UNIVERSITY OF LJUBLJANA
SCHOOL OF ECONOMICS AND BUSINESS

MASTER’S THESIS

AN ANALYSIS OF A DISRUPTIVE BUSINESS MODEL ON THE CROATIAN ELECTRIC VEHICLE MARKET

Ljubljana, September 2021 PAVAO KAŠTELAN

AUTHORSHIP STATEMENT

The undersigned Pavao Kaštelan, a student at the University of Ljubljana, School of Economics and Business, (hereafter: SEB LU), author of this written final work of studies with the title "An analysis of a disruptive business model on the Croatian electric vehicle market" prepared under supervision of assoc. prof. dr. Tamara Pavasović Trošt, PhD and co-supervision of assoc. prof. dr. Matej Černe.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

sl. – Slovene

EV – (sl. električno vozilo); Electric vehicle

BEV – (sl. električno vozilo na baterije); Battery electric vehicle

EA – (sl. zgodnji posvojitelji); Early adopters

OEM – (sl. proizvajalec originalne opreme); Original equipment manufacturer

PHEV – (sl. priključni hibrid); Plug-in hybrid electric vehicle

ICE – (sl. motor z notranjim zgorevanjem); Internal combustion engine

FCEV – (sl. vozila z gorivnimi celicami); Fuell cell electric vehicle

LPG – (sl. utekočinjeni naftni plin); Liqufied petroleum gas

CCS – (sl. kombinirani polnilni standard); Combined charging standard

NECP – (sl. Nacionalni energetski in klimatski plan); National energy and climate plan

WLTP – (sl. WLTP); Worldwide harmonized light duty vehicles test procedure

NEDC – (sl. NEDC); New European driving cycle

HEP – (sl. HEP); Hrvatska Elektroprivreda

RFID – (sl. radiofrekvenčna identifikacija); Radio frequency identification

INTRODUCTION

Disruption in business is defined as an instance where a smaller establishment is capable of effectively challenging the firm market position of an incumbent business by simultaneously utilising fewer resources (Christensen, Raynor & McDonald, 2015). An incumbent business through its growth and evolution provides the most competitive products and services, systematically attempting to pivot around a customer segment which is considered to be the most profitable (Dan & Chieh, 2008). By exercising such a strategy, the business may often surpass the needs of some of the less demanding segments and therefore fail to fulfil those in need of more basic products and services (Walker & Jeanes, 2001). Such a traditional mindset in company management indirectly causes a new wave of entrants to emerge (Tidd & Bessant, 2018). A typical scenario for a disruptive business is one that starts by successfully targeting overlooked customer segments, offering a more basic style of problem solving or promoting a more affordable price range (Souto, 2015). Industry incumbents do not consider them a threat nor as their direct competitors since they are busy chasing higher profit margins in more challenging segments (Janszen, 2000). Eventually, once market entrants move upmarket, they begin to perform as strongly as industry incumbents, being backed up by specific advantages that helped in launching their business initially (Miller, 2001). Customers of industry incumbents are usually oblivious to comparable performance figures of products and services of disruptive innovations due to a lack of market credibility, and for them, the price difference generally plays a less important role, not convincing them to switch (Prajogo & Ahmed, 2006). Once the quality aspect of the market entrant is assured in comparison to their previous choice, the switch may occur (Alegre, Lapiedra & Chiva, 2006).

There is no unified understanding of disruptive innovations, making it extremely difficult to predict or guarantee their effectiveness within an organisation (Thomond, Herzberg & Lettice, 2003). Becoming a successful industry disruptor requires a strong understanding of a particular industry, augmented by an artful mindset which leads the creative process towards a formation of a market solution capable of offering a better value for the consumer, while withstanding the counteroffer from the traditional incumbent (Lettice & Thomond, 2008). Market advantage could be realised by implementing a proactive business strategy, which differs from a reactive strategy in that it doesn't respond to unforeseen contingencies only after they occur, but is intentionally designed to anticipate and predict future possible challenges (Thompson, 2019). Firms whose innovation strategies are set to act proactively tend to accentuate the importance of research, internally and externally, frequently projecting an image of a technology market leader (Kickul & Gundry, 2002).

