer.oecd.org/