University of Glasgow

School of Social and Political Sciences

Air pollution and promotion of low-emission vehicles: A case study of Bulgaria

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Air pollution in Sofia, Bulgaria. Source:kompasbg.com

Abstract

Similarly, to freedom of movement, clean air is a human right of every citizen of the European Union. Through numerous directives and initiatives, the European Union has taken a course of action towards mitigating climate change and air pollution. As its full member, Bulgaria has pledged to follow this course of action. However, despite signing all pro-environmental agreements, the country falls behind in their implementation. Being the poorest member of the European Union with the most polluted air, Bulgaria is faced with numerous financial, legislative and environmental challenges. After examining the substantial contribution of the road transport sector to air pollution in the European Union and Bulgaria, as well as its deleterious health impact, I chose to focus on low-emission vehicles as a possible solution to decreasing greenhouse gas emissions. I have conducted a research into Bulgarians' opinions of low-emission vehicles and their role in the future car market. After discussing the results, I give my recommendations for policies that could be adopted by the Bulgarian government to promote the use of low emission vehicles.

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I. Introduction

1.1. Evolution of human development and climate change

Ever since humans came into existence and evolved their imagination, they started dreaming and creating. The urge to create led humankind to James Watt's steam engine and the Industrial Revolution. A hundred years later, the invention of the internal combustion engine revolutionised transportation and together with the Bessemer process of steel production (Encyclopaedia Britannica, 2018) boosted global economy to unseen levels. The development of communication technologies in the following decades and the Digital Revolution (Meyer, 2017) have brought society to a new post-industrial era, characterised by the transition from a manufacturing-based economy to a service-based one. Most evident in well-developed countries like the USA, Germany, Great Britain and Japan, the social and economic impacts of this transition were first described in 1973 by the American sociologist Daniel Bell. In his book "The Coming of Post-Industrial Society: A Venture in Social Forecasting" he portrays the societal and economic conditions of the information technology era (Bell, 2010). Bell argues that as the service sector of economy began to generate more wealth than the manufacturing one, humankind started to consume exponential amounts of energy (Bell, 2010). From 1973 to 2014, electric power consumption has increased about three times worldwide (World Bank, 2014). Increased energy demands have been met by burning more natural gas and fossil fuels. Research studies from the World Bank show that in 2015 more than 80% of the total consumed energy was generated from fossil fuels (World Bank, 2015). Furthermore, over the last 30 years, the world energy use for the transport sector has doubled and reached levels never seen before (International Energy Agency, 2012). Nowadays, the transport sector is still growing rapidly, and the International Energy Agency foresees a 100% growth by 2050 (International Energy Agency, 2012).

Thus, in effect, mankind's progress has started reshaping the environment. In this study I focus on the consequences of industrial and technological development, which are found to be the reasons behind air pollution and climate change (Mgbmene, 2011; United Nations, 2018).

Even though measures to mitigate climate change and air pollution have been taken, atmospheric pollution has continued to be a global problem through the years. Thus, the environmental changes brought upon by industrial and technological development and globalisation have become the scourge of the 21st century and possibly the biggest challenge humankind has ever faced.

1.2 The effects of climate change

The growth in energy demands has resulted in a significant increase of the concentrations of natural and anthropogenic gaseous constituents of the atmosphere (Baede et al., 2004). A 2007 report of The Intergovernmental Panel on Climate Change (IPCC), which is part of the United Nations Environment Programme (UNEP), showed that the levels of CO_2, CH_4 and N_2O have increased by 100%, 35% and 18% respectively, as compared with their levels in the pre-industrial era (IPCC, 2007). Also known as greenhouse gases (GHG), these atmospheric constituents are crucial to our planet because of their ability to trap radiation emitted from the Sun and reflected by the Earth's surface, thus helping to raise temperatures on Earth (Kazmeyer, 2018). The consequences of increased global temperatures affect both humans and different ecosystems (NASA, 2018; World Wildlife Fund, 2018). On the one hand, the effect of climate change might be seen as positive, due to increasing agricultural growth and reducing the energy needed for heating during the winter periods (Ministry of Environment and Water of the Republic of Bulgaria, 2018). On the other hand, though, an increase in global temperatures of only 1^{o} C has resulted in acidification of the oceans, melting glaciers, shrinking of the Arctic sea ice and many other changes which affect different ecosystems in various ways (Committee on Climate Change, 2018). Possibly the worst negative effect of climate change is the transformation of the global hydrological cycle. This transformation comprises changes in the average seasonal and annual rainfall and, most importantly, an increase in the number of extreme weather events, such as storms, floods and droughts (Committee on Climate Change, 2018).

In addition to greenhouse gases, increased energy demand stimulates the emission of particulate matter (PM) in the air, which is a big contributor to air pollution. Air pollution may be invisible for most people, but its effects on society are very pronounced. It is reported to be the 4th most significant risk factor for death, which has caused 5.5 million deaths worldwide in 2013 (Forouzanfar et al., 2016; Brauer et al., 2016). Air pollution is considered one of the main contributors to lower respiratory infections, various forms of cancer, chronic respiratory diseases, obstructive pulmonary disease (COPD) and cardiovascular disease, including ischemic heart disease and stroke (Institute of Health Metrics, 2016). In contrast to other risk factors associated with lifestyle, breathing polluted air has a negative impact on health regardless of people's wealth, education and social status. However, people who are most affected from it are usually the poorest ones. A study by the European Parliament shows that developing countries are the most vulnerable to climate changes because of their impossibility to adapt to them (Ludwig et al., 2007). The report estimated that failure to quickly adapt to the new environmental conditions could cost up to 20% of a country's GDP (Ludwig et al., 2007).

In this research, I take into consideration the negative effects of air pollution and climate change and investigate which are the main sources and how the European Union are tackling these global issues.

1.3. Economic theories for environmental deterioration

For some researchers and philosophers, environmental deterioration is a result of the development and expansion of capitalism. In social science literature, the contradiction between nature and society can be traced back to the Marx's and Engel's works. In particular, Marx's 'second contradiction' of capitalism assumes that the capital depreciates nature and predicts an environmental crisis (Correira, 2014; O'Connor, 1998.). However, Judith Cherni argues that capitalization of conditions of production and especially the environment increases the costs of the capital and lowers its resilience (Cherni, 2014). For instance, 'the use of pesticides in agriculture at first lowers, then ultimately increases costs as pests become more chemical resistant and also as the chemicals poison the soil' (O'Connor, 1998). Therefore, the theory of second contradiction of capitalism is insufficient and cannot fully explain the interrelations between environmental issues and economy. For this reason, I examine the current capitalistic world, and in particular the European conditions and policy measures in which the effects of air pollution and climate change are growing in number.

1.3. The impact of road transport on air pollution

Contemporary factors which influence the composition of the atmosphere and therefore could contribute to air pollution are numerous. They range from natural events like volcanoes, to anthropogenic factors like the growing heavy and light industries, deforestation, etc. (Climate and Weather, 2018).

In this study I focus on one of the main contributors to air pollution: road transportation. In Europe and the US, road traffic is considered one of the largest contributors to increased GHGs and air pollution in the recent years (Viana, 2013; European Environment Agency, 2018a; US Environmental Protection Agency, 2018). Transportation is the second leading contributor to GHGs emissions, in both the USA and Europe (Viana, 2013). Burning of diesel and petrol by vehicles emits carbon dioxide (CO_2), Particulate Matter (PM), nitrous oxide (N_2O), methane (CH_4), ozone (O_3), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and other halocarbons (Automotive Association, 2018; Ministry of Environment and Water of the Republic of Bulgaria, 2018). The released hydrocarbons, particles and GHGs react with sunlight and create a photochemical smog, which reduces visibility and can lead to respiratory ailments (Figure 1) (Turrentine, 2014; Hinrichs and Kleibach, 2013).

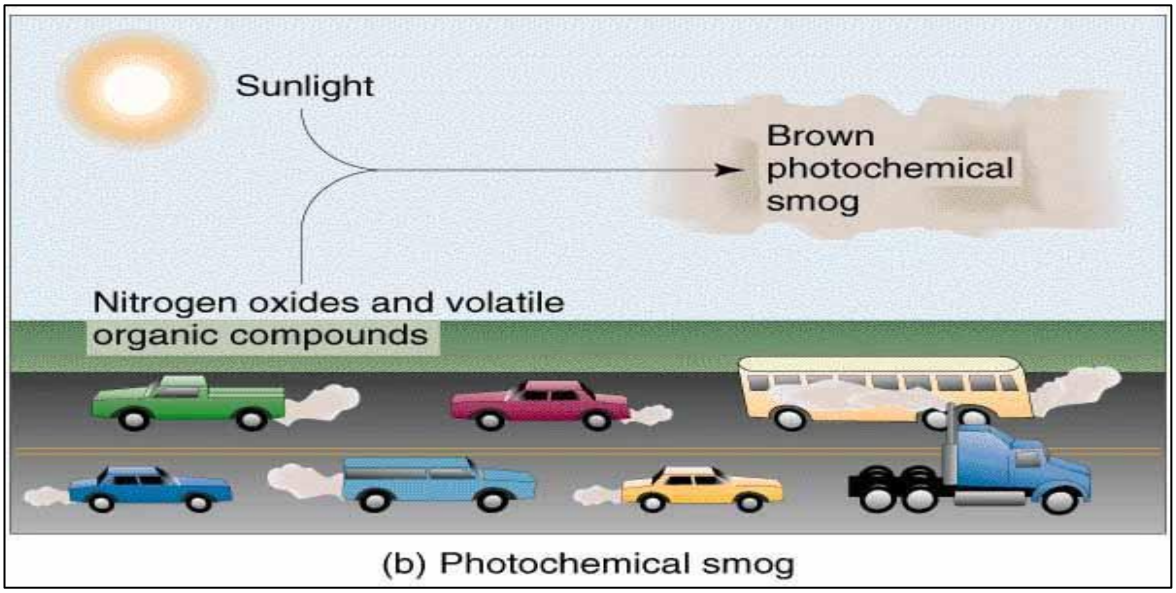

Figure 1. Production of photochemical smog*. Image source: School helper, 2018, URL: https://schoolworkhelper.net/photochemical-smog-history-summary/*

The impact of road traffic on air quality is mostly investigated through the air indicator Particulate Matter (PM) (Viana, 2013). The PM index represents the mass concentration of inhalable particles in the air smaller than 10 μm (PM_{10}) or 2.5 μm ($PM_{2.5}$). In particular, in Europe, road transport is responsible for 15-20% of the observed PM_{10} and 10-15% of $PM_{2.5}$ (Hendriks et al., 2013). In a review from 2013, the World Health Organization argues that $PM_{2.5}$ and PM_{10} are the main agents contributing to series of negative health effects (World Health Organisation, 2013). In addition, PM is examined as the most robust barometer of risk related to exposure to air pollution from various sources (Lim et al., 2013).

To minimize air pollution, scientists have found that the substantial cuts in anthropogenic GHG emissions are required (Edenhofer et al., 2014). For this reason, policymakers and stakeholders have introduced more efficient and effective national and global interventions, aiming to reduce the levels of particulate matter (PM) and GHG emissions released in the atmosphere. In the next sections I investigate global policy actions, focusing on the European practices.

1.4. Research focus

This research acknowledges the significance of climate change and its consequences, as well as the harmful contribution of road transport to air pollution. It reviews the evolution and current legislative framework and policies towards the mitigation of climate change and air pollution in the European Union and discusses the outcomes of these initiatives.

The second part of this study investigates the policies and practices associated with air pollution mitigation in the poorest country of the EU, Bulgaria, in its most developed and, at the same time, most polluted city: Sofia (Konstantinova and Okov, 2017). Even though Bulgaria has to keep pace with all other EU countries and embrace the same policies and measures in the process of constructing an environmentally friendly European economy, the country is still struggling to implement the European' instructions due to financial and legislative limitations. As the least developed country in the Union, Bulgaria suffers the most from the adverse effects of climate change and air pollution (Munawar, 2015). In particular, the atmosphere in the country's capital, is found to be the most polluted in the Union and the country death rate due to air pollution the highest (Institute of Health Metrics, 2016). I examine the role of road transportation for air pollution in Bulgaria. In the third part of this research, I investigate the factors which influence decision-making for private vehicle purchasing in Bulgaria and recommend policy changes and initiatives which might contribute to a behaviour change and ultimately stimulate purchasing of low-emission vehicles. This research could fill a knowledge gap of the vehicle preferences of Bulgarians, which on its turn could help policymakers and academics who are interested in examining or implementing future 'green' policies in Bulgaria.

1.5 Research aim

The primary aim of this research is to examine Bulgarians' willingness to contribute in the fight with climate change and air pollution by purchasing low-emission vehicles. For this reason, I have conducted an online survey.

After considering the adopted ‘green policies’ and Bulgarians’ car preferences and factors behind vehicle-purchasing decisions, I draw recommendations for future policy and legislation initiatives to promote the purchase of low-emission vehicles.

II. Literature review

2. Overview of EU efforts for mitigating climate change

Air quality standards for Particulate Matter were established comparatively earlier than GHG emission standards. The United States Environmental Protection Agency set the first PM standards in 1971, whereas European policies for CO_2 reduction date back to 1950 when the Slovenian government introduced a new agriculture strategy to reduce GHGs and promote productivity through the Rural Development Programme (European Environment Information and Observation Network, 2018). Nowadays, 68 years later, there are more than 1500 such policies and measures adopted and implemented by European countries (European Environment Agency, 2018; Vianna, 2013)

Growing scientific evidence of the consequences of air pollution and climate change has convinced policymakers to address these issues through international cooperation (Viana, 2013). Measures for reducing GHGs were first introduced by the EU in the early 1990s (Environment Directorate and International Energy Agency, 2003; United Nations, 2018a). The global debate about climate change started in 1992 with the United Nations Framework Convention on Climate Change (UNFCCC) (United Nations, 2018), an international treaty, signed by 193 parties by 2005. By its origin, this international agreement is a framework for international cooperation to "anticipate, prevent or minimise the causes of climate change and mitigate its adverse effects" (United Nations, 1992). The treaty was followed by the adoption of the Kyoto Protocol in 1997, which legally bounded the developed countries to achieve specific GHG emission goals (United Nations, 2018b). Thirteen years later, during the Cancun Conference of the Parties, the countries which signed the UNFCCC recognised that in order to prevent global temperature rising with more than 2 °C from their pre-industrial levels, they have to significantly reduce their greenhouse gas emissions (United Nations, 2011). The EU committed to these objectives by signing the Doha Amendment to the Kyoto Protocol a few years later (United Nations, 2018c). In order to meet the above-mentioned goals and keep the temperature levels stable in the future, the

EU and 150 more countries signed the Paris Agreement in 2015 and all agreed on working to create plans, strategies and regular reports on their contribution to mitigating global warming (United Nations, 2016). Even though the number of climate change-relevant laws has increased by about 2000% compared to 1997 (Nachmany et al., 2017), global efforts are still largely considered insufficient and inapplicable. For instance, the Paris Agreement does not offer an instrument to enforce legal obligations to any country that signed it (Reguly and Mccarthy, 2015; Kinver, 2015). However, we should take in consideration that it is the first-ever universal, legally binding global climate deal (United Nations, 2018). Another criticism against the Paris Agreement is that the pledges made in it are not enough to keep the rise of global average temperatures below 2°C (Rogelj et al. 2016). To respond to these criticisms, the European Union has taken several concrete steps which I investigate in the next sections.

2.1. The evolution of EU actions against climate change

To adequately face the issues of climate change and air pollution, the EU has embarked on a complex journey to adjust the shared European legislation. To "cut the Gordian knot"[1], the EU Member States had to create and implement a great number of new, innovative policies.

In 2007, the EU officials introduced an integrated approach to energy policy and climate (Nachmany et al., 2017; European Commission, 2007). The new policies addressed climate change and were aimed at promoting the energy security of the Union and strengthening its competitiveness at the same time (Nachmany et al., 2017; European Commission, 2007). A couple of years later, the "climate change package" was adopted and a new binding legislation to implement the "20-20-20" targets were applied (Nachmany et al., 2017; European Commission, 2007). In accordance to this package, the EU is supposed to:

[1] Gordian knot- a proverbial term for a problem solvable only by bold action. The phrase "cutting the Gordian knot" has thus come to denote a bold solution to a complicated problem. Source: Encyclopaedia Britannica, URL: https://www.britannica.com/topic/Gordian-knot)

- reduce its GHG emissions by at least 20%
- cut by 20% the energy consumption by improving energy efficiency
- increase the share of energy generated from renewable energy sources to 20% (Nachmany et al., 2017; European Commission, 2007).

Only 5 years later, the EU leaders increased these requirements by adopting the 2030 Climate and Energy Framework, which doubled the established GHG emission targets to 40% and increased the efficiency and 'green energy' shares to 27% (European Commission, 2014). In addition, a new climate strategy is expected to be released in the first quarter of 2019 and is most likely to follow the Low-carbon Economy Roadmap, which suggests that by 2050 the GHG emissions in the EU should be reduced by 80% compared to those in 1990 (Frederic, 2018; European Commission, 2018f). The Low-carbon Economy Roadmap concludes the EU's planning efforts to make the European economy more efficient and ecological.

The EU strategies have then been followed by legislative initiatives, implemented in directives and regulations (European Commision, 2018d; enhesa, 2018). In general, these legislations, concerning climate change and the protection of the ozone layer, are focused on several different categories:

- Greenhouse Gas Monitoring and Reporting
- EU Emissions Trading System
- Effort Sharing Decision
- Carbon Capture and Storage
- Transport/Fuels
- Ozone Layer Protection
- Fluorinated gases
- Forests and Agriculture

For the purpose of this study, I focus on the Transport category, which is estimated to account for almost 25% of all GHG emissions in the European Union and is the only sector which has never seen a gradual decline in GHG emissions (European Environment Agency, 2018). Figure 2 shows that while all other sectors have decreased their CO_2 emission levels from 1990 until 2016, the transport sector has increased them by a total of 23% (Figure 2) (European Environment Agency, 2018). The transport sector includes 6 different types of transportation: rail, road, aviation, inland navigation, maritime and others, where the road transportation accounts for about 74% of the total GHG emissions. Furthermore, road

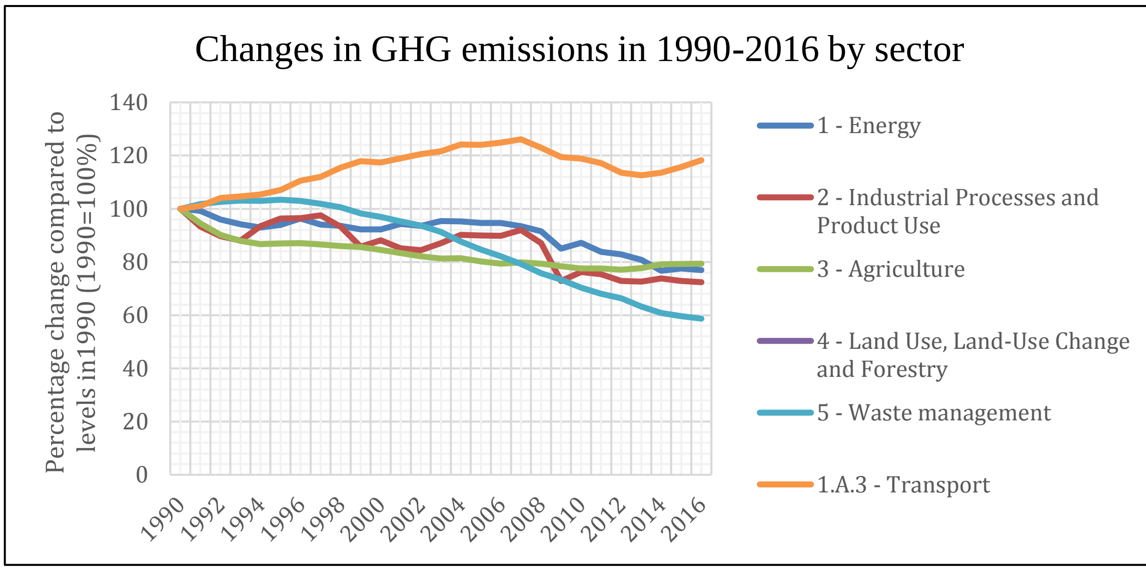

Figure 2. GHG emissions compared to GHG emissions in 1990 by sector. *Note: GHG emission in 1990 = 100% Source: EEA, http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer*

transport is found to be responsible for almost 20% of the total GHG emissions in the EU (European Environment Agency, 2018). In the next sections I investigate the specific European road transportation measures, which have been taken to tackle climate change and air deterioration.

2.2. EU policies for the reduction of air pollution from road transportation

As mentioned above, road transportation is responsible for about ¾ of the total GHG emissions from the Transport sector in the EU and includes emissions from various types of vehicles, which run on diesel, gasoline and liquid petroleum gas (LPG) (European Environment Agency, 2018; Ministry of transport information technology and communications of the Republic of Bulgaria, 2017).

The core European legislative initiatives related to lowering emissions in road transportation are “White paper: Roadmap to a Single European Transport Area 2011” (the White Paper), Energy Union Strategy 2015 and the Strategy to Low-Emission Mobility 2016 (European Commission, 2011; European Commission, 2015; European Commission 2016). The White Paper introduced a roadmap of 40 concrete initiatives for the next decade, which aim to increase mobility by removing major barriers in key areas like fuel growth and employment, and also reduce European dependence on imported oil by 60% and cut CO_2 emissions in transport by 2050 (European Commission, 2011). In the European Energy Security Strategy 2015, the oil dependency of the transport sector was identified as an “issue that need to be closely monitored and that require a more strategic coordination of the EU’s oil policy” (European Commission, 2014). Ultimately, this strategy aims to achieve better energy efficiency and a decarbonised transport sector (European Commission, 2015). A year later, transportation became the focal point of the Strategy for Low-Emission Mobility, that framed the European Commission’s initiatives to achieve the transition to zero-emission vehicles (European Commission, 2016). The key priorities of this strategy were related to increasing the efficiency of the transport system and investing in research and innovation in low emissions solutions (European Commission, 2016). In the next sections I investigate the evolution of the European transport strategy in the fight with climate change and air pollution and focus on its three main pillars: labelling of cars, promotion of new efficient fuels and vehicles.