Regardless of consistent investment of capital and time, the pursuit of the right innovation remains a frustration in numerous companies (Drake, Sakkab & Jonash, 2006). New attempts to innovate cannot guarantee positive results, despite having a healthy performance record of successful innovations, as companies such as Nokia, Hewlett-Packard, Yahoo, Polaroid and many other have proven (Lhuillery & Pfister, 2009). Innovating proves to be especially difficult if the necessity for innovation comes from the inside of an organisation previously leading the market (Poot, Faems & Vanhaverbeke, 2009). The automotive industry stands among others as one of the largest, most diverse and influential industries of the past century (Sturgeon, Van Biesebroeck & Gereffi, 2008). The intrinsic connection with innovation is linked to strong barriers to entry such as manufacturing plants, extremely high design costs and previously obligatory dealer networks (Howard, Vidgen & Powell, 2003). The electric vehicle industry in particular has gone through a transformation in the past decade yet is still on the verge of major conceptual alteration, making it ripe for innovation (Ili, Albers & Miller, 2010). Considering the challenges of CO2 emission regulation, battery electric vehicles are one of the most promising radical solutions due to their higher efficiency characteristic in comparison to conventional fossil fuelled internal combustion engines (Walther, Wansart, Kieckhäfer, Schnieder & Spengler, 2010). It may not seem evident at first, but the use of private cars is one of the largest contributors of CO2 emissions in the transport sector (Fontaras, Zacharof & Ciuffo, 2017).

Combining the market success of newly developed electric vehicles with renewable energy sources makes the newly formed market conditions attractive for the introduction of innovation due to low barriers for entry of supporting products and services (Bühler, Cocron, Neumann, Franke & Krems, 2014). Tesla Motors defied the laws of the automotive industry, demonstrating for the first time that battery electric vehicles can be well designed, offer an acceptable range, while being able to defeat established automotive brands in performance tests (Chen & Perez, 2018).

Innovation in the EV market has been mainly channelled through two incumbent innovation approaches (Sovacool, Rogge, Saleta & Masterson-Cox, 2019). The first is transformative change shaping, which is more radical, inclined towards value creation with heavy R&D investment, hoping for the formulation of a profitable breakthrough through transformative learning. The second innovation approach is conservative sustaining, characterised by lower investments in R&D, somewhat less profound learning intentions and readily available options sourcing from assessments grounded on market sustainability (del Río & Bleda, 2012).

The automobile industry is commonly characterized by consistency in its product formation, abiding to expectation when it comes to joining specific components in a traditional form of the final product. Replacing the well-proven technology draws attention for the research of the causal relationship. Generally, there are two paramount conditions which allow or promote innovation in the electric vehicle market: technological innovation and economic distress (Wesseling, Niesten, Faber & Hekkert, 2015). Within the past decade we have witnessed disruptive mobility solutions such as Uber or Lyft, which have not only introduced true disruption into the transportation industry by capturing 70.5 percent of the US business traveller market but decimated the taxi industry to only six percent of market share (Vertesi, Goldstein, Enriquez, Liu & Miller, 2020). It is of key importance to understand how disruptive technology is transforming the traditional transportation industry and therefore creating new ways of understanding our usage of its means (Avital et al. 2014).

My intention with this thesis is thus to explore possibilities for innovation in the market that is still highly dependent on the performance of external factors and examine the behavioural patterns of consumers who have adopted the technological changes before it took turn for the mainstream. Rather than fully developing a full business model, my goal is to provide general recommendation within the current market position of electric vehicles, elevating the sense of urgency. The research will benefit the automotive industry with its current transition from internal combustion engine vehicles to electric vehicles, supporting the development of new technologies such as Internet of Things, advanced driver-assistance systems and shared mobility. It will also benefit current and future BEV owners in better understanding the cost of purchasing an EV and some of the barriers in their everyday use as a consequence of an unrewarding socio-economic policies.

In line with this purpose, the goals of the master thesis are:

- to explore consumer attitudes and preferences in usage of electric vehicles based on the upcoming EV transformation of the new vehicle market in Croatia;
- to analyse the pricing, availability and diversity of private and publicly available EV chargers in Croatia;
- to determine whether current users of EVs and those who are likely to purchase an EV in the following five years would consider a commercial service based on the inclusion of charging credit in the financing deal of a newly purchased EV;
- to provide concrete recommendations regarding a potential new business model for the EV market in Croatia.

The thesis is compiled of theoretical and empirical analysis. Theoretical analysis is based on scientific findings declared in articles and research papers. The literature review and market overview are based on collecting information from secondary data sources found in articles, web sites, books and similar sources in order to shape the theoretical groundwork of elemental concepts, academic milestones followed by current trends and processes that envelop the topic. The focus is put on the rationale behind the transformational trends in the industry and its relevance for the Croatian market. Furthermore, the interpretation of theoretical concepts and their causal nature is explained along with the compliancy of legislation within the scope of its applicability. The second, empirical part of the research consists of secondary data that accounts for industry reports, government reports and market trends, as well as primary data that I collected and analysed. The qualitative data was collected using a detailed questionnaire and was given to the Croatian driving public to assess their attitudes and beliefs as potential EV customers. In order to answer the research questions and address the concerns and pain points of the target audience, the results of the questionnaire were combined with secondary data such as official statistics and consumer reports to derive a general recommendation regarding the market transformation.

Regarding the thesis structure, in chapter one I examine the definition of disruptive innovation theory, while staying attentive to the inhibitors of disruptive innovation, and rounding up with key skills necessary for disruptive business to make use of their competitive advantages. In chapter two I analyse the evolution of the automotive industry, reflecting on the evolution of the automobile as the personal mobility solution, as well as the latest trends in governing the transition to cleaner propellants and the cases of ambiguous interpretation of the true benefits of such settlement. In chapter three I inspect the direction of Croatia's strategy for the electrification of transport, current state of charging infrastructure and the development of investments that might play a key role in supporting the shift away from fossil fuel powered automobiles. Next, in chapter four I focus on the research methodology, where I describe the sample and touch upon the techniques and some limitations of the primary research I conducted. Finally, in chapter five I examine the research results, with the goal of emphasizing the key statistics used to form the recommendation and the appropriate conclusion.

1 DISRUPTIVE INNOVATION

To understand the causality of factor resulting in a disruptive innovation, one must be able to recognize the correct timing and market conditions that allow for the appropriate formation of a solution to a problem that does not fit in the usual framework that is served to the target audience by the incumbent market players. Perhaps even more importantly, an organization's capability to provoke and finally pursuit a disruptive innovation largely depends on recognising the barriers installed by an established governing body within or outside the organization. This chapter is devoted to specifying the known variations in the definition of disruptive innovation and outlines the key barriers of evoking disruptive innovation within a business organization.

1.1 Definition of disruptive innovation

Understanding the disruptive spectre of an innovation may be one of the most important realization a market incumbent can pursue. In acting so, one increases the chance of evading the detrimental consequences of ignoring a disruptive innovation relevant to the market in question. Unfavourable outcomes range from less severe ones, such as reduced market share and descending market status, to ones of critical nature, as bankruptcy or death of organisation (assink & Christensen, 1995). Owing to the fact that the ability to predict disruptive innovations can have important effects, numerous researchers have sought to predict disruptions caused by innovations. However, these studies share at least three common problems: the definition of disruptive innovation is vague due to their focus on market impacts, how disruptive innovations can occasionally impact some, yet not all organizations, and analytic information is generally formed only post to innovation taking effect. The aforementioned issues have forced the researches to push the boundaries on defining more accurately what a disruptive innovation actually is (Schmidt & Druehl, 2008).

In the recent years, the pace of developing new products has increased tremendously; typical product lifecycles have been cut by half or more, and it is reasonable to expect the continuation if this trend. The quintessential nature of the need to innovate is rather revolutionary than evolutionary and considered to be nothing less than an imperative characteristic of business organisations which are attempting to survive in dynamic and complex markets, as too in unforeseeable economic circumstances. That said, ways of developing and implementing disruptive innovation are not up to the confident level of understanding, meaning that, relatively speaking, not many companies successfully administer and utilize their disruption innovation capability. Excluding radical innovation, the path down the declining route is simply destined.

Materializing on the aforementioned, a Deloitte Research study from year 2004 uncovered that there is an immense gap between intention and concrete disruptive innovation potential of the same companies (Deloitte Research, 2004). With this in mind, the development of specific capabilities can be the critical instrument in company's growth strategy through which the company is able to bridge that gap. An important note to have in mind, is that, organisational learning devotes its attention mainly to successful cases and under-samples the failed ones. Any learning process has a tendency to eradicate failure. Moreover, this tendency is underlined by the characteristic to build confidence, which in turn helps to develop favourable expectations and favourable interpretations of results. Such short sightedness for failure is an unwelcoming but a realistic phenomenon (Assink, 2006).