2.2.1 EURO vehicle standards

To regulate the exhaust emissions of new vehicles sold in the EU, the Member States have introduced EURO emission standards to all types of vehicles in several EU directives (European Commission, 2009a). While carbon dioxide (CO_2) emissions are related to fuel consumption, methane (CH_4) and nitrous oxide (N_2O) emissions are dependent on engine technology (Sarkan et al., 2017). Table 1 and 2 show the European emission standards for passenger cars running on gasoline and diesel established by several European directives.

Ultimately, all these directives aim to reduce the amount of emitted gases and to improve the fuel economy of cars sold within the EU.

Emission Stage	Implementation Date	Emission (g/km)				
		CO	HC	HC + NO_x	NO_x	PM
Euro 1	July 1992	2.72 (3.16)	—	0.97(1.13)	—	—
Euro 2	January 1996	2.2	—	0.50	—	—
Euro 3[a]	January 2000	2.3	0.20	—	0.15	—
Euro 4[b]	January 2005	1.0	0.10	—	0.08	—
Euro5[c]	September 2009[d]	1.0	0.10[e]	—	0.06	0.005[f, g]
Euro 6[c]	September 2014	1.0	0.10[e]	—	0.06	0.005[f, g]

Note: At the Euro 1–4 stages, passenger vehicles > 2500 kg were type approved as category N_1 vehicles. Values in brackets are in conformity with production (COP) limits. The dash means no regulation.
[a] Euro 3 stage—80,000 km or 5 years, whichever occurs first.
[b] Euro 4 stage—100,000 km or 5 years, whichever occurs first.
[c] Euro 5/6 stage—in-service conformity: 100,000 km or 5 years; durability testing of pollution control devices for type approval: 160,000 km or 5 years (whichever occurs first).
[d] 2011.01 for all models.
[e] NMHC = 0.068 g/km (NMHC: nonmethane hydrocarbon).
[f] Applicable only for vehicles using DI engines.
[g] 0.0045 g/km using the PMP measurement procedure (PMP: Particulate Measurement Program).

Table 1. European emission standards for passenger cars running on gasoline*. Source: Srivastavax, and Hancsók, 2014*

Emission Stage	Implementation Date	Emission (g/km)				PN* (#/km)
		CO	HC + NO_x	NO_x	PM	
Euro 1	July 1992	2.72(3.16)	0.97(1.13)	—	0.14(0.18)	—
Euro 2—IDI**	January 1996	1.00	0.70	—	0.08	—
Euro 2—DI***	January 1999[a]	1.00	0.90	—	0.10	—
Euro 3	January 2000	0.64	0.56	0.50	0.05	—
Euro 4	January 2005	0.50	0.30	0.25	0.025	—
Euro 5[a]	September 2009[b]	0.50	0.23	0.18	0.005[d]	—
Euro 5[b]	September 2011[c]	0.50	0.23	0.18	0.005[d]	6.0×10^{11}
Euro 6	September 2014	0.50	0.17	0.08	0.005[d]	6.0×10^{11}

Note: At the Euro 1–4 stages, passenger vehicles > 2500 kg were type approved as category N_1 vehicles. Values in brackets are in conformity with production (COP) limits. * PN—Particle number limit, ** IDI—indirect injection, *** DI—direct injection. The dash means no regulation.
[a] Until 1999.09.30 (after that date DI engines must meet the IDI limits).
[b] 2011.01 for all models.
[c] 2013.01 for all models.
[d] 0.0045 g/km using the PMP measurement procedure.

Table 2. European emission standards for passenger cars running on diesel. *Source: I Srivastava, and Hancsók, 2014*

Through Regulation (EC) No 443/2009 of the European Parliament, the EU has also set a goal for 2021 of 95g CO_2 emissions per kilometre (European Commission, 2009a). It corresponds to 4.1 liters of gasoline or 3.6 liters of diesel per 100 km (European Commission, 2009b; Paltsev et al, 2018). The European joint efforts have resulted in a 19% decrease in the average CO_2 levels emitted by new cars compared to the levels in 2009 (European Environment Agency, 2017).

2.2.2 Sulphur free fuels for all European vehicles

Greenhouse gas emissions are also influenced by fuel type and quality (Viana, 2013). Sulphur content in fuels is found to have adverse effects on certain types of engines and on the environment (Viana, 2013). To reduce sulphur dioxide levels, the European Parliament introduced European fuel standards in several directives: Directive 93/12/EEC, Directive 98/70/EC, and 2003/17/EC (European Commission, 1993; European Commission, 1998; European Commission, 2003). Thus, in 2009, European efforts towards the reduction of sulphur content resulted in a full transition to 'sulphur-free' diesel and gasoline fuels (Viana, 2013).

2.2.3 European measures for biofuels

Another approach for decreasing the air pollution footprint of fuels can be found in the use of biofuels. Biofuels like fatty-acid methyl esters (FAME or biodiesel), paraffinic fuels from biomass-to-liquid procedures (BTL) or hydrotreated vegetable oil (HVO) and bioethanol have been found to reduce PM emissions (Lapuerta et al., 2008; Kousoulidou et al., 2008; Xue et al., 2011). Other studies showed that due to their 100% paraffinic composition, the estimated impact of HVO fuels can lead to reductions in both NOx (~10%) and PM (~30%), (Nylund et al., 2011). Under these circumstances, the EU considers that an effective reduction of GHG emissions could be achieved by using advanced biofuels, synthetic fuels and other low-carbon fuels (European Commission, 2016b). It has promoted the use of biofuels in several directives and set a target of minimum 6% reduction of GHG emissions per unit of energy compared to EU-average levels in 2010, that must be achieved by 2020 (European Commission, 2003; European Commission, 2009). As a result of these measures, the consumption of biofuels increased from 41 TJ to 553 667 TJ in 2016 (European Environment Agency, 2018).

However, not all types of biofuels have been recognized as beneficial. "First generation" biofuels, produced from food and crops, such as bioethanol, biodiesel, pure vegetable oils, hydrotreated vegetable oils and others, will not receive public support after 2020 because they were found to contribute to GHS emissions indirectly (European Commission, 2016a). For example, the expansion of croplands for ethanol and biodiesel are found to increase greenhouse gases emissions due to increased land-use (Searchinger et al., 2008). In addition, biofuel measures are criticised for driving rainforest destruction (Greenpeace European Unit, 2010).

For these reasons, in the European Strategy for Low-Emission Mobility, the EU Commission emphasizes on the need for a "gradual phase out" of biofuels and replacement with more advanced ones. Moreover, the EU Commission has proposed an effective framework for low emission alternative energy (European Commission, 2014), which I examine in the next section.

2.2.4 Alternative powertrain technologies and the promotion of low-emission vehicles (LEVs)

"I call on the car industry to come clean and make it right…they should be investing in the clean cars of the future" (President Jean-Claude Juncker, State of the Union Speech, 13 September 2017)

A different solution to the reduction of air pollution from road transportation has been found in the face of alternative powertrain technologies. After years of development and research, hybrid, hydrogen and electric technologies were designed to significantly reduce fuel consumption, GHG emissions and therefore the European Union's dependence on fossil fuels (Viana, 2013). While hybrid and hydrogen cars are found to emit significantly lower NOx and other pollutants compared to combustion engine cars with the same emission standards (Fontaras et al. 2010; Schultz, 2003), emissions from battery-electric vehicles are equal to zero (Viana, 2013). Considering these observations, the term 'low-emission vehicles' (LEVs) in the EU legislation refers to cars and trucks emitting below 50g of CO_2 per kilometre, whereas 'zero-emission vehicles', like electric and hydrogen vehicles, refer to vehicles producing no CO_2. In addition to better air quality, electric vehicles contribute to the reduction of noise pollution, especially in urban areas (Viana, 2013; Society of Motor Manufacturers and Traders, 2018). Although low-emission vehicles are found to be one of the most promising solutions to air pollution, there are many obstacles to their large-scale implementation. In general, LEVs are more expensive and have some technological limitations in comparison with vehicles running on fossil fuels. For example, electric vehicles have shorter driving range, require a lot of time for battery charging and, last but not least, need the appropriate infrastructure for charging the battery (Knez, 2017; Kassakian, 2013). In addition, the market and customers are not so well informed about the implementation of LEVs and have almost no experience with them. Numerous studies have reported peoples' doubtful opinions of electric vehicles (Kurani et al., 2009; Turrentine 2014; National Academy of Sciences, 2013; Knez, 2017). Thus, the future use of LEVs and their contribution to the fight with air pollution and climate change are largely dependent on customers' readiness to embrace the 'green idea' (Krupa et al., 2014; Knez, 2017).

European legislation related to these alternative powertrain technologies was first introduced in the European Strategy on Clean and Efficient Vehicles and then implemented in the White Paper, in which low-emission vehicles were suggested as a way to ease the problem with air pollution in urban regions (European strategy on clean and energy efficient vehicles, 2010). Three years later, in Directive 2014/94/EU, the EU Parliament and Council emphasized on the use of electricity as an alternative to combustion fuel and instructed every Member State to construct a national policy framework for the development of infrastructure and market for alternative fuels (European Commission, 2014). In particular, it is required that 'an appropriate number of recharging points accessible to the public are put in place by 31 December 2020' in order to provide an adequate infrastructure for electric vehicles to circulate at least in urban and suburban agglomerations and other highly populated areas (European Commission, 2014).

The next step towards the promotion of low-emission vehicles was the European Strategy for Low-emission Mobility, which put the transition towards zero-emission vehicles as one of the main priorities of the Union (European Commission, 2016a). Through this strategy, the EU Commission has been looking to accelerate the use of alternative energy powertrain and improve the efficiency of the transport system by providing strong incentives for innovation. As a result, by the Directive on the Promotion of Clean and Energy Efficient Road Transport Vehicles (DIRECTIVE 2009/33/EC), financial incentives have been allocated to stimulate to the development of a low-emission car market within the Union (European Commission, 2009a; European Commission, 2016). Together with President Juncker's Investment Plan for Europe and the European Fund for Strategic Investment, the EU Member States are provided not only with a toolbox to design their strategies for low-emission mobility, but also with the resources to achieve a zero-emission transport sector (European Commission, 2018a; European Commission, 2018b). Furthermore, under the European Structural and Investment Fund, 70 billion euros are allocated for transport, from which 39 billion for supporting the transition to low-emission mobility, including 12 billion for low-carbon and sustainable urban mobility projects (European Commission, 2018; European Commission, 2016b). The R&D and low-carbon mobility projects are financed by the programme Horizon 2020, which provides 6.4 billion euros (European Commission, 2016f).

Thus, by adopting different legislative tools and incentives, all EU Member States have officially started the fight with climate change and air pollution from road transportation. In the next section I assess the current progress made in the EU.

2.3. The outcomes of the EU's efforts towards GHG reduction in the transport sector

In critical moments even the very powerful have need of the weakest.

Aesop

— The Lion and the Mouse

The European initiatives towards the mitigation of climate change and air pollution resulted in 25% decrease of GHG emissions compared to GHG levels from 1990 (European Environment Agency, 2018).

This means that by 2016, the EU successfully achieved the 20% GHG reduction target, adopted in the 2020 Climate and Energy Package (European Commission, 2014). Some of most significant decreases in emissions are observed for CO, NOx, NMVOC and SO2, which are reported to indirectly influence climate change (European Environmental Agency, 2018). In particular, CO, NOx and NMVOC are precursors for ozone, which on its turn is considered a GHG. Another air pollutant - sulphur, is recognised as the main contributor to microscopic particles (PM) which play an important role in air pollution and at the same time reflect sunlight back into space and contribute to climate change. As shown in Table 3, the largest GHG reduction between 1990 and 2016 was in SO_2 (89%), while CO, NMVOC and NOx reduced by 66%, 58% and 57% respectively.

However, emitted GHGs from the road transport sector alone did not follow the same trend. On the contrary, they increased by 18% for the same time period (European Environment Agency, 2018). A key factor was the 15% increase in GHG emissions from passenger cars

Table 3. Aggregate indirect GHGs and SO_2 emissions in the EU between 1990-2016*. Source: European Environment Agency, 2017*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
NO_x	17 960	15 430	13 398	12 286	11 950	11 635	10 747	9 872	9 683	9 293	8 974	8 562	8 217	8 060	7 781
CO	63 317	51 556	40 089	31 629	30 326	30 406	28 524	25 980	26 603	24 216	24 384	23 198	21 481	21 650	21 417
NMVOC	16 981	13 818	11 445	9 607	9 387	9 031	8 658	8 096	8 102	7 703	7 562	7 390	7 131	7 142	7 105
SO_2	24 605	15 789	9 585	7 373	7 144	6 786	5 409	4 599	4 345	4 213	3 944	3 533	3 271	3 175	2 730

and the 14% increase of the number of cars in the period 2013-2016. (European Environment Agency, 2018; European Commission, 2018). However, due to the European initiatives, improved engine technologies and implemented EURO standards, the amount of emitted NO_2 and CH_4 significantly decreased (Figure 3).

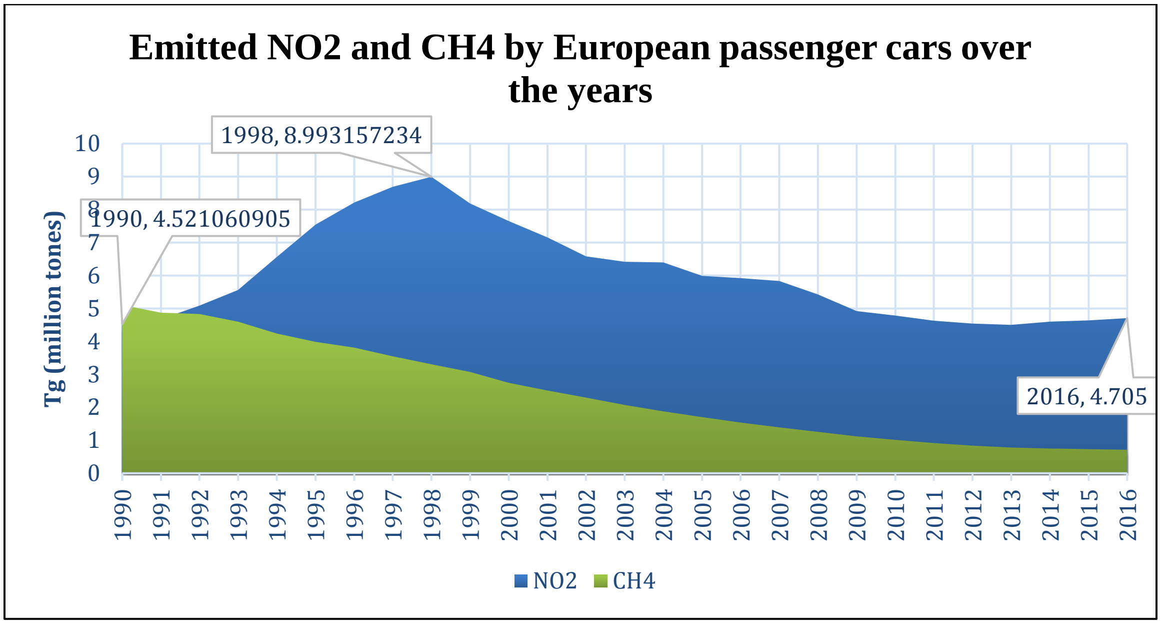

Figure 3. NO2 and CH4 emission trends in the EU. *Source: Eurostat, 2018 URL: http://ec.europa.eu/eurostat/web/transport/data/database*

Furthermore, in effect of the successful implementation of Directive 2003/30/EC and Directive 2009/30/EC, promoting the use of biofuels and other renewable fuels, combustion of biofuels has increased from 41TJ to 553 667 TJ in the EU (European Environmental Agency, 2018; European Commission, 2009a; European Commission, 2003). The increased use of liquid biofuels helped Estonia, Slovakia and Sweden to cut their GHG from the transport sector and to achieve lower GHS levels compared to those in 1990 (European Environment Agency, 2018a).

After considering these outcomes, it can be concluded that the EU has successfully achieved some of its targets but is still far from accomplishing the "zero-emission transport sector".

The reason for this partial success lies in the very nature of the European Union. As a political and economic union, the EU achieves progress at a pace defined by all its members. To put it differently, if we assume that the EU is a chain, then it would not be stronger than its weakest link. Thus, when the EU Commission adopts new regulations and directives, it should take in consideration that the Union can progress only with the speed of its “slowest” member. When it comes to economic development of a political union, the weakest links are the countries with the least contribution to economy. Thus, the role of the weakest link in the development of innovative transport initiatives can also be ascribed to the poorest and least developed country.

With this in mind, in the next chapter of this study, I investigate the legal initiatives in the least developed and poorest country in the EU: Bulgaria. This is the Member State with the lowest Human Development Index and lowest GDP per capita in the EU (Human Development Report, 2016; European Commission, 2018a). The European Environment Agency (EEA) report shows that although Bulgaria has ratified many of the EU directives, GHG emissions from the transport sector have undergone a 29.4% increase between 1990 and 2016, instead of reduction (European Environment Agency, 2018). To further examine Bulgarian contribution in the fight with climate change and air pollution, I conduct a research on GHG emissions and PM in the country.

3. The Bulgarian case

3.1. Geographic, political and economic overview of Bulgaria

The Republic of Bulgaria is a unitary state with capital city Sofia and is located in south-eastern Europe (Figure 4) (National Assembly of the Republic of Bulgaria, 2007). Due to its strategic position on the Balkan peninsula, Bulgaria connects the East and the West and is one of the gateways to Europe and the EU (Figure 6). Although Bulgaria's territory is relatively small compared to its neighbours', a total of five major European transport corridors cross the country (Figure 5) (Association of the Bulgarian enterprises of international road transport and the roads, 2018). This fact makes Bulgaria an important player in the geopolitics of both the Eastern and the Western world. Hence, in 2004, Bulgaria became a Member State of the North Atlantic Treaty Organization (NATO) and in 2007 joined the European Union (NATO, 2004; European Union, 2007).

Figure 4. Political map of the Balkan peninsula. Source*: Nations Online, URL: http://www.nationsonline.org/oneworld/map/Balkan-Peninsula-Map.htm*

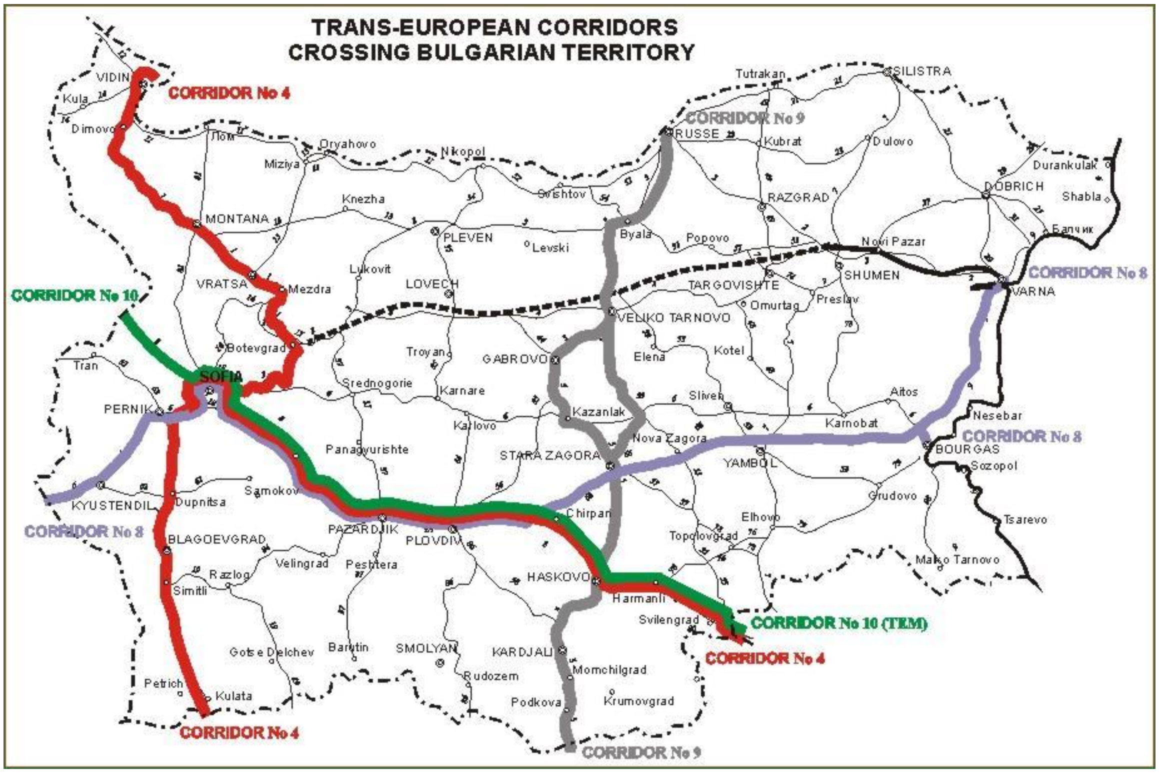

Figure 5. Trans-European corridors crossing Bulgaria. *Source: Association of the Bulgarian enterprises of international road transport and the roads, 2018*

Even so, Bulgarian economy is considered quite modest and the country is characterised as developing by the International Monetary Fund (International Monetary Fund, 2017). Bulgaria's Human Development Index ranks it 56th out of 190 countries for 2015 (United Nations Development Programme, 2016). In addition, with a population just above 7 million, Bulgaria is the poorest (by GDP per capita) and the least developed country in the EU (National Statistical Institute, 2018; International Monetary Fund, 2018; Eurostat, 2018a). Another statistic indicates that 38.9% of Bulgarians are at risk of poverty or social exclusion, while the average rate for the EU is 23.5% (Eurostat, 2017).

As a full Member State of the EU, Bulgaria is required to keep pace with all other EU countries and has agreed to implement all EU policies and measures in the process of constructing an environmentally friendly European economy (European Union, 2018a). However, the country is still struggling to implement all European regulations and policies due to financial and legislative limitations. Furthermore, as the least developed country in the Union, Bulgaria suffers the most from the adverse effects of climate change and air pollution (Munawar, 2015).

In the next sections, I examine the significance of air pollution and climate change for both the Bulgarian population and economy and investigate all legal initiatives the Bulgarian state has taken over the years.

3.1.1. The effects of climate change and air pollution in Bulgaria

A study on the Cost of Air pollution conducted by the World Bank, estimated that Bulgaria has the highest rate of premature mortality due to air pollution in Europe - 7,297 deaths in 2013 (World Bank, 2016; Health and Environment Alliance, 2014). Moreover, a more recent study showed that Bulgaria has the highest premature death rate attributable to household air pollution and ambient air pollution in Europe (174 per 100 000 citizens) (Figure 6) (Institute for Health and Metrics, 2016). These studies illustrate the significant negative effects of air pollution on the health of Bulgarian citizens. In addition, diseases caused by polluted air negatively impact the country's productivity. The estimated total welfare losses due to air pollution in Bulgaria in 2013 were $10 299 million or 8.85% of the Bulgarian GDP (World Bank, 2016). In addition, from 1999 to 2016, severe floods reinforced by climate change took 45 victims and generated hundred thousand dollars of material damages (National Statistical Institute, 2017a; Capital, 2017).

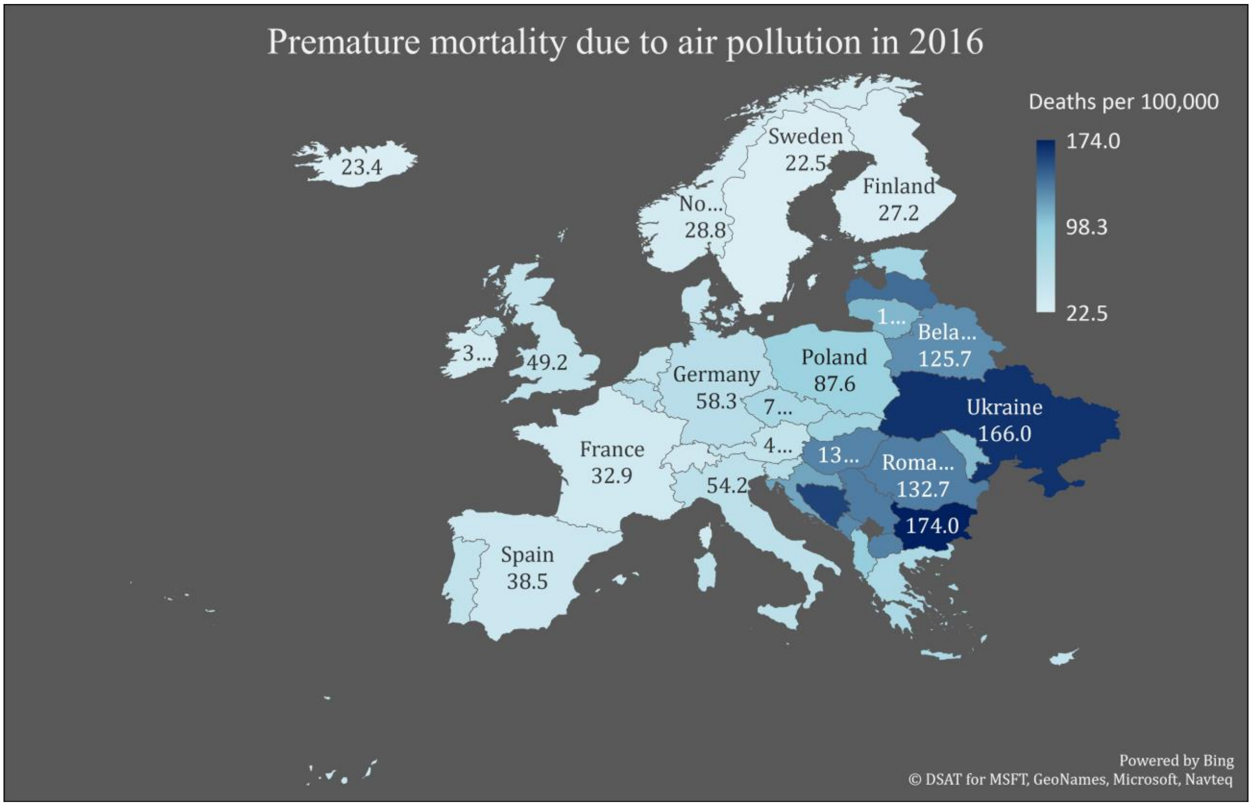

Figure 6. Premature mortality due to air pollution in 2016*. Age-standardized death rate attributable to household air pollution and ambient air pollution (per 100,000 population); Source: Institute of Health Metrics, 2016; URL: http://www.healthdata.org/infographic/global-burden-air-pollution*

Another aspect of the economic burden of climate change is the shortened winter season due to rising temperatures, which affects the development of winter tourism (Ministry of Environment and Water of the Republic of Bulgaria, 2018). In the 1988-2018 period, the average annual temperature has risen by 0.8^{o} C compared to the average annual temperature from 1961-1990 (Ministry of Environment and Water of the Republic of Bulgaria, 2018; Raychev and Dimitrova, 2016; Nozharov, 2017). A recently conducted simulation by the Department of Weather Forecasts, which is part of the National Institute of Meteorology and Hydrology of the Republic of Bulgaria, has shown that if the pollution tendencies and GHG emissions remain the same, average temperatures in the "near future" (2021-2050) and "distant future" (after 2050) will increase by 1.5-2^{o}C and 2.5-3.5^{o}C respectively compared to the current referral period (1961-1990) (Ministry of Environment and Water of the Republic of Bulgaria, 2018). Thus, if nothing changes in the near future, the adverse effects will continue to resonate on Bulgaria and its economy. With this in mind, Bulgarian officials have started the process of fighting climate change and air pollution.

3.2. Bulgarian legislation framework towards air pollution

After joining the European Union in 2007, Bulgaria was faced with challenging responsibilities and significant expectations to improve the country's standards of living. The EU provided guidance on areas which needed improvement as part of the Lisbon Agenda, which introduced eco-innovations, such as renewable energy technology and new vehicle fuels (Ungureanu and Marcu, 2006). Moreover, the EU adopted Directive 2008/50/EC, which set the European standards for ambient air quality: 20 μg/m3 $PM_{2.5}$ average annual concentrations in urban areas by 2015, which must be achieved by every Member State (European Commission, 2008). Although the Bulgarian government ratified this EU decision in 2010 (Ministry of Environment and Water of the Republic of Bulgaria, 2010), Bulgaria has never achieved its objective. The annual urban air pollution in Bulgaria in 2014 is found to be over 30 μg/m3 PM. This makes Bulgaria one of the most polluted Balkan countries and the most polluted country in the EU (Figure 7) (Health in Bulgaria, 2014). Even though in 2017 the country was found guilty by the EU Court for persistently violating EU norms for particulate matter, according to Greenpeace Bulgaria, the Bulgarian government still lacks political effort towards resolving this issue (Alexe, 2017; news.bg, 2017). To investigate the source of the air deterioration in Bulgaria, I examine the sources of emitted GHGs and discuss the Bulgarian climate change initiatives in the next sections.

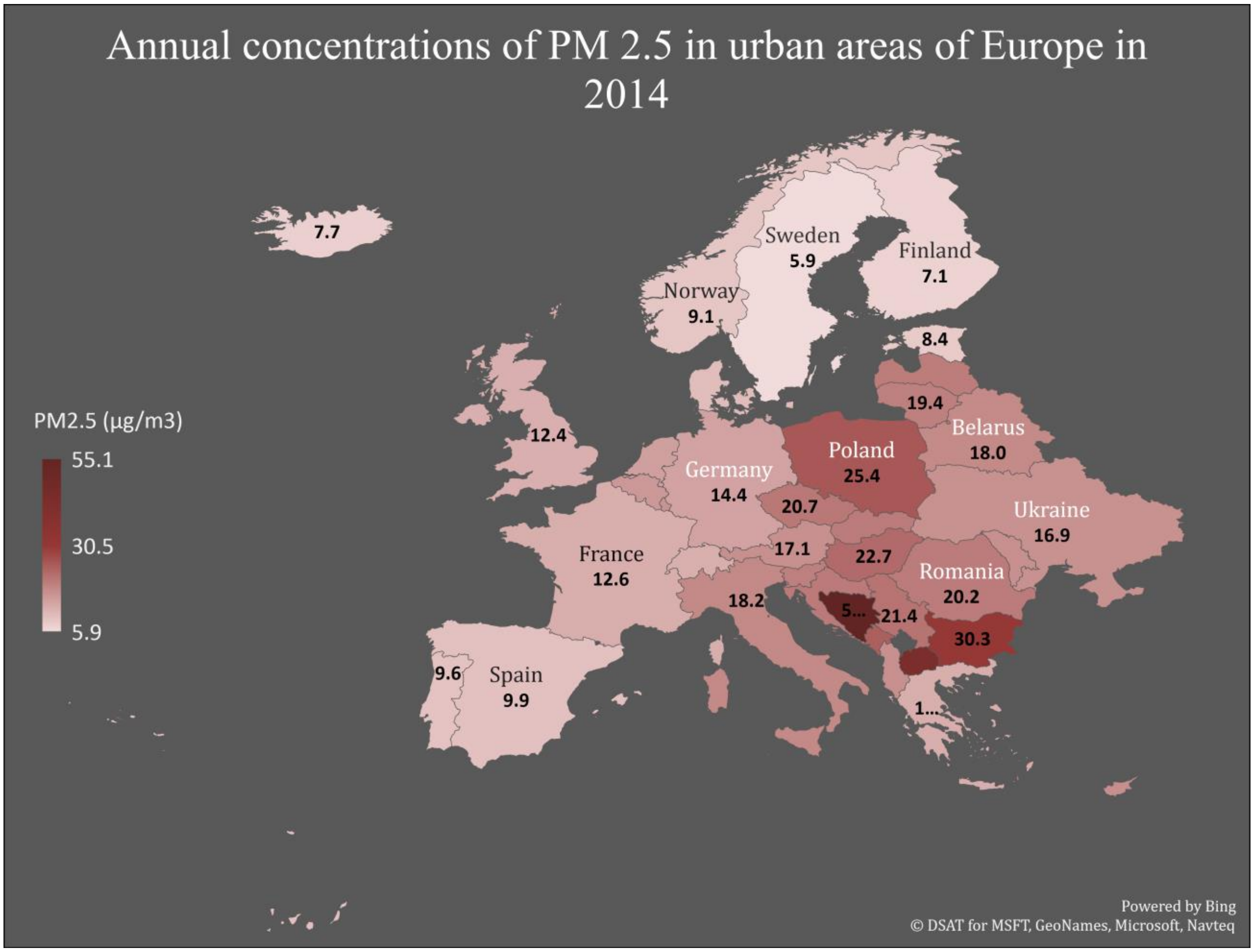

Figure 7. Annual concentration of PM 2.5 in urban areas of Europe*. The map is generated using data from the World Health Organization, 2014, URL: http://apps.who.int/gho/data/node.main.152?lang=en*

3.3. International and Bulgarian legislations focused on the fight with climate change

In order to help mitigate climate change and acknowledge the need of international partnership, the Bulgarian government signed the United Nations Framework Convention on Climate Change (UNFCCC) in Rio de Janeiro in June 1992 (Environment and ecology, 2018) which was ratified by the government in 1995 (Ministry of Environment and Water of the Republic of Bulgaria, 2018). By 2000, the government embraced and successfully achieved the UNFCCC target to reduce greenhouse gas emissions to their levels from 1990 (Ministry of Environment and Water, 2018). Furthermore, Bulgarian officials adopted and ratified the Kyoto Protocol from December 1997 and Decision 406/2009/EC of the European Commission (European Commission, 2009; United Nations Framework Convention on Climate Change, 2018e). With the above-mentioned EU legislations, Bulgaria took the commitment to reduce its national greenhouse gas emissions by 20% compared to their levels in 2005. In particular, the Bulgarian government has committed to promote and achieve 10% share of biofuels in Transport sector by 2020 (Ministry of transport information technology and communications of the Republic of Bulgaria, 2017). To reach this goal, Bulgarian legislators have adopted several strategies illustrated in 4 priority axes (Figure 8) (Appendix 1, 2) (United Nations Seventh National Communication on Climate Change, 2018). The adopted laws included measures, classified according to their effect on GHG emissions reduction, with direct measures having a measurable effect and indirect measures – unmeasurable. Although almost all of the embraced regulations with direct impact on GHG emissions were implemented in the last years, only one of the measures with indirect effect was applied (Table 4 and 5). Thus, we could conclude that the Bulgarian government is falling behind in the implementation of measures with indirect effect on GHG emission in the Transport sector.

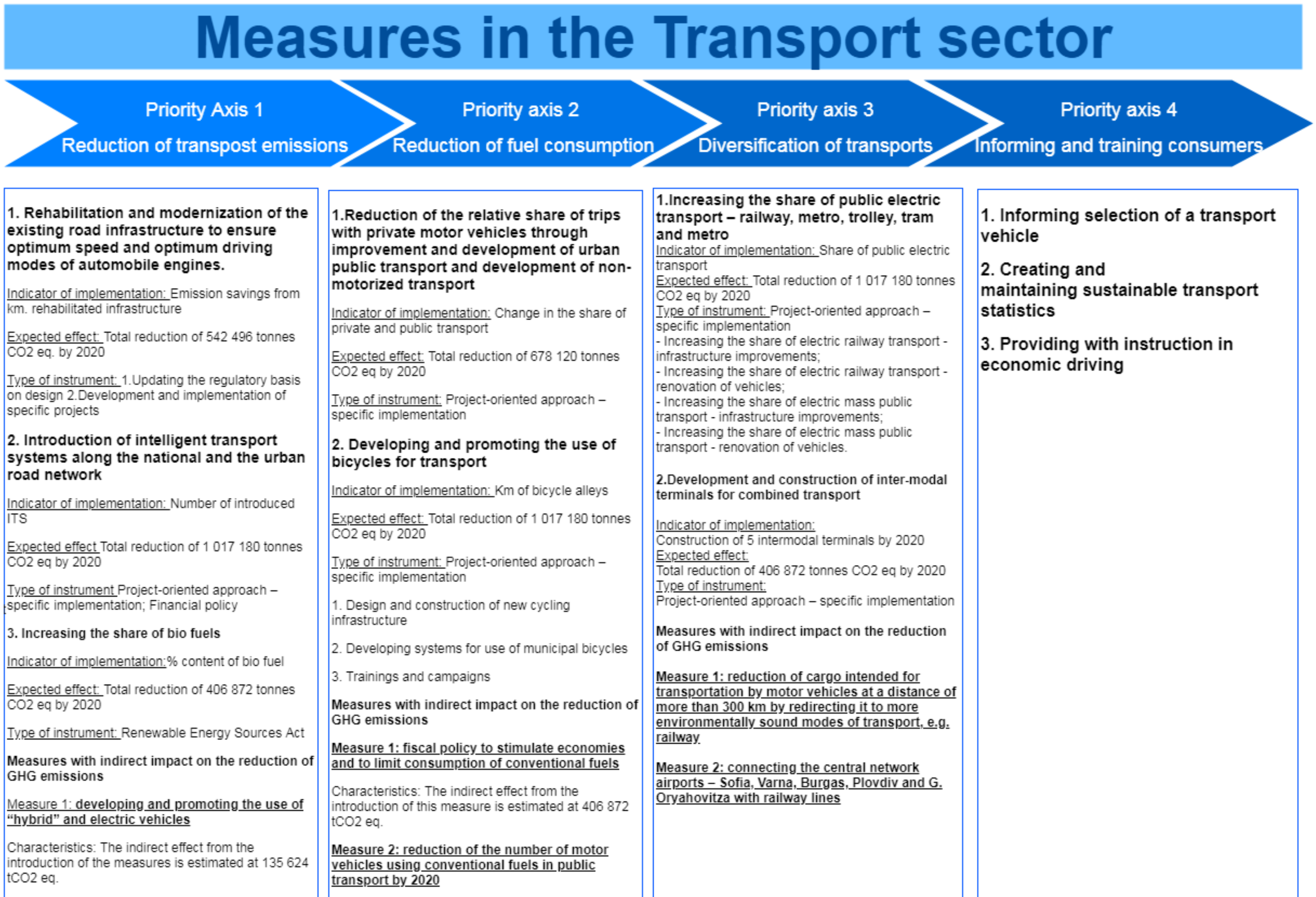

Figure 8. Measures in the Transport sector in Bulgaria. *Source: Seventh National Communication on Climate Change, UNFCCC, 2018*

Name of mitigation action	GHG (s) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO2 eq)		
								2020	2025	2030
Rehabilitation and modernization of the existing road infrastructure to ensure optimum speed and optimum driving modes of automobile engines	CO2	Improved transport infrastructure	Economic	Adopted	For implementation of the measure have been realized: Projects funded under the Operational Programme Transport - building lots of highways Trakia, Hemus, Maritsa - 15 sites with total length 318 km. Projects funded under the Operational Programme Regional Development - 22 sites: newly constructed or rehabilitated road infrastructure (roads II and type III) with a total length of 349.5 km.	2014	MF, Ministry of Transport, Information Technology and Communications (MTITC), MRDPW, Road Infrastructure Agency	80	60	70
Introduction of intelligent transport systems along the national and the urban road network	CO2	Intelligent transport systems and telematic solutions help improve road safety, promote the efficiency of the used existing infrastructure and contribute to the reduction of environmental pollution through control over traffic flows and management of traffic volume.	Fiscal, Regulatory, Economic	Implemented	Intelligent Transport Systems (ITS) encompass a wide range of technical solutions designed to improve transport by improving mobility and increasing the safety of road traffic. Telematics (a combination of telecommunications and informatics) uses advanced technologies to meet transport needs. Intelligent transport systems and telematic solutions help improve road safety, promote the efficiency of the used existing infrastructure and contribute to the reduction of environmental pollution through control over traffic flows and management of traffic volume. The intelligent transport systems in urban settings can include integrated management of public transport charges, enhanced management of customer relationships, traffic forecasts, improved traffic management, traveler information and toll collection. These systems apply advanced technologies to collect more and better data, to make a precise analysis of these data and to link them through more effective networks. The result: more effective, more efficient and better oriented towards citizens on the move services.	2014	MTITC	170	170	170
Increasing the share of biofuels	CO2	The most promising projects in Bulgaria are the projects for production of ethanol and biodiesel.	Regulatory	Implemented	Biofuels are fuels produced from biomass and used in transport. They diversify the energy mix and reduce the dependence on fossil fuels. The main types of biofuels are bioethanol, biodiesel, biogas, synthetic biofuels, bio-hydrogen, pure vegetable oils. The most promising projects in Bulgaria are the projects for production of ethanol and biodiesel. The consumption of biodiesel in Bulgaria in 2010 amounted to 38 911.13 tonnes. In the previous two years these amounts were respectively 4260 t and 6566 t. The Renewable Energy Sources Act (Art. 47(1)) introduces stages for the introduction of certain percentages of biodiesel and bioethanol content in the relevant fuel, as well as requirements to the types of biofuels and sustainability criteria which they must meet.	2012	ME, SEDA, MOEW	101	101	101
Reducing the share of trips by private motor	CO2	Improving the urban public transport and non-motorized transport	Economic, Planning, Regulatory	Implemented	Reducing the share of trips by private motor vehicles by improving the urban public transport and non-motorized transport development. Project-oriented approach – specific implementation	2012	MRDPW	75	75	75

Table 4. A review of policies and measures with direct effect on the reduction *of GHG emiss**ions aggregate**d by Transport sector in Bulgaria. Source: Seventh communication on climate change, UNFCCC, 2018*

Development and promotion of cycling	CO_2	Promotion of cycling	Education, Information, Economic	Implemented	Project-oriented approach – specific implementation 1. Design and construction of new cycling infrastructure 2. Developing systems for use of municipal bicycles Trainings and campaigns	2013	MF; MRDPW; MEW; Municipal authorities	120	130	130
Increasing the share of public electrical transport - railways, trolley, tram, metro	CO_2	Modal shift to public transport or non-motorized transport	Economic Planning Voluntary/negotiated agreement	Implemented	• Increasing the share of public electrical transport. • Increasing the share of electric railway transport - infrastructure improvements; • Increasing the share of electric railway transport - renovation of vehicles; • Increasing the share of electric mass public transport - infrastructure improvements; • Increasing the share of electric mass public transport - renovation of vehicles. Creasing the share of public electrical transport. • Increasing the share of electric railway transport - infrastructure improvements; • Increasing the share of electric railway transport - renovation of vehicles; • Increasing the share of electric mass public transport - infrastructure improvements; Increasing the share of electric mass public transport - renovation of vehicles. OP "Transport" 2007-2013, Priority axis 1 "Development of railway infrastructure along the major national and Pan-European transport axes" provides for: modernization of the railway line Sofia – Plovdiv; reconstruction and electrification of railway line Svilengrad - Turkish border; renewal of sections of railway infrastructure on the railway line Plovdiv - Burgas (along Trans-European Transport Network); modernization of railway line Sofia - Dragoman (along TEN-T); design of the construction of railway line Vidin - Sofia. Given the crucial importance of the central section of Line 2, it is currently a separate Sofia Metro Expansion Project which is included in Operational Programme Transport, with financing by the European Regional Development Fund, with national and local co-financing. This stretch covers the section: "Road junction Nadezhda - Central Railway Station – Sv. Nedelya Square - Cherny Vrah Blvd." International tender procedures were conducted in 2007-2008 for selection of contractors of this project and the contracts entered into force in December 2008 with a time limit for completion - autumn 2012. The expected effect of the implementation of such measures is reduction of hazardous and greenhouse gases – 90 500 tonnes CO_2 per year.	2014	MF; MTITC; MRDPW; National Railway Infrastructure Company, municipal governments	127	127	127

Table 4. A review of policies and measures with direct effect on the reduction of GHG emissions aggregated by Transport sector in Bulgaria. *Source: Seventh communication on climate change, UNFCCC, 2018*

Development and construction of intermodal terminals for combined transport	CO_2	Improved transport infrastructure	Economic	Implemented	The measure aims to achieve a two-sided effect, consisting, on one side, in increase of the degree of utilization of more environmentally friendly modes of transport and, on the other side, in the creation of favorable conditions for increasing the added value of transport activity with overall reduction of transport costs per unit of GDP. The expected results of its implementation are: • more efficient use of rail and water transport; • development of transport schemes and technologies meeting contemporary requirements with regard to environment and climate; • increased coordination and integration of different transport modes; • lower cost for passenger and cargo transport; • integration of the Bulgarian transport system with that of the EU and increasing its competitiveness.	2014	MF; MTITC; National Railway Infrastructure Company	58	58	58

Table 4. A review of policies and measures with direct effect on the reduction of GHG emissions aggregated by Transport sector in Bulgaria. *Source: Seventh communication on climate change, UNFCCC, 2018*

Table 5. Review of policies and measures with indirect effect on the reduction of GHG emissions aggregated by the Transport sector in Bulgaria. *Source: Ordinance of the Council of Ministers of the Republic of Bulgaria, No. 76 from 12 April 2016. URL: http://dv.parliament.bg/DVWeb/showMaterialDV.jsp;jsessionid=AB4413168D544B872C5AEDE3DCC36EF5?idMat=102745*

Name of mitigation action	GHG affected	Objective and/or activity affected	Type of instrument	Status of implementation	Start year of implementation
Exemption of environmental product fee for electric vehicles	CO_2	Promotion of EVs	Economic	Implemented	2016

3.4 Greenhouse gas emission trends in Bulgaria

According to the international agreements mentioned above, the Bulgarian state must publish an annual report on all man-made GHG emissions, nitrous oxide (N_2O), the so-called F-gases (hydrofluorocarbons, perfluorocarbons, nitrogen trifluoride (NF_3) and sulphur hexafluoride (SF_6), carbon dioxide (CO_2), and methane (CH_4) (Ministry of Environment and Water of the Republic of Bulgaria, 2018). Each gas is measured with individual global warming potential (GWP), and all of them are integrated into a single indicator expressed in units of CO_2 equivalents (Ministry of Environment and Water of the Republic of Bulgaria, 2018). The report focuses on five sectors: Energy, Industrial processes and product use, Agriculture, Land Use, Land-Use change and Forestry and Waste (Ministry of Environment and Water of the Republic of Bulgaria, 2018). In 2016, Bulgarian GHG emissions, including those from international aviation, equalled about 59

701 572 Mg tonnes CO_2, which makes Bulgarian GHG contribution moderate compared to other EU Member States (Figure 9).