Regardless of the model chosen to categorise disruptive changes, the academic community achieved a universal consensus to concentrate on coming up with a range of new approaches to development viewed as an ecosystem management. In order to materialize the consensus, it is necessary to shift from a paradigm of "best-practice" to one of "best-fit" – that is, creative interventions that seek for optimization in the view of socioeconomic, political and environmental circumstances at any point in time. A potentially useful framework comes from recent work on systems thinking and complexity. It is argued that if a firm wants to confidently enhance its development it has to focus on boosting the system's capacity to adapt. As is the case in nature, efficiency of adaption depends on two things: selection and variation. Counter interventions of essentially disruptive nature which are capable of significantly affecting selection and variation will essentially help the organization to facilitate the self-organising continuous symphony we jointly name – development (Buckley & Ward, 2016).

Traditionally, disruptive innovation focalized on market characteristics, new market, and low-end innovations. For the purposes of this thesis, it is also important to introduce a point of view of theoretical identification of disruptive innovation on the base of technology as well, not only the market placement. In light of this realization, three innovation characteristics are identified: innovation's technical standard, functional aspect and type of ownership. Applying these innovation characteristics can be potentially used to examine the relative effects of a specific innovation, by referring to existing technologies used by an organization, to analyse organization's reactions in times of operational uncertainty and economic distress. Moreover, by using the logic of value chain, the effect of a potentially disruptive innovation can be understood better by referring to organization: the innovation itself and its impacts can be rated, according to its direction of disrupting primary or secondary operations, sustaining the aforementioned or even lacking effect in total.

However, identifying the impacts of various disruptive innovations on the example of a company or even a whole market is doubtlessly helpful, however a transparent definition of disruptive innovation is not given. In order to facilitate the quest for one, an American academic and business consultant Clayton Magleby Christensen (1995) brought in two diverse types of disruptive innovation: new market innovation and low-end innovation. It is no surprise then, that these two types of disruptive innovation have different effects on markets.

New market innovation acts, as its name suggests, by instituting new demand for a novel technology, resulting in consumer demand for market novelty. Vice versa, low end innovation tends to offer similar benefits of the existing technology but simultaneously being more affordable. Assembling the impact of the two different type of innovation, Christensen (1995) concluded that it is completely possible that the same particular set of innovations is disruptive to one group, and yet sustaining to the other group. Although the academic community consents to acknowledge the divergent influence of the changes upon the marketplace behaviour, the practical inquiry is to search for innovation characteristics which cause the markets to get disrupted.

Accordingly, two definitions of disruptive innovation are proposed. The first definition puts the functional quality and the cost of an innovation in the focal point. In other words, it defines disruptive innovation as an innovation with "satisfiable" functionality accompanied by a low cost of purchase. In theory, the two introductory differentiating aspects of the disruptive innovation, being lower quality and price, gradually increase in order to achieve performance goals of the company until the innovation is on par with market leading products, hence disrupting the status quo. Having said that, defining disruptive innovations as products of lower quality that compete on price does not seem to be a suitable innovation characteristic with which to define a classification of a technological product or service. Surely, an obvious cut in the market price of the competing innovation reflects many factors that in the end come together to form an offering, ranging from basic raw materials to organisational structure and specific market conditions. The attribute of "good enough quality" is a useful function of comparing several innovations, or comparing an innovation to an existing competitive offering, that ultimately complete a similar task. Set price and perceived quality are not constitutional characteristics of innovation but are rather suggestive of basic ideas behind strategic decisions a business has made. Moreover, competing on price and quality is a repeatedly accepted business strategy – yet still, these characteristics fail to ground the definition of how to tell whether an innovative technological solution is truly disruptive or not. As such, this definition fundamentally focuses on strategic decision regarding market entry and underestimates distinct innovation characteristics. This is crucial, because these specific traits are responsible for changing customer expectations and therefore, potentially disrupt existing or form new markets.

In comparison, the second definition keeps its focus away from the innovation's cost or perceived quality but has its eye on contemporary market characteristics. It is advocated that disruptive innovations question the performance standards, or consumer expectations, of a market. This definition completely changes the premise of the phenomenon forwards, as it takes the focus out of the market strategy to position innovation's characteristics alongside market expectations. Provided that, there are no means of identifying innovation characteristics that may probably disrupt the marketplace preferences, resulting from the inclusion of this theory. What is more, this theory hides no solution on the dilemma of how an innovation can be disruptive to one group, but sustaining to other (Nagy, Schuessler & Dubinsky, 2016).