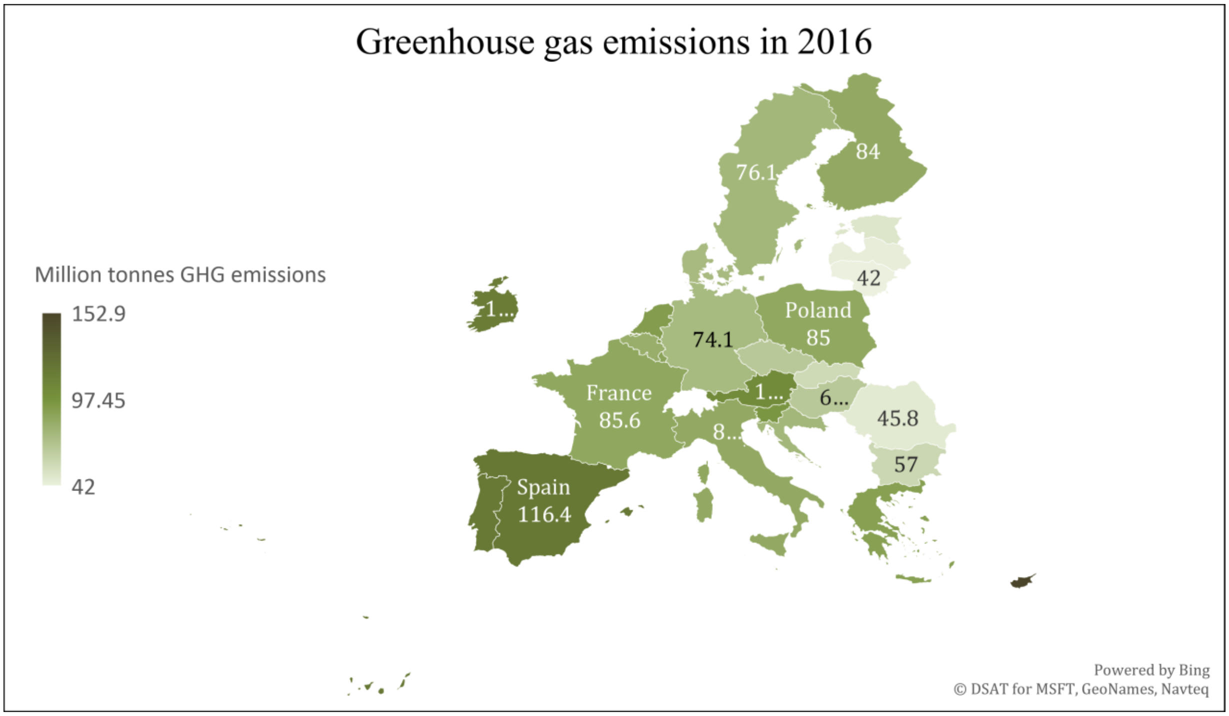

Figure 9. Greenhouse gas emissions in Europe in 2016. *Source: European Environment Agency, 2018*

The amount of GHG emissions in Bulgaria marked a 49.41% decrease in 2016 compared to GHG levels from 1988 and 4.4% decrease compared to emissions from 2015 (European Environment Agency, 2018b) (Figure 10). The main factors behind this trend are the reduced population size, economic changes which occurred after 1989 and the shift from centrally-planned economy to market-based economy.

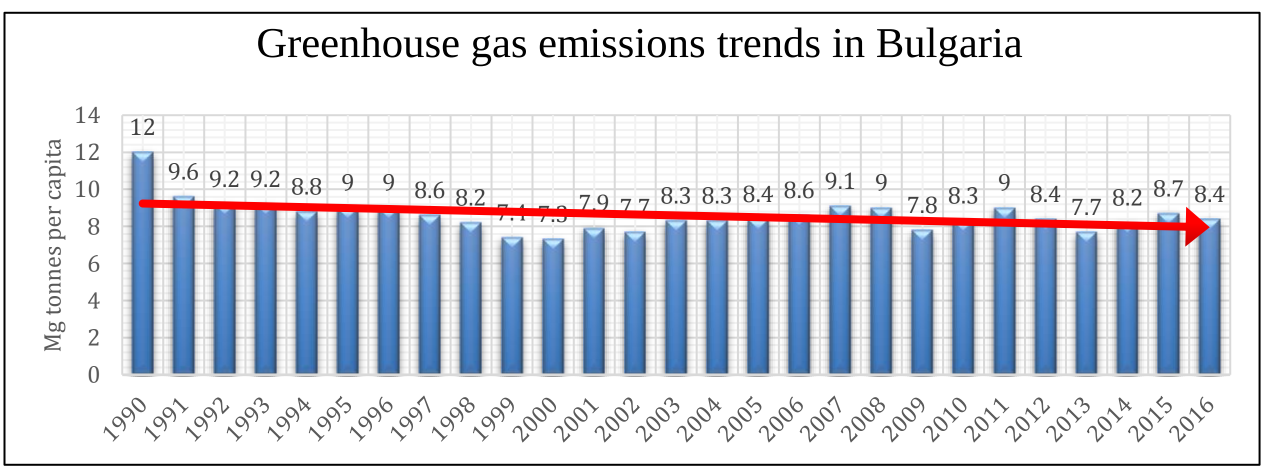

Figure 10. Greenhouse gas emissions trends in Bulgaria 1990-2016 per capita. *Source: European Environmental Agency(EEA), 2018,*

Between 1990 and 2016, the Bulgarian population decreased by 21% due to increased immigration (Ministry of Environment and Water of the Republic of Bulgaria, 2018; World Population Review, 2018). Political instability and destabilised economy have been the main reasons for this demographic crisis. Although Bulgaria was never a part of the USSR, the collapse of the Soviet Union affected the ruling communist party, resulting in the fall of its totalitarian leader Todor Zhivkov. After series of street protests, the Party was forced to give up its claim on power and conduct the first free elections in the country since 1931. With the adoption of the new constitution in July 1991, Bulgaria became a representative democracy with an elected President, a Prime Minister and a Cabinet. These political transformations were followed by changes in the economic structure, which caused a reduction in power production from thermal power stations and increase in nuclear and hydro power production (Ministry of Environment and Water of the Republic of Bulgaria, 2018).

Other reasons for the reduction of GHG emissions were the shift from energy-intensive enterprises to a service-oriented industry, the introduction of energy efficiency measures in residential areas and the transition from solid fuels to natural gas (Ministry of Environment and Water of the Republic of Bulgaria, 2018). However, despite the immense shrinkage of GHG emissions, the reduction of GHG emissions per capita for the same time period (1988(90)-2016) is only 30% (Figure 11) (Ministry of Environment and Water of the Republic of Bulgaria, 2018). Thus, GHG emissions per capita in Bulgaria remain higher (8.38Mg(tonnes)) than these of other Eastern European countries: Romania (5.75Mg (tonnes)), Macedonia (4.28 Mg(tonnes)), Serbia (5.28 Mg(tonnes)), Greece (8.79 Mg (tonnes)) and Hungary (6,32 Mg (tonnes)) (European Environment Agency, 2018a; Knoema, 2016; World Bank, 2014).

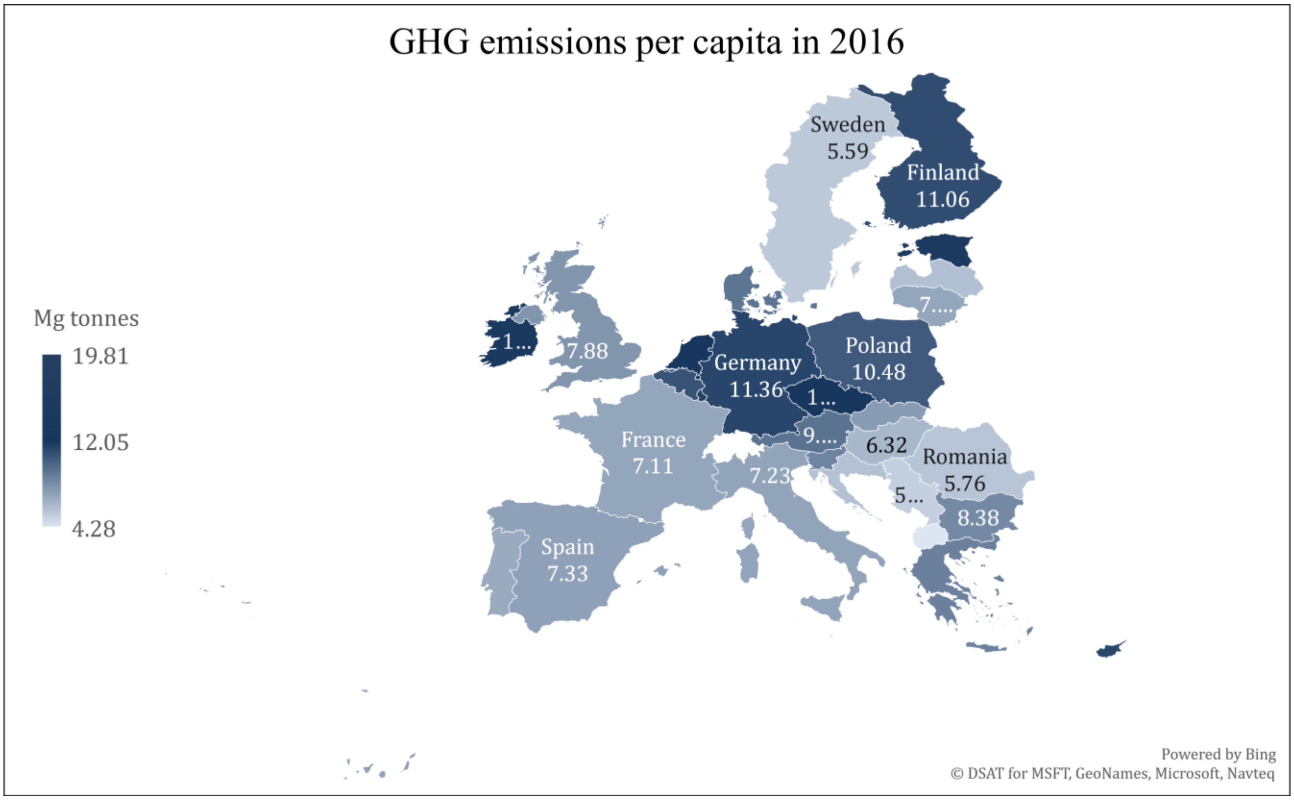

Figure 11. GHG emissions per capita in 2016. *Source: European Environment Agency, 2018; Knoema, 2016*

3.4.1. The greenhouse gas composition in Bulgaria

To understand the source of greenhouse gas emissions in Bulgaria, I investigate the composition of the annually aggregated GHGs in the country. The three most influential greenhouse gasses in Bulgaria are Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous oxide (N_2O). Despite the 49% decrease in CO_2 between 1988 and 2016, it still comprises a large proportion (72.6%) of total GHG emissions (Figure 12). The second most abundant constituent of GHG emissions are Methane (CH_4) emissions, followed by Nitrous Oxide (N_2O) emissions. In the last 20 years the concentrations of these gasses have decreased by 58% and 49% respectively due to technological development in waste collection and the diminution of the Agriculture sector (Ministry of Environment and Water of the Republic of Bulgaria, 2018; European Environment Agency, 2018b; Ministry of Transport, Information Technology and Communications of the Republic of Bulgaria, 2017). To investigate further the origins of these gases I examine all GHG emitted by sector in the next section.

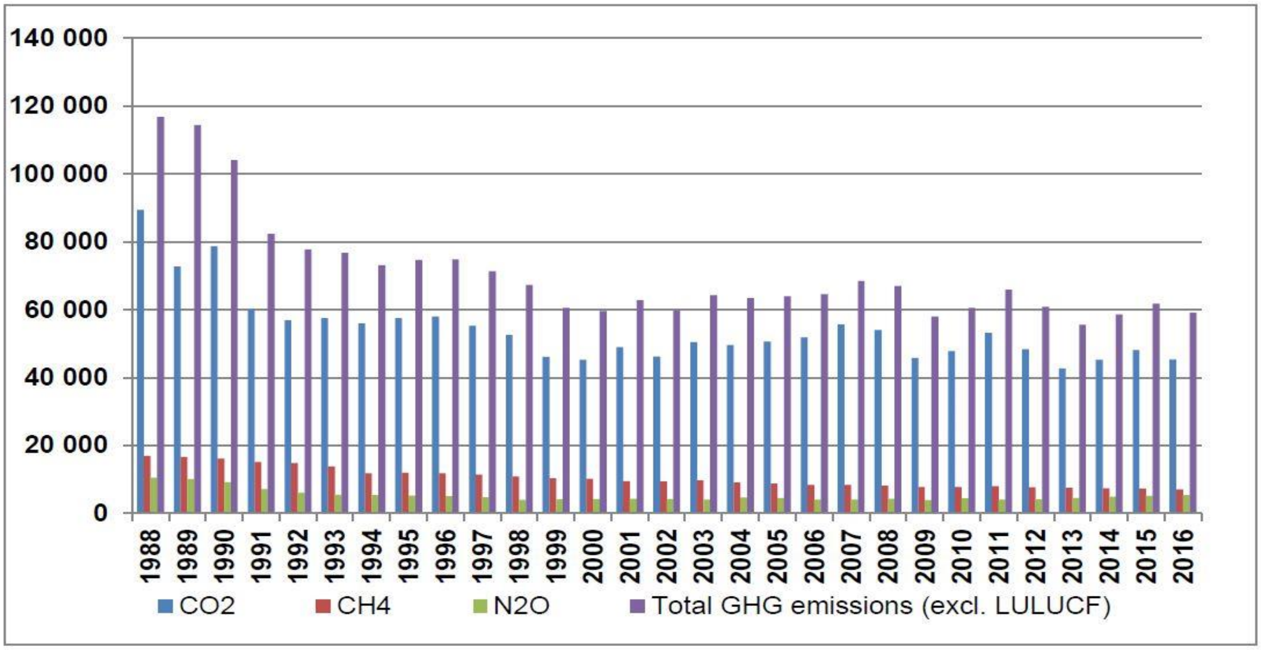

Figure 12. Total GHG emissions in Bulgaria in the period 1988-2016, measured in Gg CO2.
Source: Ministry of Environment and Water of the Republic of Bulgaria, 2018
**Note: LUCUCF- Land-Use Change and Forestry sector*

3.4.2. Greenhouse gas emissions by sector

In this section I analyse data gathered by the National Statistical Institute of the Republic of Bulgaria, the Bulgarian National Inventory Report and the National environmental protection report, which distinguish several sectors, found to be the main sources of GHGs: Energy, Industrial Processes and Product Use, Agriculture, Land Use, Land-Use Change and Forestry, Households, Services and Waste Management (Ministry of Environment and Water of the Republic of Bulgaria, 2018; Ministry of Environment and Water of the Republic of Bulgaria, 2018a; National Statistical Institute, 2018) For the purpose of this study, I focus on the primary source of GHGs: the Energy sector. In 2016, it generated about 72% of all emitted GHGs in Bulgaria (Figure 13). Despite the 47.9% shrinkage of the amount of emitted GHGs by this sector (Figure 14), it remains the most polluting one because it is mainly supported by combustion of solid fuels. Hence, the decrease in GHG emissions is not so much a consequence of an innovative initiative promoting alternative fuel use, but a result of the economic slowdown in the early 1990s, as the Bulgarian economy shifted from a centrally-planned system to a market-based system (Ministry of Environment and Water of the Republic of Bulgaria, 2018; Ministry of Transport, Information Technology and Communications of the Republic of Bulgaria, 2017). At the time, the demand for electricity, produced by thermal power stations has dropped significantly. The emissions from fuel combustion in the energy industries, the manufacturing industry and other sectors (agriculture, forestry, etc.) decreased by 35.7%, 83.4% and 72.3% respectively between 1988 and 2016 (European Environment Agency, 2018b).

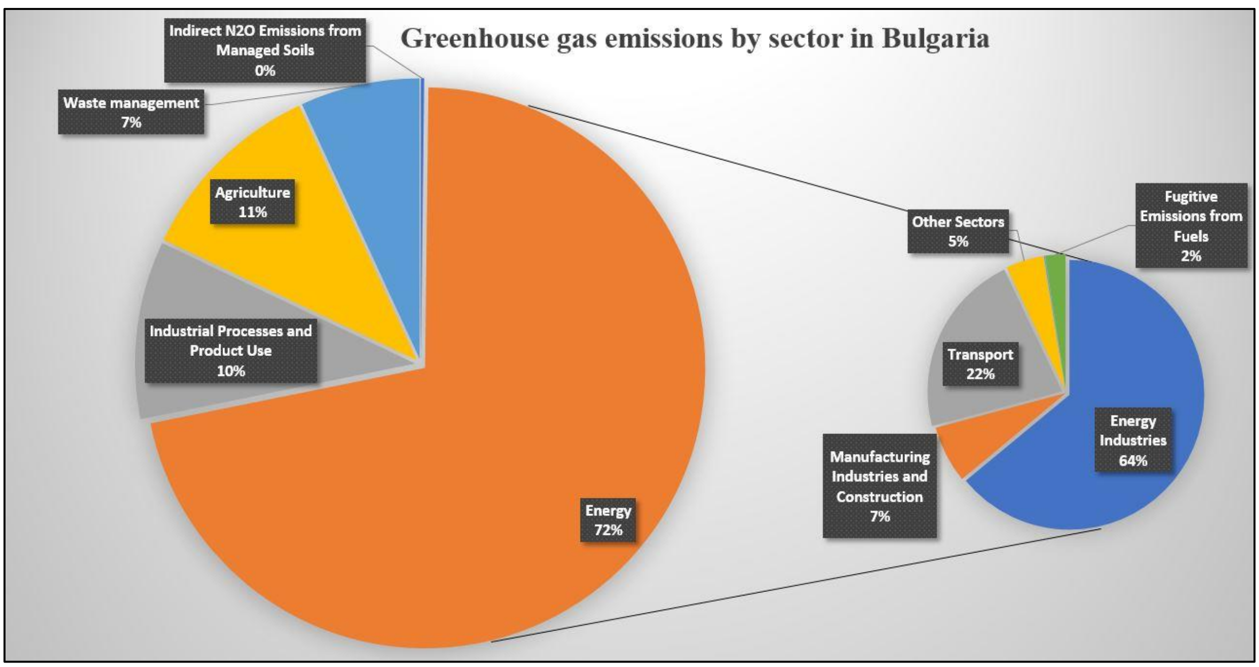

Figure 13. Greenhouse gas emissions by sector in 2016 in Bulgaria. *Source: European Environment Agency, 2018*

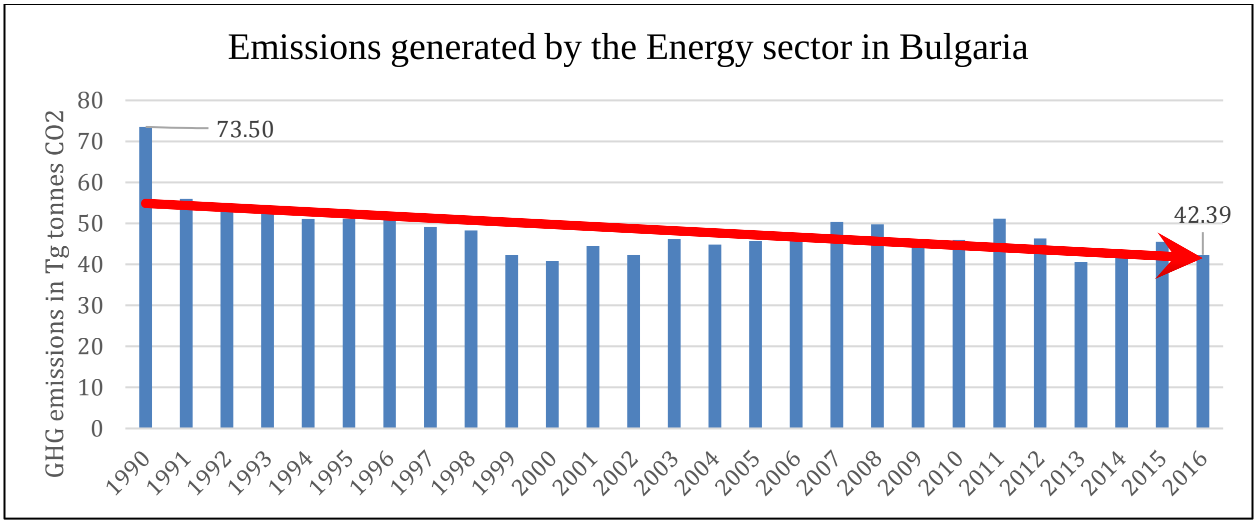

Figure 14. Trend of greenhouse gas emissions generated by the Energy sector in Bulgaria. *Source: European Environment Agency, 2018*

However, during this time period, the GHGs emitted by road transportation increased by about one third (29.42%) (Figure 15). Due to several political and economic crises in the country, a significant drop is observed after 1990 (Figure 15). The introduction of a currency board and numerous reforms in 1996 and 1997 led to an economic recovery, which resulted in a significant increase of GHG emissions (Figure 15). As illustrated in Figure 15, the forecast for GHGs aggregated by road transportation in Bulgaria is to continuously grow in the next few years. In the next section I explore the factors influencing this trend.

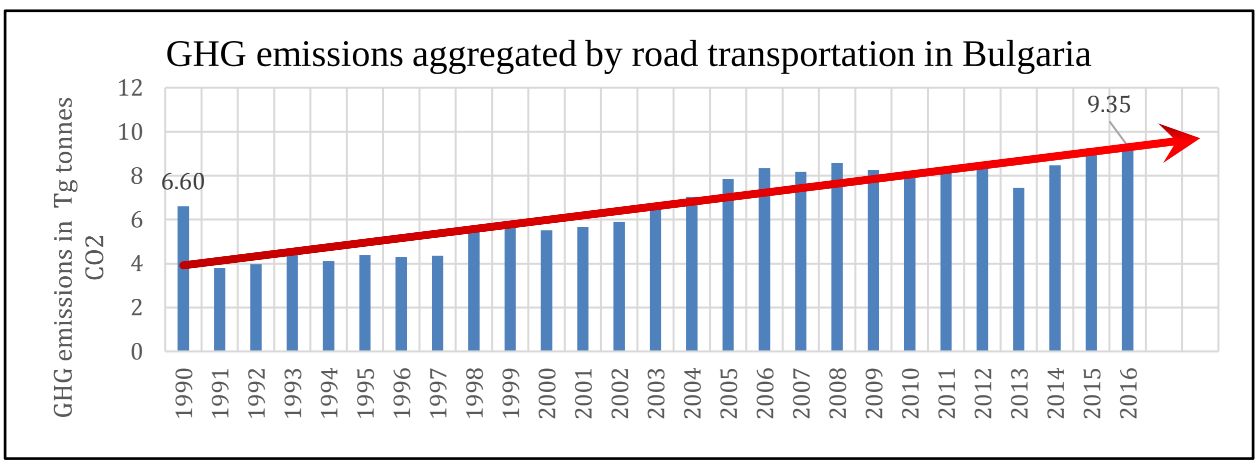

Figure 15. GHG emissions aggregated by the Transport sector in Bulgaria. *Source: European Environment Agency, 2018*

3.5. Main contributors to the emitted GHGs by the Bulgarian Transport sector

The Annual Bulgarian GHG Emission Inventory Report distinguishes several factors for GHG emissions in the road transportation sector (Ministry of Environment and Water, 2018). Figure 16 presents the main contributors to GHG emissions in this sector and demonstrates that passenger cars are the biggest contributor, as they are responsible for 63.23% of all GHG emissions produced by the Road Transportation sector (Figure 16).

Throughout the past years, the number of passenger cars in Bulgaria has doubled, leading to an almost 50% increase in car-related GHG emissions (Table 6 and Figure 17,). Thus, this has become one of the fastest growing aggregators if GHGs in the country.

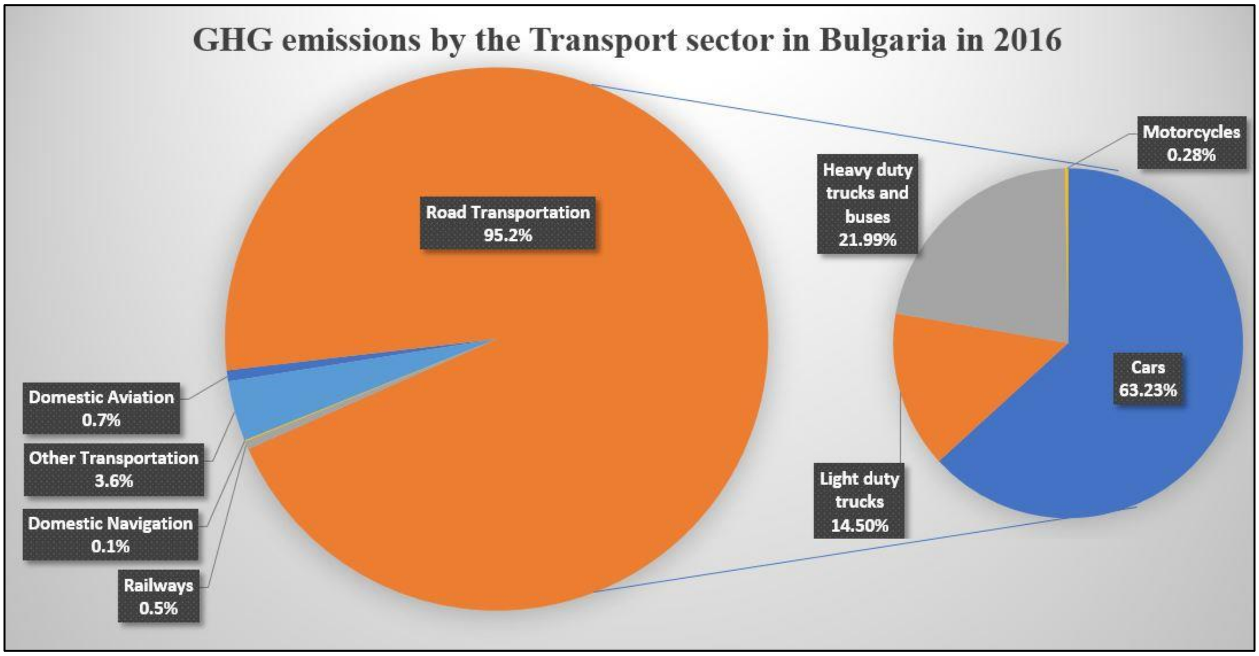

Figure 16. GHG emissions by the Transport sector in Bulgaria in 2016*. Source: European Environment Agency, 2018*

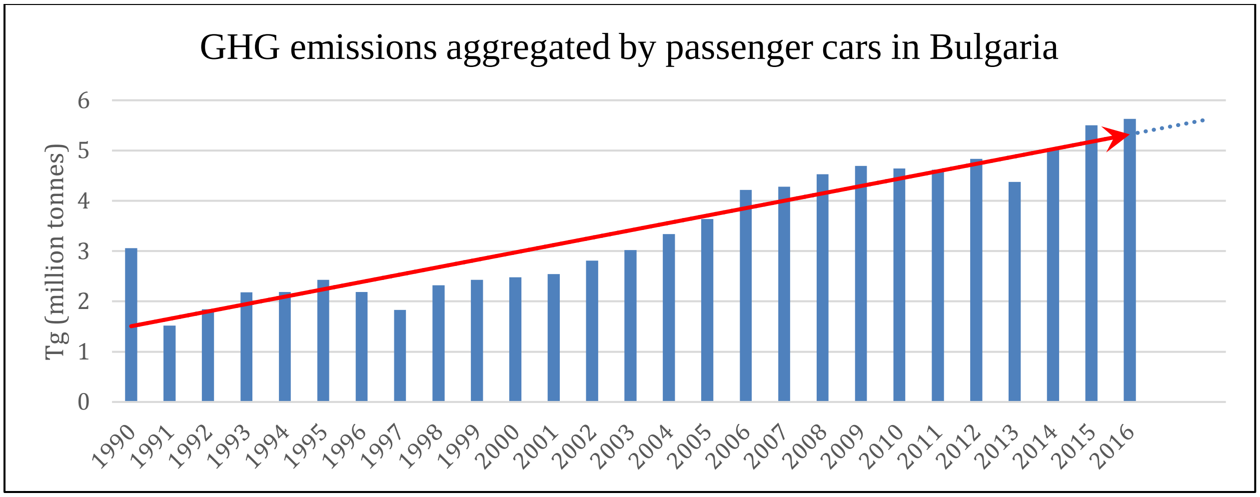

Figure 17. GHG emissions aggregated by passenger cars in Bulgaria. *Source EEA, 2018.*

Vehicle type	Passenger cars	LDV and HDV	Busses	Motor-cycles	Mopeds
1988	1 220 784	210 805	5 486	217 360	276 901
1990	1 317 437	227 782	7 468	225 533	281 270
1995	1 647 571	289 430	15 371	233 365	285 901
2000	1 992 748	326 204	17 290	236 327	286 047
2005	2 544 198	393 565	12 584	97 754	48 667
2010	2 602 461	368 195	20 458	70 394	54 983
2011	2 694 862	382 324	20 120	73 805	58 019
2012	2 806 814	402 648	20 040	77 972	61 840
2013	2 910 235	424 299	20 277	82 481	65 479
2014	3 013 863	449 458	20 685	88 035	68 982
2015	3 162 037	483 945	21 265	93 869	71 885
2016	3 237 493	496 038	21 302	99 806	74 690

Table 6. Vehicles by type and numbers in Bulgaria. *Source: Ministry of Environment and Water of the Republic of Bulgaria, 2018; Ministry of Interior of the Republic of Bulgaria, 2016*

3.5.1 Bulgarian car fleet structure

Even though Bulgaria has adopted all EU directives for passenger cars, implementation of the adopted measures is hindered by the fact that the country's car fleet is exceedingly aged. In 2016, about 86% of the Bulgarian car fleet was comprised of vehicles older than 10 years, of which 43% were older than 21 years and 28% between 16 and 20 years (Figure 18) (Ministry of Interior of the Republic of Bulgaria, 2018). In contrast, only 4% of cars were new (between 0 and 5-year-old) (Figure 18) (Ministry of Interior of the Republic of Bulgaria, 2018). Compared to other car fleets within the EU, it is estimated that the Bulgarians are driving the oldest cars in the Union (Automotive Association, 2017).

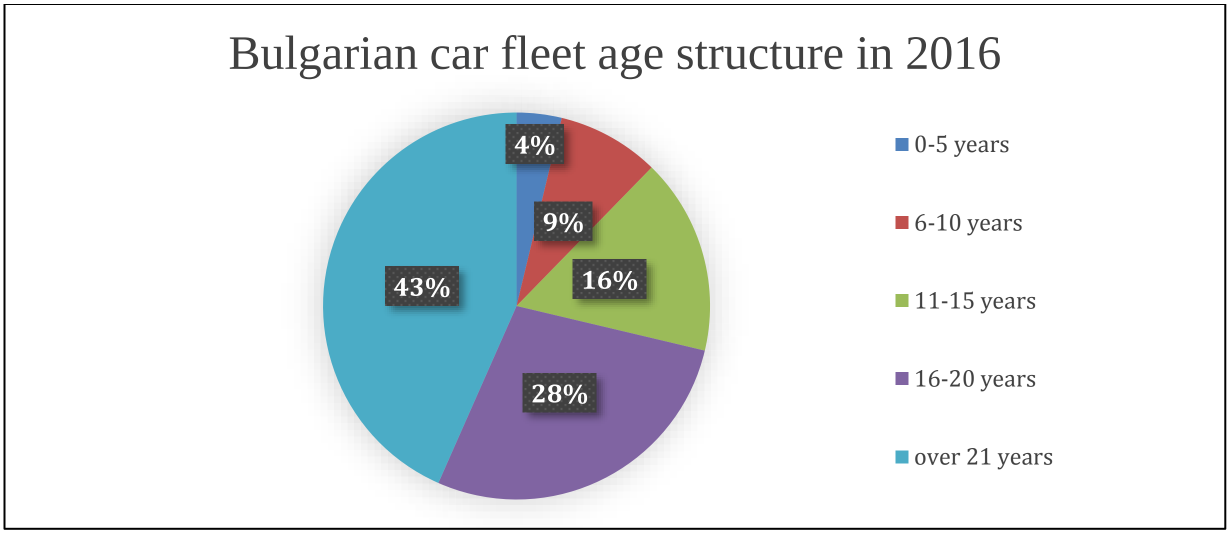

Figure 18. Bulgarian car fleet age structure in 2016. *Source: Ministry of Interior of the Republic of Bulgaria, 2018*

The advanced average age of the Bulgarian car fleet means that more vehicles have engines with the EURO 1,2 and 3 standards, which are less environmentally-friendly and emit comparatively more GHGs than new engines (Table 1 and 2) (Nanaki, 2016). In fact, as much as 33.4% of Bulgarian vehicles are without EURO standard and 22.4% are with EURO 1, which explains why the passenger cars are the biggest pollutant from the road transportation sector (Ministry of Environment and Water of the Republic of Bulgaria, 2018). Another important statistic is the number of new cars sold in Bulgaria; in 2016, they were only about 20,000, which is about 0.06% of the total car fleet (European Environment Agency, 2017). Thus, if purchasing of new cars continues with the same pace, the Bulgarian car fleet will be renovated in several decades.

However, the biggest challenge is not only to renew the car fleet, but also to reduce its dependence on liquid fuels. More than the half of the registered passenger cars in Bulgaria (>55%) are running on gasoline (Ministry of Interior of the Republic of Bulgaria, 2016). Hybrid and electric vehicles were the least numerous in 2016, as they comprised only 0.05% and 0.005% of all passenger cars in the country (Ministry of Interior of the Republic of Bulgaria, 2016). The Bulgarian low-emission vehicle share is also the lowest in the EU (European Environment Agency, 2018b). In effect, the average CO_2 emissions from new passenger cars in Bulgaria (125.8 gCO_2/km in 2016) remain higher than the average CO_2 emissions aggregated in the EU (119.5 g CO2/ km). Therefore, if Bulgarians continue to buy combustion engine vehicles, the GHG emission trend will continue to increase and contribute to air pollution and climate change.

In the third part of this research I focus on one of the measures, which can indirectly contribute to a reduction of GHG emissions and is not yet adopted by the Bulgarian government: the promotion of low-emission vehicles.

4. Interpretation of factors influencing the decision-making process of car buyers

In order to inform policymakers on the best policy and legal practices which could be adopted to stimulate the demand on low-emission vehicles, it is crucial to consider the factors underlying purchasing behaviour (Carreno and Welsch, 2009). For this reason, I acknowledge previous attempts to conceptualise individuals' future vehicle purchasing behaviour and apply a few theories and models to behaviour change.

4.1. Previous researches of consumer behaviour

Previous studies on the topic of purchasing behaviour, have mostly been focused on specific vehicle characteristics, such as fuel efficiency, maintenance costs, etc., or driver characteristics, such as education, age, sex, etc. (Train, 1986; Golob et al., 1997; Choo and Mokhtarian, 2004; Sprei and Wickelgren, 2011). It was found that psychological and situational factors significantly influence purchasing behaviour and could lead to a behaviour change (Kollmus and Agyeman, 2002; Steg 2003). Thus, when examining future policies related to behaviour change, models interpreting psychological and situational factors behind certain behaviours need to be considered. Such models are presented by Lane and Potter (2007) and Borthwick (2015). While Lane and Potter' model is focused on situational and psychological factors and produces a one-size-fits-all conceptualisation of vehicle purchasing decisions, Borthwick's behavioural model (2015) distinguishes several different society groups: "No-Greens", "Maybe Greens" and "Go-Greens". Furthermore, I take in consideration the researches of Knez, Jereb and Obrecht (2014), Zupan (2014) and Knez (2017) conducted on Slovenians' consumer behaviour.

4.2. Behaviour change models to interpret consumer behaviour

Behaviour change models have been widespread among the social and health sciences since the 1950's and their application has expanded throughout the years to education, criminology, international development and the transport sector (Borthwick, 2015). They are usually used to interpret specific behaviours and the factors which influence them (Darnton, 2008). Once these factors are recognized by policymakers, they can be used to interfere with consumer behaviour (Jackson, 2005). Linden (van der Linden, 2013) argues that for a successful intervention and change of any given behaviour, a detailed knowledge of the influencing factors is needed, because frequently the examined behaviour is a sophisticated symbiosis of unconsidered factors (Ajzen, 1991). Thus, it is important to not only focus on behavioural outcomes, but on the psychological and economic motivation of why a specific intervention has achieved success or not (Government Communication Network, 2009; Steg and Vlek, 2009). For this reason, I investigate psychological and economic motivations of Bulgarians to contribute to the fight with climate change through purchasing low-emission vehicles.

Another criticism to behaviour change models is that they fail to differentiate various audience groups and usually focus on the global population's behaviour (Borthwick, 2015). I recognise this limitation and build on the thesis that a cluster analysis could be applied to highlight the magnitude of constructs to every identified population group in any given society (Darnton, 2008).

4.3. Economic model of behaviour change

The economic model of behaviour change is often represented as the rational choice or expectancy-value model, which considers that individual's goals resonate with his preferences (Crouch, 1979). In particular, this model emphasizes on individual's decisions, which are thought to be taken on the account of the means that are needed in the process of achieving these ambitions, such as finance and time (Scott, 2000). Thus, by acknowledging the issue of scarcity, (Heath, 1976; Levi, 1997) every individual conducts a cost-benefit analysis (Simon, 1955; Coleman, 1973), seeking to acquire a positive balance of benefits over costs (Homans, 1961; Simon 1997). When it comes to buying a vehicle, rational decision-making model foresees that individuals will calculate all related losses and profits following this choice. Therefore, according to the economic model of behaviour change, the cost-benefit balance is essential to the deliberative choice of buying an environmentally-friendly vehicle.

Although this may be true, the main criticisms to the rational choice model are related to the difficulty of an individual to acquire the whole existing information related to a decision during the process of decision-making, which on its turn questions the applicability and value of this model (Simon, 1957). In the case of vehicle purchasing, lack of knowledge on fuel consumption and running costs often prevent individuals from quantifying the environmental impacts of their vehicle, making them incapable of calculating future benefits and costs (Kurani et al, 2007; Turrentine and Kurani, 2007).

4.4. Psychological model of decision making

Equally important in the process of decision-making are non-economic factors such as moral, social and altruistic behaviour (Jackson, 2005). A big part of deliberated decisions is based on heuristic and cognitive evaluation (Bettman et al, 1998; Kahneman, 2003).

The interpretation of an individual's willingness to undergo behaviour change through a psychological perspective is a complex task (Kollmuss and Agyeman, 2002). Because of the inconsistence in one's values, thoughts and actions, it is hard to predict how they might react to changes (Kurani and Turrentine, 2002; Darnton, 2008). After conducting a literature review, I found that to build my psychological model of behaviour change, I have set two main assumptions at the beginning:

- People are differently receptible and open to changes (Anable, 2005; Anable et al., 2006). These differences could be overcome through segmentation of society and designing policy interventions according to every segment's needs (Borthwick, 2015).
- The process of behaviour change is an incremental process, which requires many small steps to be taken in one direction (Bamberg et al., 2011; Bamberg, 2013).

Moreover, when it comes to policy actions, individual’s behaviour change might never be observed (Borthwick, 2015), however, indirect effects on behaviour such as changed perception and attitudes should be considered as successful first steps to the ultimate behaviour change (Carreno and Welsch, 2009).

III. Research methodology

5. 1 Research philosophy

After conducting a literature review of the challenges presented by climate change and air pollution, I compared different EU and Bulgarian policies to overcome them, as well as the outcomes they have produced. I identified road transport as a leading cause for air pollution in both the EU and Bulgaria and discovered that passenger cars emit the largest share of GHGs out of all road vehicles in Bulgaria. Hence, they are one of the major obstacles before the fight with air pollution in Bulgaria. Improving the ecological impact of the Bulgarian car fleet is therefore a solution to decrease GHG emissions from the road transport sector. I have conducted research into Bulgarians' opinions of low-emission vehicles and the role in the future car market.

The research that I conduct is based on an objectivist ontology, which sees the world as being objective and being able to be measured (Bryman, 2012). According to this philosophy, the researcher does not change the reality by gathering data and does not interfere with the individual's perceptions of the world, therefore the principal for objectivity of the research is being kept (Borthwick, 2015; Crotty, 1998). Furthermore, I investigate the gathered data from a positivist perspective, which establishes behavioural interrelations between an individual's acts and thoughts. For this reason, positivism assumes that the human behaviour could be foreseen (Crotty, 1998). With this in mind, I conduct a quantitative research of Bulgarian consumer behaviour and preferences when buying a private vehicle.