In conclusion, neither of the above definitions of disruptive innovations recognizes that single distinct innovation characteristic that may be disruptive. They both set on external factors to the innovation, more precisely – market factors like cost, quality, performance metrics, and consumer expectations. Methodically speaking, these market factors impose their function referring externally to the innovation, owing to the fact they change. True traits of the innovation are instilled, fundamentally intrinsic, and are grounded within the innovation itself. Decision on the cost of the innovation, is always made by the innovation's owner, and it may be affected by the continuous flux of variety of factors external to an innovation. For example, quality aspect of the innovation is really only perceived by the consumer, as it always stays relative to previously issued competitive interpretations of the basic idea. Likewise, consumer expectations shift over time relative to peer innovations, which are again, external to an innovation (Nagy, Schuessler & Dubinsky, 2016).

Ownership of an innovation might seem as a peculiar disruptive characteristic as it is innate to the innovation, yet still, it is abstract. Ownership over an innovation does not have a physical manifestation. Lack of tactility makes it significantly different from the other characteristic, like radical functionality or discontinuous standards. However, differently determined ownership model strongly influence businesses, both inside and outside of the business entity. For instance, on the inside of the organisation, atypical model of ownership can shape the cost structure, employee motivation and organisational performance. On the contrary, on the outside of the organisation, it can influence the resource utilization and development, forms of sales and complimentary services associated with the innovation. Because ownership dictates the pricing policy, innovation related services and other means through which an innovation interacts with the market, ownership has many external market repercussions on innovations. Alternative forms of ownership in fortified industries have disrupted the status quo of these industries because by executing such a radical move, firms were able to dramatically lower the price, or introduce novel services surrounding the innovation. Such changes largely influence the market expectations circumventing disruptive innovations.

Notwithstanding, perhaps the exemplar realisation on the disruptiveness of innovations lies in the "Innovation Diffusion Theory (IDT), which suggests five key innovation attributes affecting the adoption of an innovation: relative advantage, compatibility, complexity, trialability and observability. Within the aspect of relative advantage, functionality of an innovation is the one influencing the adoption of technology. The concept of relative advantage is conscious of the volatile relation between technologies. As the name alone implies, functionality of an innovation inherently constructs a relative relationship between consumers and the technology in question. Furthermore, IDT foundations of compatibility and complexity are integrally connected to the technical standards of an innovation. Technical standards are ubiquitous among compatible technologies, while complex technologies introduce unfamiliar technical standards that impose an understanding obstacle for users. Inescapable complexity compels its adopters to overcome knowledge obstacles to fully utilize the effectiveness of the new technology. Other attributes of IDT, trialability and observability, are linked to market awareness in combination with distribution channels, and are conditional on ownership of an innovation. The owners of an innovation dictate the approach in presenting the innovation to the market in terms of aforementioned trialability and observability (Nagy, Schuessler & Dubinsky, 2016).

All things considered, because companies both take advantage of innovations and develop innovations, entrepreneurs and managers must be able to identify innovative technologies that may potentially disrupt either the markets of interest, or the innovations which will inevitably be employed by them. For instance, let us hypothesise that the automobile market may or may not be disrupted by the accelerated development of electric powertrains. The functional aspect of the conventional, internal combustion engine powered vehicle and the novel, battery powered vehicle, is nearly unaltered – one does not need to relearn how to drive an automobile based on her or his choice of propulsion. Nonetheless, technical standards that merge the materials and processes to build the vehicle considerably change. If market preferences were to shift aggressively to a strong demand for electric vehicles, automobile manufacturers that did not comply with the technical standards to build electric vehicles, including materials and manufacturing capabilities, may suffer a reduction in market share or total termination of production (Nagy, Schuessler & Dubinsky, 2016).

Disruptive innovations are frequently derived by combining the top qualities of multiple smaller ideas based on different world perspectives, challenging presumptions, the urge to expand boundaries, spotting the finesse between the lines. When a desire to create is as strong as the spectre of the already created, it allows the disruptor to discover yet unrealised needs of customers, simultaneously setting challenging goals and reaching them by thinking the unthinkable, because the fear to challenge our underlying mental model was conquered (Assink, 2006).

It is important to remember that technical innovation delivers no value directly. Pragmatically put, its value arises from the change in processes, functionality or utility. The realistic, frequently immeasurable change emerges from the value of internal change within the operational sector of a company. Equally so, it emerges from the external change among company's customers, ultimately creating leverage against established, yet weaker in performance, incumbent competitors (Paap and Katz, 2004). The concept of innovation spans over the continuum from incremental or sustainable innovation by modifying functionality to disruptive or radical innovation that breaches through the long-standing practices, shifting the paradigm (Assink, 2006).