5.1 Research method

To investigate the factors which could stimulate more Bulgarians to buy low-emission vehicles and gather data on Bulgarian consumer behaviour, I survey Bulgarians using an online questionnaire. The questions in the questionnaire were influenced by previous researches of consumer behaviour and “green strategies” in Scotland and Slovenia (Borthwick, 2015; Knez, 2017; Knez, et al., 2014; Zupan, 2014). As a research method, the questionnaire is considered one of the best methods when analysing a specific behaviour, attitude or beliefs of a population (Borthwick, 2015). I have chosen this method on account of its cost-effectiveness ratio and high level of objectivity (Lavrakas, 2008; Terrel, 2015). Furthermore, this method allows to overcome the social-desirability bias which is thought to lead respondents to ‘socially-acceptable’ behaviour (Bradburn et al., 1979; Oppenheim, 1992). In this research case, some individuals might not wish to appear anti-environmental and might therefore feel pressured to answer questions according to an ‘eco-friendly’ manner which goes against their beliefs. I have addressed this concern by conducting the research anonymously and in an online environment, away from the researcher, thus minimising potential bias (Sudman and Bradburn, 1982). Moreover, the online questionnaire allows to reach a large number of individuals who can participate at the most convenient time for them, thus stimulating participation.

I used Google Forms as a platform to conduct the questionnaire and gather the responses. Google Forms allowed me to easily share the online survey and keep track of the number of participants. The questionnaire was spread using social media and emails.

Ultimately, I apply the survey results to formulate policy recommendations for future ‘green policies’ to stimulate an increase in the number of low-emission vehicles in Bulgaria.

5.2.1 Research sample

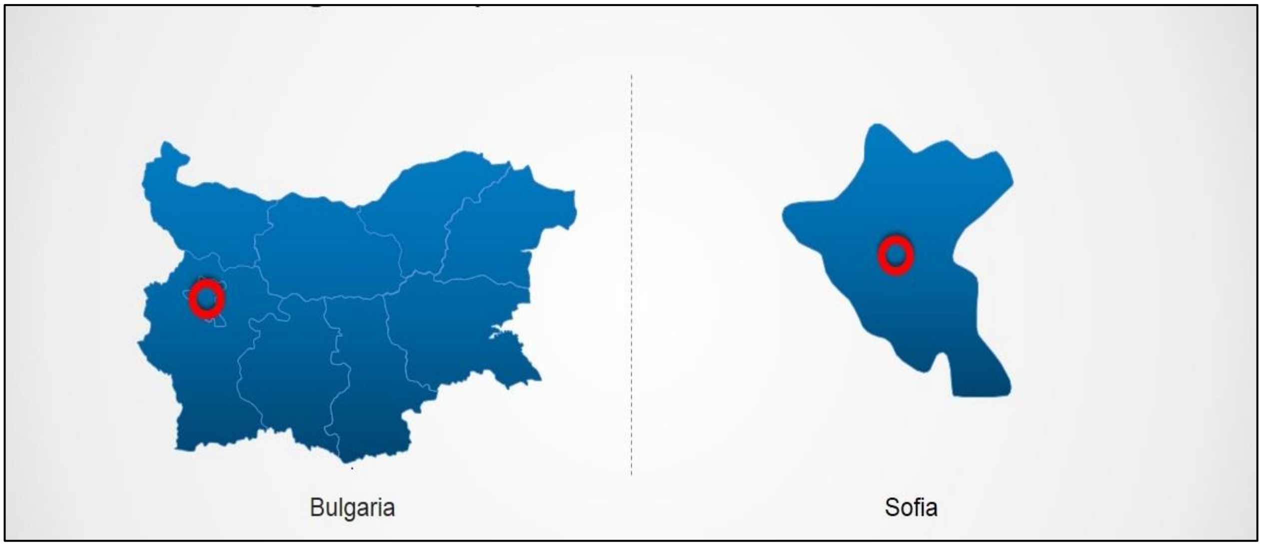

Figure 19. Maps of Bulgaria and Sofia. *Data source: National Statistical Institute, 2018*

The sample group for this online questionnaire were Bulgarian individuals, who are above 18 years old, currently live in the area of Sofia city and hold a driving-license. The age limit was such, as only people above 18 years of age have the legal rights to drive a vehicle in Bulgaria (National Assembly of the Republic of Bulgaria, 2006). I narrowed my study to the capital city of Bulgaria, Sofia, because it is the most developed and most populated area in the country. In 2016, the GDP per capita in Sofia was 28 465 leva (≈£13 037), which is more than twice the average for the country (13 016 leva ≈ £5 961), and more than four times the GDP in the least developed region, Silistra (6 080 leva ≈ £2 784) (Figure 19) (National Statistical Institute, 2018). Economic development of the Sofia region might help in the implementation of the relatively expensive measures involved in promoting low-emission vehicle use, such as building the appropriate charging infrastructure for electric vehicles and hydrogen refuelling stations for hydrogen vehicles.

At the same time, Sofia is the most polluted Bulgarian area, ranking as the 10th most polluted city in the EU and 3rd most polluted in Eastern Europe (Numbeo, 2016). This could suggest that 'green' measures and policies would receive strong public support amongst the residents of Sofia. An evidence for this is a recently conducted study by one of the biggest independent Bulgarian research agencies for social and market surveys: Alpha Research. Their study, titled "Support towards the municipality's measures against air pollution in Sofia", included interviews of 800 adults from Sofia who shared their opinions about air pollution in the capital (Alpha research, 2018). A staggering 86% thought that there is an issue with air pollution in Sofia, and 51% pointed out automobiles are the main contributor to this problem. Another evidence for citizens' willingness to contribute in the fight with air pollution in Sofia is also the fact that 69% of the interviewed people expressed that there is a need for people's contributions in the fight with air pollution. Therefore, I consider the population of Sofia as one of the best subjects to study the future of 'green policies' in the road transport sector in Bulgaria.

5.2.2 Questionnaire design and content

After conducting a research on quantitative methods and past attempts in assessing individual's behaviour, I adopted the following characteristics for my online questionnaire:

1. Simple and direct language (Payne, 1951; Freed, 1964; Moser and Kalton, 1977).
2. Shorter questionnaires to receive more responses (Leslie, 1970)
3. Clear instructions for completing the questionnaire, which provide better clarity (Berdie et al., 1986; Verma and Mallick, 1999).
4. Logical graphic formatting (Cohen et al., 2000; Bryman, 2008)

Furthermore, I designed questions related to specific environmental or purchasing behaviours to be answered in a three or five-point Likert scales (Likert, 1932; Bollinger, 2015). The three-point scale helps to measure the directionality of an individual's opinion, while the five-point Likert scale enables to measure the strength of individual's opinion (Matell et al, 1971). Ultimately, I seek to identify the most influential factors for consumer behaviour and highlight on the purchasing habits of a specific group of Bulgarians when purchasing a vehicle. Considering the focus and sample group of this questionnaire, Bulgarian language was used for the online questionnaire. The original Bulgarian version and the translated English version are both available in Appendix 3 and 4.

5.2.2.1 Section 1 - Consent form and personal details

Section 1 of the online questionnaire included an introduction to the survey topic and questions pertaining to the profile and eligibility of the respondents. The introduction started with an overview of the research, its purposes and voluntary nature, and the deadline for completing the questionnaire. The questionnaire was active for over eight weeks - it was published on 1st June 2018 and ended on 1st August 2018. Furthermore, respondents were presented with the privacy policy required by the University of Glasgow and received assurance that their personal information will be kept strictly confidential. Respondents were also informed of the contact details of the researcher and the University of Glasgow's Ethics Committee in case they had any further queries related to the questionnaire. Section 1 finished with a few personal questions, in particular - age, sex, driving license holding status and social occupation of the respondent. The answers of these questions were utilized to breakdown the sample group.

5.2.2.2 Section 2 – Car preferences

5.3.2.1. Situational factors

This section is dedicated to assessing the significance of situational factors when purchasing a future vehicle. It is based on previous attempts to capture individuals' future purchasing behaviour (Lehman et al., 2003; Lane, 2005; Lane and Potter 2007; Anable et al., 2008; Borthwick, 2015). In the beginning of the section, respondents were asked to put themselves in an imaginary situation where they have to buy a new car and have to think about some of the factors behind choosing this car. I take in consideration the risk of hypothetical bias that stands for the difference of behaviour in real situation and in hypothetical one (Hensher, 2010). However, my review of previous studies on this topic showed that examining the factors behind a previous purchase of a car is not relevant to an individual's future purchasing behaviour (Oppenheim, 1992; Borthwick, 2015).

The first questions concerning situational factors in the questionnaire are related to social conditions and structures (Lane and Potter, 2007). Figure 20 illustrates how these factors are categorized into three groups. Questions were related to specific car characteristics, such as brand, capacity, mileage (for used cars), engine power, amount of emitted GHGs, etc. In addition to vehicle attributes and environmental considerations, some questions were associated with financial considerations, such as different taxes, fuel and repair costs. The respondents were able to answer these questions in a three-point Likert scale, ranging from “Not Important” and “Moderately Important” to “Very Important”. I have decided to represent these answers using a point system, in which “Not important”, “Moderately Important” and “Very Important” equal 1, 2 and 3 points respectively. After all answers are collected and summed, the averages are calculated and used to represent the level of importance of each situational factor.

Ultimately, by applying the three-point Likert scale, I aim to evaluate individuals’ opinion of the significance of different situational factors, which are related to the economic and regulatory frameworks adopted by Bulgaria.

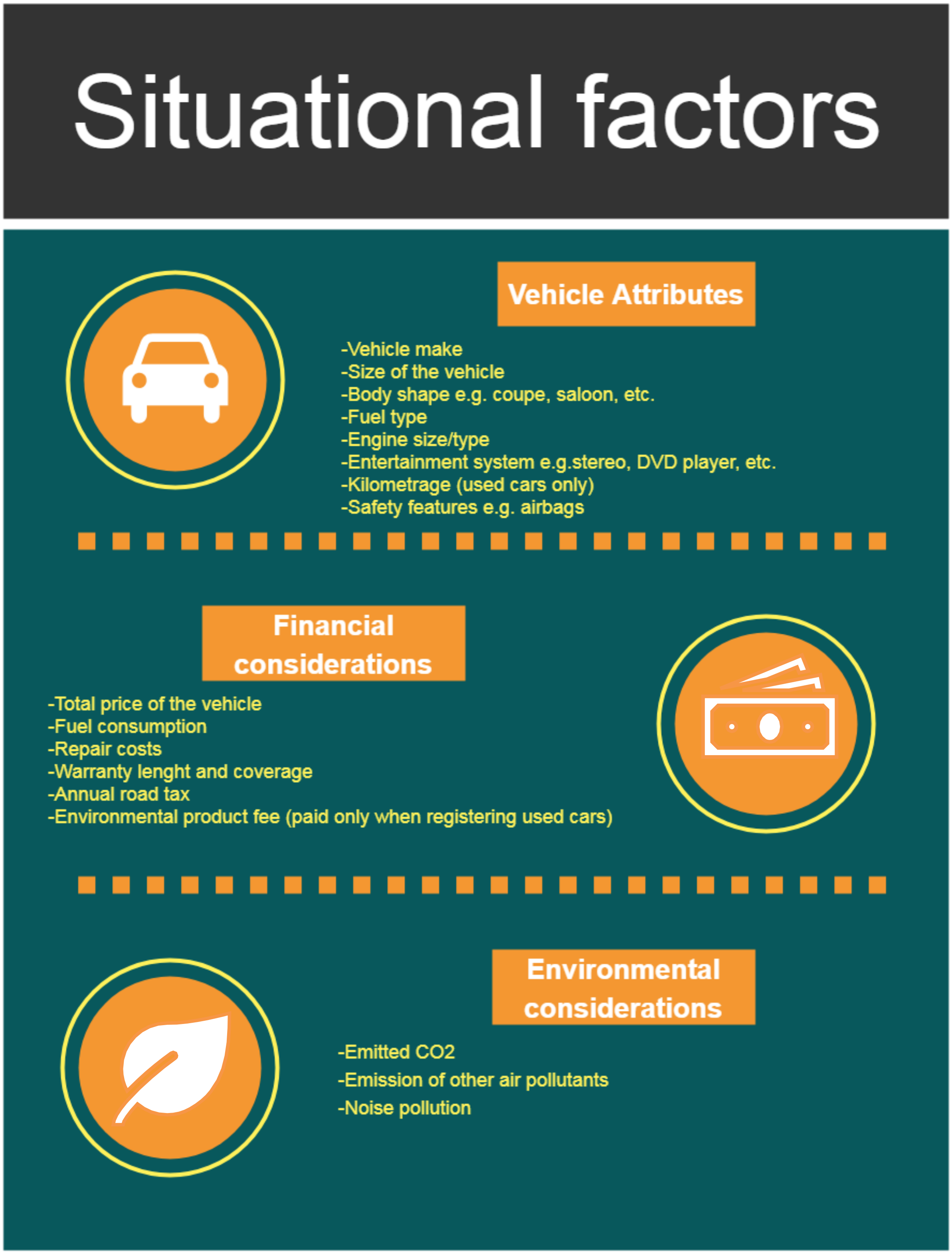

Figure 20. Situational factors implemented in the online questionnaire. *A modification of the situational factors of Borthwick (2015; Porter and Lane (2007); Lehman et al. (2003); Lane (2005); and Anable et al. (2008).*

5.3.2.2 Psychological factors

In contrast to situational factors, psychological factors resonate with respondents' subjective perceptions of the world, such as beliefs, values, norms, etc. (Schade and Schlag, 2003). Furthermore, psychological factors predispose some people to behaviour change and contribute to understanding pro-environmental decision-making (Max Success, 2009; Bamberg et al., 2011). Psychological factors which were applied in my online questionnaire are based on several previous researches on purchasing behaviour (Lane and Porter, 2007; Borthwick 2015; Knez, Jereb, and Obrecht, 2014; Zupan, 2014). In this case, they are used to evaluate Bulgarians' attitudes towards purchasing of a low-emission vehicle.

These subjective factors were assessed through several statements presented in Figure 21. A 5-point Likert scale was adopted to estimate to what extent respondents agree with these statements. The strength of agreement with each statement was estimated using the following scale system: "Strongly disagree" - "Disagree" - "Don't know" - "Agree" - "Strongly Agree", where each of these answers corresponds to a point number from 1 to 5 (Table 7).

Table 7. Five-point Likert scale adopted to measure the psychological factors.

Answer	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
Points	1	2	3	4	5

The potential for systematic response bias in displaying large amount of statements formulated in the same manner is often overlooked (Wong et al., 2003; Zikmond et al., 2013). Several researches show that reverse-wording could overcome this bias (Nunnally, 1978; Churchill, 1979; Baumgartner and Steenkamp, 2001). For this reason, in several of the statements I used reverse-wording; for instance, "I feel no personal responsibility to …" instead of "I feel a personal responsibility to …".

Ultimately, studying psychological factors could help policymakers to break up the population into several smaller groups according to their level of awareness of the factors contributing to climate change and air pollution. In that sense, acknowledging the psychological factors behind consumer behaviour could contribute to encouraging pro-environmental behaviour and promoting purchasing of low-emission vehicles.

***Figure 21. Psychological factors implemented in the online questionnaire**. A modification of the psychological factors of Borthwick (2015) and Potter et al. (2005)*

5.2.2.3 Potential external factors/policies which could influence purchasing of a low-emission vehicle

In this part of the questionnaire, changes in tax measures were examined as external factors in car purchasing. Respondents were asked which of the suggested new tax measures, calculated according to the amount of emitted CO_2, would influence them to buy a low-emission vehicle (Table 8). The influence of these policies was measured on a 3-point Likert scale, using “Not influential” - “Neutral” - “Very influential” scale, which equate 1, 2 and 3 points respectively.

Finally, blank space for comments was left in the end of the questionnaire, in effort to capture any additional thoughts and comments regarding the topic of low-emission vehicles in Bulgaria or the questionnaire itself.

Table 8. Hypothetical policy measures introduced in the online questionnaire

Types of additional taxes calculated on emitted amount of CO_2	Scenario
Annual Transport Vehicle Tax	Increase of the Transport Vehicle Tax regulated in Art. 52-61 of the Local Taxes and Fees Act (LTFA), as a disincentive, for a vehicle with equal/greater emissions than the current one.
Road infrastructure charge (vignette fees)	Increase of the cost of road infrastructure charge (vignette fees), set according to Art.10., Paragraph 2 from the Bulgarian Law for the Roads, depending on the emitted GHG emission, as a disincentive, for a vehicle with equal/greater emissions that the current one.
Insurance tax	Increase of the compulsory insurance against civil liability in respect of the use of motor vehicles, set art. 477 Paragraph 2 in the Insurance Code, as a disincentive, for a vehicle with equal/greater emissions than the current one

5.2.5. Limitations of this research and potential future studies

By applying a quantitative method to study the car preferences of Bulgarians, I try to capture the impact of several factors on purchasing decisions of a specific group of Bulgarians. One of the limitations of this study is related to the sample group that was used. Including only people who live in the capital of Bulgaria, Sofia, means that the study is not representative of the attitudes of all Bulgarians. However, I recognize this limitation and admit that by concentrating on the most developed region of Bulgaria, the results of this study would only represent the "best-case scenario" when it comes to the future of low-emission vehicles in Bulgaria.

Another limitation is that some groups of people may not be represented equally. For instance, people aged 60 and over may not have access to the questionnaire as they generally use social media and emails less often (Hutto and Bell, 2014). To avoid over-representation of a group, weighting of variables could be implemented in future studies focussed on low-emission vehicles in Bulgaria. Studying different groups of people in future comparative studies could help to discover the potential roles of poverty, industrialization, education and other factors in LEV purchase decision making.

6. Discussion of the results

6.1. Socio-demographic profile of the respondents

The online questionnaire was completed by 136 people during the eight-week period it was active. The response rate was unknown before the end of that period, which introduced uncertainty about the representativeness of respondents. Fortunately, about 91% of them, or 124 people, were eligible to participate, as they matched the research criteria[2]. In the next sections I investigate their answers and draw my conclusions.

The questionnaire distinguishes several socio-demographic factors, such as age, gender and social occupation of respondents. As demonstrated in Figure 22, males in this research are over-represented by 36%, while females are under-represented. One of the participants has refused to identify their gender.

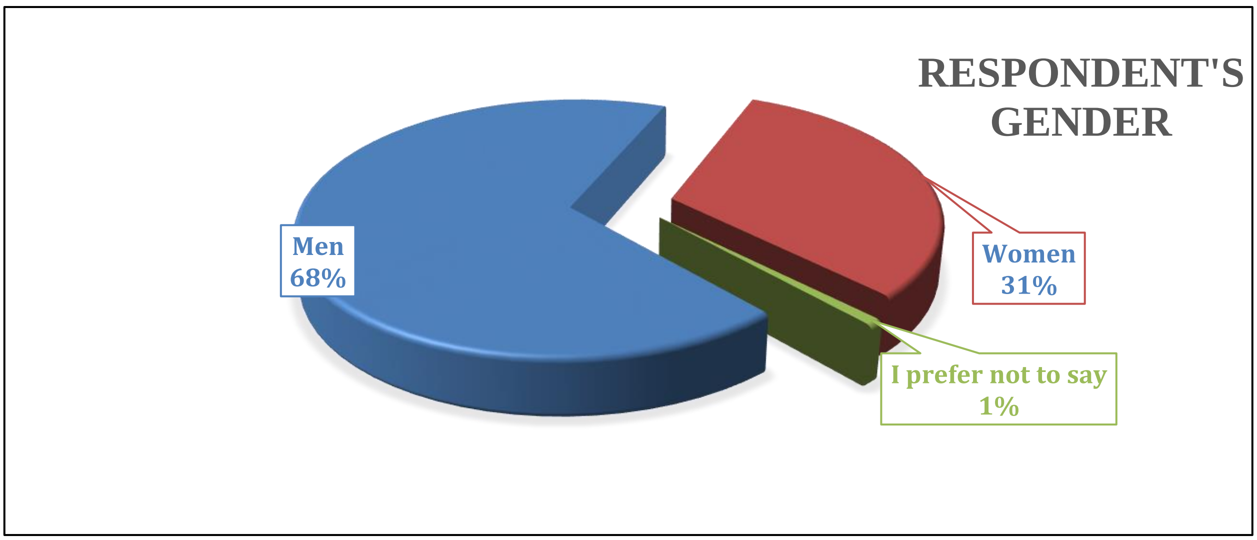

Figure 22. Breakdown of respondents' gender

[2] The participants of this survey had to correspond to the following criteria:

1. To be over 18 (to be able to have a driving license by the Bulgarian law for the roads)
2. To be holding a driving-license
3. Their current residency to be Sofia

More than the half of the respondents were aged between 24 and 40 and about one third of all participants were between 18 and 23 years old (Figure 23). Least represented are people aged 65 and older, an age group with no representatives, followed by people between 41 and 65 years old (Figure 23).

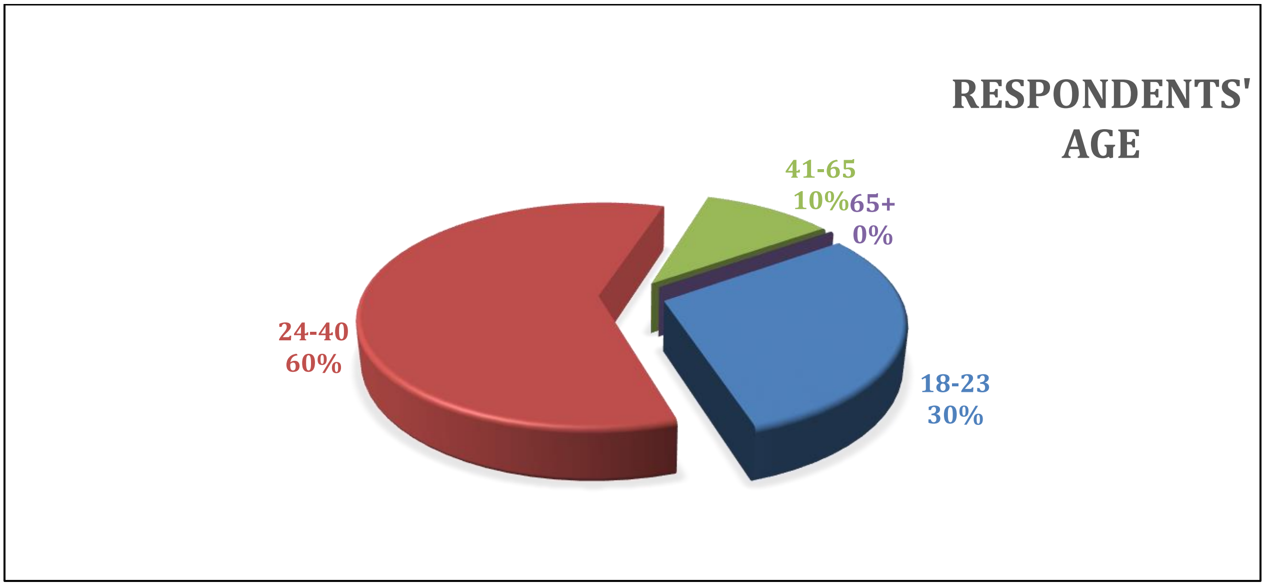

Figure 23. Age of respondents

When it comes to social occupation, about half of the participants are employed (48%), 37% defined themselves as 'working student' and 11% were students. About 1% of the respondents answered there are on a maternity leave at the moment of completing the questionnaire and no retired people took part in this survey (Figure 24).

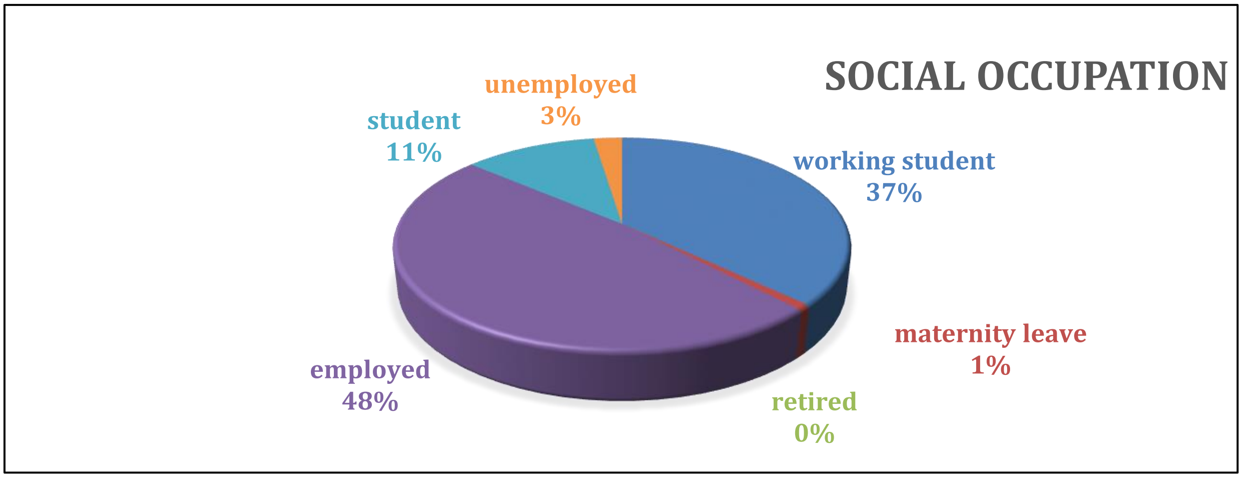

Figure 24. Social occupation of respondents

6.2. Analysis of the importance of situational factors in purchasing a low-emission vehicle

Respondents were asked to rate several situational factors (Figure 20) according to their importance for them. The calculation of the average importance score for each question is discussed in section 5.3.2.1. Figure 25 illustrates the importance level of all situational factors according to the average importance scores calculated from the answers. Evidently, financial considerations and security are the two most important types of factors for buying a low-emission vehicle (Figure 25). In particular, the total price, repair costs and fuel consumption, as well as the security of the vehicle are expressed as crucial (Figure 25). These results are consistent with Knez's and Borthwick's findings from similar studies conducted in Slovenia and Scotland, in which the primary situational factors for purchasing a low emission vehicle were found to be the total price and fuel economy (Knez, 2017; Borthwick 2015). Although fuel consumption is seen as a key factor in buyers' purchasing behaviour in the current study (Figure 25), it is more likely related to vehicle running costs rather than environmental effects. The same observation was made in the Slovenian study by Knez and Anable et al's research, who both found that CO_2 emissions and environmental impact do not have significant influence on car choice (Knez, 2017; Anable, 2008).

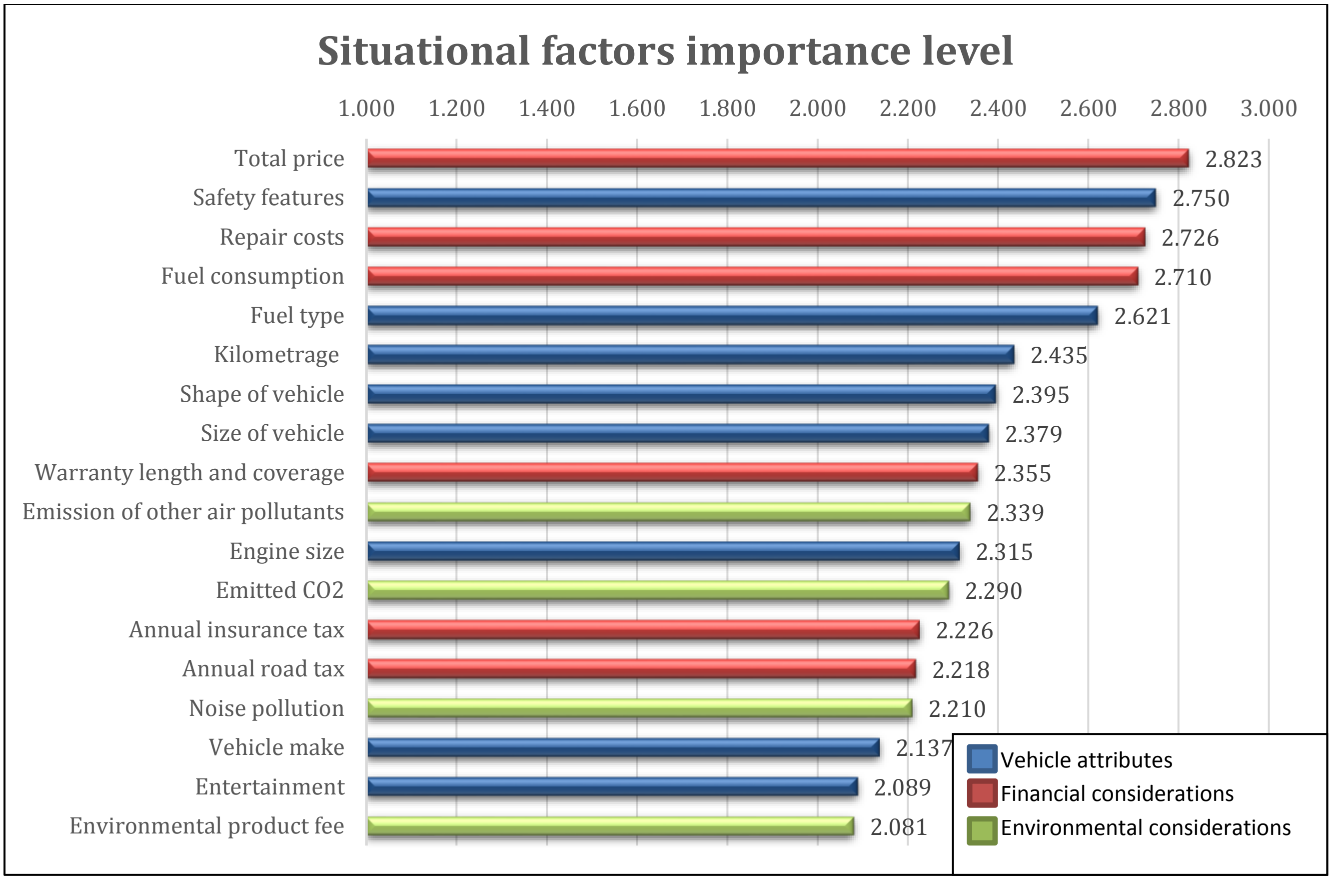

***Figure 25. The importance of situational factors**. The scale ranges from 1.000 ("not important") to 3.000 ("most important")*

The second and third most important types of factors are related to the physical characteristics of the vehicle (kilometrage, shape and size) and the fuel and performance factors, such as fuel type and engine size (Figure 25). Environmental factors, such as the environmental product fee and noise pollution, are ranked towards the bottom of the graph, whereas emitted CO_2 and emissions of other pollutants are ranked next to annual insurance tax and warranty length and coverage (Figure 25). Other factors with little importance included vehicle make and entertainment features. Calculating the average importance score for every situational factor group allowed to rank the three groups (Table 9). Ranking revealed that financial considerations are the most important group of factors, whereas environmental considerations – the least.

Table 9. Ranked situational factors according to average importance level. *The scale ranges from 1.000 ("not important") to 3.000 ("most important")*

Rank	Situational factors	Importance level
1	Financial considerations	2.856
2	Vehicle attributes	2.390
3	Environmental considerations	2.280

6.3 Analysis of psychological factors

As mentioned above, psychological factors were measured using a 5-point Likert scale. However, to make them comparable to situational factors, I convert the answers to a 3-point Likert scale. The methodology for conversion is explained in Appendix 5. The importance score of all psychological factors was calculated in the same way as in 6.2. The importance scores are illustrated in Figure 26 and the ranking of psychological factors – in Table 8.

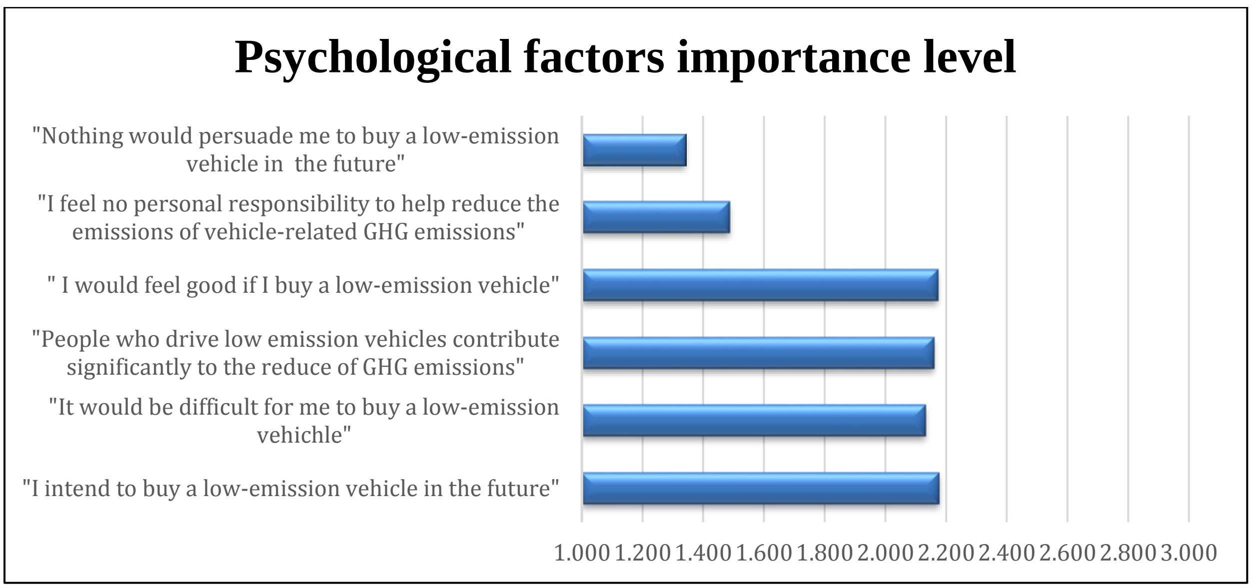

Figure 26. Psychological factors importance level. *The scale ranges from 1.000 ("strongly disagree") to 3.000 ("strongly agree") Note: the 5-point Likert scale has been converted to 3-point scale (Appendix 5).*

Ranking of psychological factors (Table 10) reveals that respondents are driven towards purchasing a low-emission vehicle mostly by the emotions the purchase would bring them. The second most important psychological factor is related to the respondents' desire to achieve positive outcomes for the environment when buying a low-emission vehicle. In contrast with the Scottish study (Borthwick, 2015), in which perceived behavioural control is a comparatively insignificant psychological factor when purchasing a vehicle, most Bulgarians answered that they would not be able to afford a low-emission vehicle (LEV) in the near future (Figure 26, Table 10). This is probably because Bulgarians have the lowest GDP per capita in the EU and the LEVs are still much more expensive than vehicles with a combustion engine (Knez, 2017; Statistics times, 2018). The ranking of "Behavioural intentions" on fourth place (Table 10) shows that although respondents are still reluctant about the possibility of buying a LEV in the near future, they remain relatively interested in doing so in a more distant future.

Rank	Psychological factor	Importance level
1	Emotions	2.173
2	Perceived positive consequences	2.161
3	Perceived behavioural control	2.133
4	Behavioural intentions	1.760
5	Personal responsibility	1.343

Table 10. Ranked psychological factors according to average importance level, where 1.000 equals "Strongly disagree" and 3.000 equals "Strongly agree"

This study found that the least important psychological factor is individual's personal responsibility (Table 10). Apparently, respondents feel little obligation to purchase a LEV in order to benefit the environment and society. This finding differs from Knez's and Borthwick's findings about Slovenian and Scottish drivers, who put social responsibility as one of their most influential psychological factors for purchasing a future LEV (Knez, 2017; Borthwick, 2015).

6.4 Comparison of situational and psychological factors for future vehicle purchasing decisions in Bulgaria

Comparison of the importance of situational and psychological factors (Table 11) revealed that situational factors are more influential to Bulgarians when making a vehicle purchasing decision. Notably, the first 15 ranks are occupied by factors related to financial considerations and vehicle attributes (Table 11), including total price, repair costs, safety features, etc. This partially matches the results from the study on Scottish vehicle purchasing behaviour, where the top three most influential factors are situational factors associated with financial considerations (Borthwick, 2017). However, the main difference between the results of this study and the Scottish ones is that psychological factors have much greater influence on Scottish drivers than on Bulgarian drivers. For example, the most influential psychological factor is ranked on 4^{th} place in the Scottish study, whereas the most influential psychological factor in Bulgaria, "Emotions", is ranked on 16^{th} place. In general, situational factors dominate the process of vehicle purchasing decision making amongst Bulgarians, while psychological factors do not have a strong influence.

In conclusion, Bulgarians are much more concerned with the financial considerations of purchasing a new vehicle rather than the emotional and psychological benefits it would bring them.

Table 11. Ranked Situational and Psychological influencing factors in individual's' future purchasing decisions in Bulgaria. *Measured in an importance scale from 1.000-Not important to 3.000-Very important*

Rank	Type	Factors	Importance level
1	Situational	Total price	2.823
2	Situational	Safety features	2.750
3	Situational	Repair costs	2.726
4	Situational	Fuel consumption	2.710
5	Situational	Fuel type	2.621
6	Situational	Kilometrage	2.435
7	Situational	Shape of vehicle	2.395
8	Situational	Size of vehicle	2.379
9	Situational	Warranty length and coverage	2.355
10	Situational	Emission of other air pollutants	2.339
11	Situational	Engine size	2.315
12	Situational	Emitted CO2	2.290
13	Situational	Annual insurance tax	2.226
14	Situational	Annual road tax	2.218
15	Situational	Noise pollution	2.210
16	Psychological	Emotions	2.173
17	Psychological	Perceived positive consequences	2.161
18	Situational	Vehicle make	2.137
19	Psychological	Perceived behavioural control	2.133
20	Situational	Entertainment	2.089
21	Situational	Environmental product fee	2.081
22	Psychological	Behavioural intentions	1.760
23	Psychological	Personal responsibility	1.488

6.5 Behavioural model of individuals' purchasing decisions in Bulgaria

There were many previous attempts to capture individuals' vehicle purchasing behaviour in a model. To create a unique behaviour model based on the received results, I take in consideration previous research by Lane and Potter and Borthwick (Potter et al. 2005; Borthwick, 2015). In Figure 27, I illustrate the importance of influencing factors by ordering them in a clockwise spiral, staring with the most influential factor in the middle. Situational factors are represented in red, whereas psychological – in blue.

In brief, this model aims to illustrate the most important situational and psychological factors during the decision-making process of a specific group of Bulgarians when purchasing a vehicle. I acknowledge the fact that I use a one size-fits all model and due to this fact, the model's accuracy could be contested. However, I believe that this model is a good starting point for discussions about future 'green policies' stimulating the purchase of LEVs in Bulgaria.

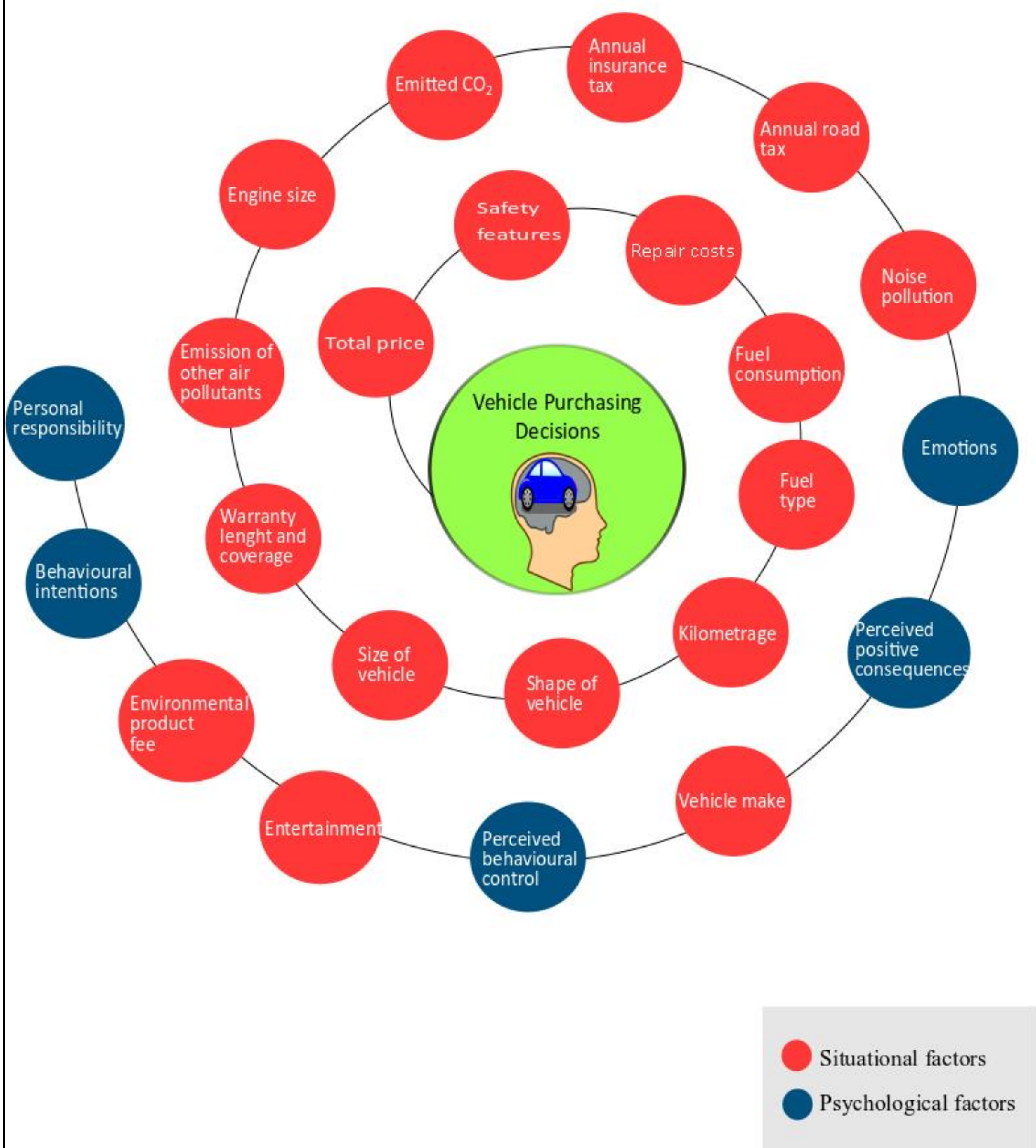

Figure 27. Behavioural model of Bulgarians in the process of decision-making when purchasing a vehicle.

6.6 Analysis of the results of hypothetical policy measures

The third part of the questionnaire aims to explore the public opinion about the direction of future policies encouraging low-emission vehicle purchase. The respondents were asked to assess the influence of three hypothetical policy measures which would promote low-emission vehicle purchase. In brief, these policy measures are based on the current legislation and are strongly related to the amount of emitted CO_2. A three-point Likert scale was used to measure the influence of these measures, where “Not influential” equals 1 point, “Neutral” - 2 points and “Very influential” - 3 points. The suggested policy measures were discussed in more details in section 5.3.3.

Table 12. Ranked results on influential level of hypothetical policy measures promoting LEV purchase, where 1.000 is “Not influential” and 3.000-“Very influential”

Rank	Type of additional taxes calculated on the emitted amount of CO2	Influential level
1	Insurance tax	2.637
2	Road infrastructure charge (vignette fees)	2.467
3	Annual Transport Vehicle Tax	2.451

According to the respondents, the most influential policy change to promote LEV purchase would be an increase in Insurance tax rate (Table 12). Increase of the Road Infrastructure Charge (vignette fees) is ranked on 2^{nd} place with 2.467 influential rate, while the Annual Transport Vehicle Tax increase is on third place. These results show that the surveyed group of Bulgarians consider the increase of taxes very seriously and confirms previous findings that financial considerations are the most important to Bulgarians in the process of purchasing a vehicle.

Therefore, this suggests that introduction of financial policy measures promoting preferential taxation of LEVs could potentially stimulate the LEV market in Bulgaria.

6.7 Analysis of received answers in the space for comments

In the end of the questionnaire, blank space for comments was available to all respondents, so everyone could express their opinion on the topic or leave feedback. About 23% (29 people) of all respondents left comments, expressing their vision on the future of LEVs in Bulgaria.

The predominant opinion was that Bulgarians do not drive LEVs simply because it is too expensive to purchase such type of vehicles in Bulgaria and the required infrastructure for LEVs is missing. More than half of the people think that this is result from the lack of effort of the Bulgarian state to promote LEVs in the country. One respondent wrote that "the taxes for old vehicles are not high enough to even consider buying a new car, let alone to buy a LEV". To resolve these issues, a respondent suggested that the state should provide some sort of subsidies to stimulate purchasing of LEVs.

It is interesting to note that three people expressed their concerns about the effectiveness of LEVs to positively impact on air pollution and climate change. Two of them state that electricity in Bulgaria is produced from power plants, and if the demand for it increases, the effects on the environment would worsen.

Overall, the comments in this questionnaire confirm that Bulgarians take financial considerations as their primary factor for purchasing a LEV and consider buying one as 'impossible not because of an absence of willingness to switch to 'eco', but because of financial unfeasibility'.

6.9 Discussion of the Bulgarian car market

To better understand Bulgarians' main financial concerns, I conducted a research on the Bulgarian car market. I used the biggest online car selling platform in Bulgaria, www.auto.bg, and found that the average price of a car with combustion engine (diesel or petrol fuelled car) in 2017 cost 14 552 leva (≈ £6 650), while the average price of a low-emission vehicles is 62 239 leva (≈£28 500) (Figure 30) (Auto.bg, 2018). This data shows that vehicles with internal combustion engine are about four times more accessible than LEVs (Figure 28).

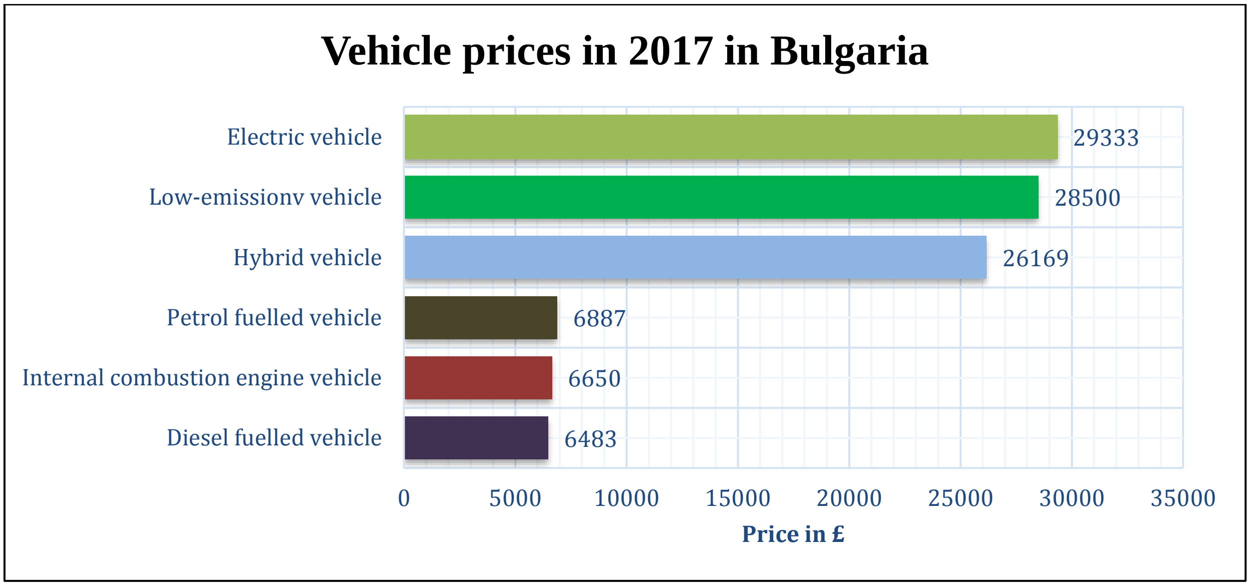

Figure 28. Vehicle prices in 2017 in Bulgaria. *Source: Auto.bg, 2018*

Thus, if we make the following assumptions:

- The average Bulgarian can afford a combustion engine car for 14 552 leva (≈ £6 650) with €6 300 (≈ £5 654) GDP per capita in 2017
- The economic growth will continue to increase with the same speed. The average GDP growth per year for the last 11 years, since Bulgaria joined the EU, is 3.145 % (National Statistical Institute, 2017a)
- The demand for LEVs will remain the same as in 2017 and the average price of a LEV in Bulgaria will remain to be £28 500,

then we could calculate that the average Bulgarian would be able to afford a low-emission vehicle in 2064.

However, this prediction is not in accordance with the course of action Bulgaria has agreed to, especially the European Union's 2050 vision for a low-carbon Transport sector (2050 Low-carbon Economy Strategy, 2018). For this reason, the Bulgarian government should take immediate policy initiatives in promoting the use and purchasing of low-emission vehicles.

7. Policy recommendations and conclusions

As suggested by the findings of this study, to transform Bulgarian vehicle purchasing decisions and promote pro-environmental thinking, Bulgarian officials should consider changing the legislative framework in the country. Past researches of Scottish and Slovenian drivers and transport pricing policies suggest two types of measures (Borthwick, 2015; Carreno, 2012; Knez, 2017; Schade and Schlag, 2003b):

1. Push-measures – penalising those who chose not to buy a LEV
2. Pull-measures - promoting the purchase of LEV by rewarding the buyer

After considering the role of situational and psychological factors in shaping vehicle purchasing decisions in Bulgaria, I recommend both push- and pull-measures to be implemented.

7.1 Push-measures

Firstly, I suggest introducing a circulation tax, which is a type of insurance based on the amount of emitted CO_2. In the online questionnaire, this policy was ranked as the most influential future measure (Table 11) Similarly to what Ryan et al., Borthwick and Carreno found in their studies, drivers in Bulgaria are mostly concerned about future financial expenditures (Borthwick, 2015; Carreno, 2012; Ryan et al., 2009). For this reason, vehicles which have greater contribution to air pollution and environmental damage must be charged with higher insurance fee.

Another policy measure which could stimulate the purchase of LEVs in Bulgaria is related to road infrastructure charges (vignette fees) based on CO_2 emissions of the vehicle. Although previous studies show that this measure is relatively less significant to drivers (Hayashi et al., 2001; Giblin & McNabola, 2009), Bulgarians ranked it as the 2nd most influential factor, which could convince them to buy a LEV (Table 11). According to the

Law for the Roads all vehicles which use the Bulgarian transport infrastructure must pay a Road fee (Table 12) (National Assembly of the Republic of Bulgaria, 2006). As seen in Table 13, trucks and vehicles weighing up to and over 12 tonnes are charged for vignette fees according to their EURO standard, but passenger cars, which mostly belong to the category of "vehicles up to 3.5 t. with max 8 seats" are charged regardless of the amount of emitted GHGs. To promote LEVs in Bulgaria, LEVs could be excluded from the vehicle category which has to pay road infrastructure charges (vignette fees).

Table 13. Prices of vignette fees for 2018 in Bulgaria. *Source: Tolls.eu, 2018; Agency Road Infrastructure, 2018 https://www.tolls.eu/bulgaria; http://www.api.bg/index.php/en/vinetni-stikeri*

Validity/category	Up to 3,5t with max. 8 seats	Up to 12t and vehicles with more than 8 seats Euro 0, I, II	Up to 12t and vehicles with more than 8 seats Euro III, IV, V, EEV and higher	Trucks over 12t Euro 0, I, II	Trucks over 12t Euro III, IV, V, EEV and higher
1 day	-	€ 11,00	€ 11,00	€ 11,00	€ 11,00
Weekly	€ 8,00	€ 27,00	€ 21,00	€ 45,00	€ 34,00
Monthly	€ 15,00	€ 54,00	€ 41,00	€ 89,00	€ 69,00
Annual	€ 50,00	€ 537,00	€ 413,00	€ 891,00	€ 685,00

The last 'push-measure' which I suggest to be adopted by the Bulgarian government is related to Annual Transport Vehicle Taxes. In their study of the fiscal framework for transport in the EU, Potter et al. found that increasing this annual tax in accordance with the amount of emitted CO_2 encourages the purchasing of a low-emission vehicle (Potter et al., 2005). The questionnaire conducted on Bulgarian drivers shows that this tax is highly influential to vehicle purchasing decisions and could therefore significantly contribute to shaping an 'eco' mindset (Table 12).

Up to present time, all owners of a vehicle in Bulgaria have to pay a Transport Vehicle Tax regulated in Art. 52-61 of the Local Taxes and Fees Act (Lex.bg, 2018). The amount of this tax is based on the vehicle's engine power and year of production (Ministry of Finance of the Republic of Bulgaria, 2018). The total price of the Transport Vehicle Tax is calculated after the engine power of the vehicle is multiplied by a specific coefficient, determined by the year of production of the vehicle (Table 14). Only after the tax is calculated, CO_2 emissions are considered. Vehicles with EURO standard III and IV receive 50% reduction of the standard Annual Transport Vehicle Tax and EURO V and VI vehicles get 60% off (Ministry of Finance of the Republic of Bulgaria, 2018).

Table 14. Specific coefficient based on year of production of the car. *Source: lex.bg, 2018 URL://lex.bg/en/laws/ldoc/2134174720*

Age of the vehicle	Coefficient
Over 14 years	1
Over 5 years and above 14 (incl.)	1.5
Up to 5 years (incl.)	2.8

Thus, in Sofia an owner of a five-year old car with 150 horse powers has to pay 476 leva (£218). If his car is with engine EURO 5 or 6, he pays only £87.2. However, this tax is still higher than the tax that an owner of a much older, 14-year-old, car has to pay: 170leva (£78) (Calculator.bg, 2018). Thus, instead of promoting the purchase and use of new, less polluting vehicles, the Bulgarian government is over-charging them. To resolve this issue, I suggest a new system to be applied when considering the amount of annual road tax. Changing the coefficients for new and old cars, so that new cars are prioritised over the old ones, could stimulate car buyers to purchase less polluting vehicles.

7.3 Pull-measures

When it comes to pull-measures, the Bulgarian government is significantly falling behind compared to the other Member States. In Table 15 I summarise different practices for promoting LEVs within the European Union. Evidently, the Bulgarian state has done far less than the rest of the EU states. For this reason, political will and more policy initiatives for stimulate the purchase of LEVs are needed. I suggest considering a grant scheme, similar to the ones implemented by Germany, Ireland, UK, France and other countries (Table 15), where people receive a grant as incentive from the state when buying a LEV. Furthermore, just like the Bulgarian government decided to exempt electric vehicles from paying taxes, it could do the same for all types of LEVs. In particular, Bulgarian officials could exempt LEV owners from paying the Environment product fee, a fee for all cars entering the Bulgarian car market. Since this fee is considered a strong influential factor in the process of buying a vehicle (Table 15), abolishing it for LEV owners it would mean stimulating the interest to this type of vehicles.

Table 15. Overview on tax incentives for electric vehicles in the EU. *Source: European Automobile Manufacture Association, 2018;*

Country	Incentives for LEVs
Austria	Electric vehicles are exempt from fuel consumption/pollution tax and ownership tax. In addition, a deduction of VAT is applicable for zero-CO2 emission cars (e.g. electric and hydrogen-powered cars).
Belgium	Electric vehicles pay the lowest rate of tax under the annual circulation tax in all three regions. In the Brussels-Capital region, financial incentives apply to companies electric, hybrid or fuel-cell vehicles. Electric and plug-in hybrid (until 31 December 2020) vehicles are exempt from registration tax in Flanders. Incentives ("Zero Emission Bonus") for the purchase of battery electric and hydrogen-powered cars and vans are granted.
Bulgaria	Electric vehicles are exempt from ownership tax.
France	Electric and hybrid electric vehicles emitting 20 g/km or less of CO 2 benefit from a premium of €6,000 under a bonus- malus scheme. An incentive scheme grants an extra €4,000 for switching an eleven year or more diesel vehicle for a new BEV (or €2,500 in case it's a PHEV).
Germany	From July 2016, the government granted an environmental bonus of €4,000 for pure electric and fuel-cell vehicles and €3,000 for plug-in hybrid and range-extended electric vehicles.
Ireland	Electric vehicles and plug–in electric hybrids entitle the buyer to a grant of up to €5,000 on purchase until 31 December 2021 for electric vehicles and December 2018 for plug–in hybrid electric vehicles
Romania	An incentive scheme grants €10,000 for the purchase of a new pure electric vehicle (plus €1,500 for scrapping a vehicle older than eight years) and €4,500 for the purchase of a new hybrid vehicle.
Slovenia	Applied an incentive scheme grants, providing from €7,500 for a new electric vehicle with zero emissions or a BEV to €200 for a new electric vehicle with zero emissions (L1e-A)
United Kingdom	From April 2018 until March 2021, cars that emit less than 50g/km qualify for 100% first year writing down allowances (FYAs). Zero emission vehicles attract a zero rate of vehicle excise duty (VED). Grants are provided for LEV, up to 35% or €5,000.

The last pull-measure to stimulate the interest in LEVs in Bulgaria, which I recommend, is improving the refuelling/recharging infrastructure. The need for constructing the required infrastructure for LEVs within the EU is emphasized in Directive 2014/94/EU, which obligates all Member States to provide their citizens with adequate conditions for driving LEVs (European Commission, 2014c). While the EU does not give specific recommendations on the number of hydrogen stations, all Member States are required to provide at least one refueling station with public access for every 10 electric cars by 2020 (European Commission, 2014c). In accordance with this directive, in 2018, countries like Germany and the UK have built 13 500 and 6 047 electric vehicle charging points and 30 and 45 hydrogenic fueling stations respectively (Zap-map, 2018; Percov, 2017; FuelCellsWorks, 2018; Netiform.de). Although Bulgaria ratified this directive in 2014, there are only 114 electric charging stations in the country in 2018 and no hydrogen fueling stations (vsichkotok.bg, 2018 ;dnevnik.bg, 2018). More than 70% of the charging stations are located near Sofia, and the rest are in the biggest regional cities: Plovdiv, Varna, Burgas, etc. (Figure 29).

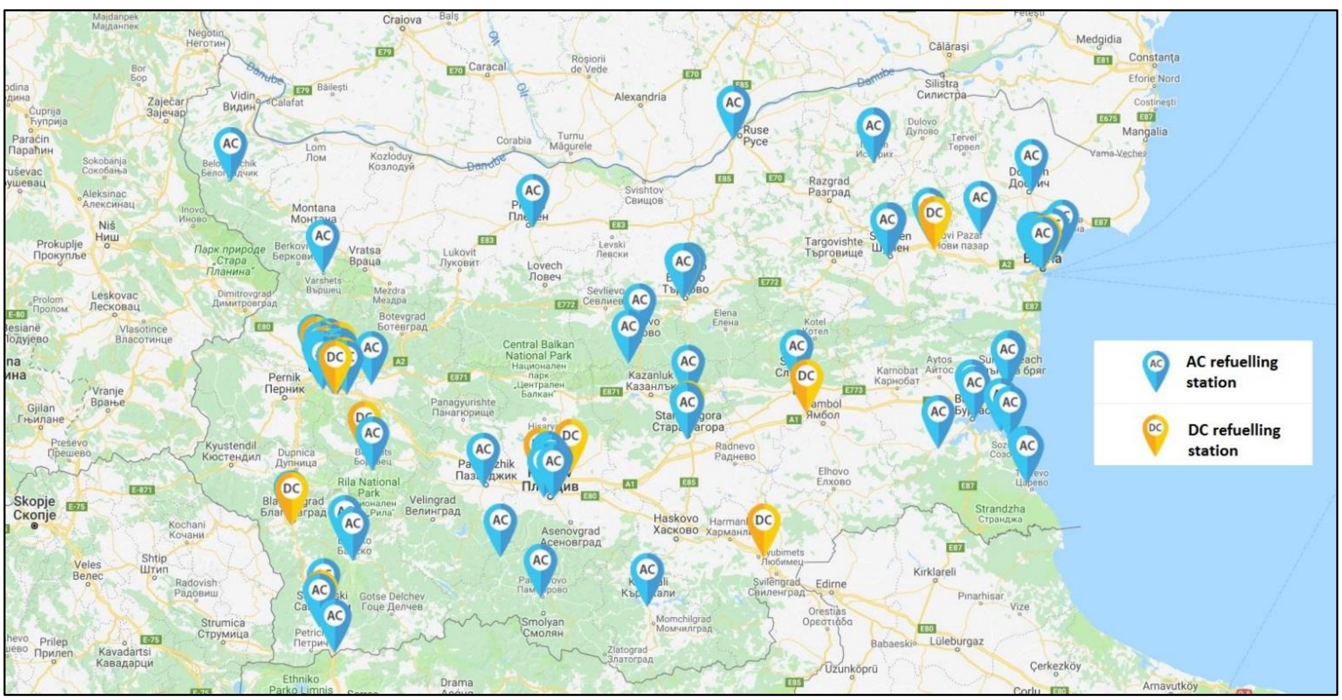

Figure 29. Refuelling stations for electric vehicles in Bulgaria. *Source: vsichkotok.bg, 2018*

To achieve a large-scale adoption of LEVs, an equally developed infrastructure is needed; however, building this infrastructure would be highly expensive. At the moment a charging point for electric vehicles in Bulgaria costs between £800 and £1700 (eCars shop, 2018). In Poland, funding for LEV infrastructure, in the amount of €400 000, was received through the EU's Connecting Europe Facility (CEF) programme for the project titled "LEM project – pilot implementation of electromobility along the TEN-T base network" (Lotos, 2018). Similarly, Bulgaria could apply for funding through EU programmes for promoting LEV use. Other European countries, including the Czech Republic, Slovakia, Croatia, Hungary, Slovenia, and Romania, have already secured funding for electrical vehicle (EV) infrastructure by participating in the NEXT-E project (Balkan Green Energy News, 2018). This project aims to provide EV infrastructure along major highways in Central and Eastern Europe by setting up a total of 252 car chargers. The NEXT-E project is funded with €18.84 million by the European Commission's Innovation and Networks Executive Agency (INEA) with co-financing from the CEF program (Balkan Green Energy News, 2018). European financing of LEV infrastructure in Central and Eastern Europe signifies that EU officials recognize the need for promoting LEVs in these regions of the EU.

As an Eastern European country with important transport corridors, Bulgaria might also expect to receive similar support from the EU. Needless to say, political action from the Bulgarian government is necessary to ensure that Bulgaria takes a course of action in accordance with the EU directives and initiatives it has accepted. Furthermore, regardless of the financial considerations associated with LEVs, pro-environmental thinking is something that needs to be instilled through education. With this in mind, there are many ways in which the Bulgarian government can approach air pollution and climate change, some of which do not require substantial funding. As shown in the results of this study, Bulgarians express willingness to switch to "eco-friendly" transport, which the Bulgarian government needs to support with its policies.

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APPENDICES

Appendix 1

Bulgarian National programmes and strategies towards climate change. Source: Seventh national communication on climate change united nations framework convention on climate change, 2018

Bulgarian National programmes and strategies towards climate change
National Development Programme: “Bulgaria 2020”
Energy Strategy of the Republic of Bulgaria until 2020
National Energy Efficiency Programme until 2015
National Energy Efficiency Action Plan 2014-2020
National Action Plan for Renewable Energy
Third National Climate Change Action Plan (2013 – 2020)
National Programme for Promotion of the Biofuels Use in the Transport Sector 2008-2020
Integrated Transport Strategy for the period until 2030
Strategic Plan for Development of the Forestry Sector in the Republic of Bulgaria 2014-2023
National Strategy for the Development of the Forestry Sector in the Republic of Bulgaria for the period 2013-2020
National Strategic Plan for management of building demolition waste 2011-2020
National Strategic Plan for management of the sludge from urban wastewater treatment plants 2014-2020
National waste prevention programme (NWPP) 2014 – 2020
National Waste Management Plan (NWMP) 2014 – 2020
National Regional Development Strategy

Appendix 2

Legislation acts adopted in the years by the Republic of Bulgaria. Source: Seventh national communication on climate change united nations framework convention on climate change, 2018

Legislation acts in the Republic of Bulgaria
Climate change mitigation act (SG 22/2014, last amended SG 85/2017)
Environmental Protection Act (EPA) (SG 91/2002, last amended SG 96/2017)

Energy from Renewable Sources Act (ERSA) (SG 35/2011, last amended SG 58/2017)
Energy Efficiency Act (EEA) (SG 35/2015, last amended SG 105/2016)
Clean Ambient Air Act (CAAA) (SG 45/1996, last amended SG 85/2017)
Forestry Act (FA) (SG 19/2011, last amended SG 58/2017)
Local Government and Local Administration Act (LGLAA) (SG 77/1991, last amended SG 9/2017)
Spatial Planning Act (SPA) (SG 1/2001, last amended SG 96/2017)
Agricultural Land Protection Act (ALPA) (SG 35/1996, last amended SG 96/2017)
Agricultural Producers Support Act (APSA) (SG 58/1998, last amended SG 58/2017)
Waste Management Act (WMA) (SG 86/2003, last amended SG 105/2016
Geological Storage of Carbon Dioxide Act (GSCDA) (SG 14/2012, last amended SG 14/2015)

Appendix 3

Questionnaire in Bulgarian

Appendix 4

Questionnaire in English

Appendix 5

To convert 5-point Likert scale to 3-point Likert scale I used a linear transformation, discussed in Cohen et al. study (1999). Firstly, I find the linear transformation which will allow me to use a new scale where the minimum is 1.0 and the maximum 3.0.

I used following formula:

Y = (B - A) * X + A ,

where

A – new minimum
B – new maximum
X – the original result in the 5-point Likert scale
Y – the coefficient which I will use to multiply the results from 5-point scale to convert it to 3-point Likert scale result.

Results in 5-point scale	Linear transformed score to 3-point scale
1	1.0
2	1.5
3	2.0
4	2.5
5	3.0

(3-1)*(x-1)/(5-1)+1=2*(x-1)/4+1=x/2+0.5

When x is 1, y=1.0

when x is 2, y=1.5

when x is 3, y=2

when x is 4, y=2,5

when x is 5, y=3.0

Source:

Patricia Cohen , Jacob Cohen , Leona S. Aiken & Stephen G. West (1999) The Problem of Units and the Circumstance for POMP, Multivariate Behavioral Research, 34:3, 315-346, DOI: 10.1207/S15327906MBR3403_2