Engagement in a disruptive innovation development process requires a mindset capable of supporting an interdependent system, grounded on the concepts of system thinking and of dynamic strategic thinking unified by learning as the focal point (Dickson, Farris, and Verbeke, 2001). Furthermore, the process of disruptive innovation can be contemplated as a certain rhythm, composed of search and stipulated selection, pragmatically supported by explorative experimenting, repeatedly underlined by learning and yet more unlearning, wrapped up in cycles of divergent and convergent thinking. It is, undoubtedly, an elaborate and interactive flux of testing and learning on the basis of feedback (Assink, 2006).

1.2 Inhibitors of disruptive innovation

It is no unusual practice for companies to be faced with internal and internal obstructions that get in the way of constructing the necessary capabilities to support the development of innovation. While internal and external forces create pressure to induce innovative exploration, their share in weight is not equal. Regardless of the degree of changes being imposed by the environment, the bulk of resistance to change comes from the inside of a firm. How severely would the firm's disruptive innovation capability change be upon the removal of inhibitors and how challenging the process of removal would be rests on the nature of these obstructions.

A study done by Assink (2006) contains a conceptual model that identifies several key inhibitors that negatively influence a firm's disruptive innovation capability. The following barriers represent the types of integrated flaws which an incumbent company can be faced with upon the quest for reimagining their market position in terms of innovativeness. The key inhibitors originate from diverse functions of a company, having their roots in company's strategic perspective which prioritizes already proven concepts and formulas. Coupled with risk associated investments which often provide no guarantee for their expected return, it becomes clear that traditional management does not favour such endeavours with questionable outcomes.

1.2.1 The Mindset Adoption Barrier

Firstly, it is an often practice that companies contain their development capabilities and overvalue the effectiveness of incremental innovations, such as refinement of existing designs and technologies of the handsomely called dominant design. By acting mundane, a company accepts the risk of being overtaken by entrepreneurial entities launching a disruptive innovation that may disrupt the market completely (Henderson, 2006). Contemporary successful products, designs and technologies create an obstacle for taking a risky investment while increasing the risk of getting entrenched in the familiarity trap, authoritarianism of business success (Ahuja & Lampert, 2001). Secondly, the renowned hierarchical structure, although deemed as effective for routine-based processes, undertakings, and refinement cycles, is less suitable and not as flexible for radical innovation. Such collisions are more frequent in large corporations due to a lack of a clear two-fold structure, simultaneously supporting incremental innovation of existing products and technologies, and adaptability to test their capabilities for radical innovation (Cosier & Hughes, 2001). Thirdly, excessive bureaucracy is often synonymous with big organizations that are obliged to comply with an abundance of rules and extensive procedures that ultimately restrain creativity.

The result comes in the form of delayed reactions and a conservative approach to risk taking. What's more, generic conservatism and an accentuated learning deficiency are the most persuasive reasons why large incumbents have such a hard time embracing radical innovation and later turning it in a commercial success. The explanation for such irrational modus operandi lies in the genetic material of most large companies, where embracing radical innovation might upset its status quo, therefore jeopardizing great investments put in the company. Last but not least, the ability to unlearn stands as one of the most critical competencies companies require to surpass prejudgement and obsolete mental models – principal barriers to disruptive innovation.

Unlearning the existing paradigm is central to higher order learning: the ability to generate and apply meta learning and counteract with challenging assumptions (Baker & Sinkula, 2002). The timing of sensing when to deploy the unlearning treatment seems critical. When a business organisation is unable to unlearn, to look through the barriers of conventional thinking, and to gradually reject outdated perspectives, it impedes the dismissing of obsolete mental models. Such behaviour influences how a company approaches to collecting market information, along with the later interpretation and implication. If scrutinizing core assumptions is avoided, accurate interpretation and possible unlearning are repressed. For instance, when Apple Inc. decided to entry the music industry, it used its position of an outsider, which gave it an independence of thought and model formation that consequently allowed to execute what the music industry itself apparently failed to conceive – trading single songs rather than CD albums (Assink, 2006).

1.2.2 The Risk Barrier

Investing company's assets induces pressure to predict the monetary return, hence it is no surprise that investing in disruptive innovation constitutes a barrier for its initialization (Harper & Becker, 2004). Reasoning behind investing into the development of disruptive innovation in incumbent companies often lay in aggressive revenue expectations. High revenue targets may keep venture managers away from deciding to target emerging markets as the suitable environment in which disruptive technologies are likely to enjoy initial success. Similarly, including features that may please customers in existing markets increases chances of a stronger commercial success but also potentially makes the product too expensive, therefore negatively impacting sales revenue (Gilbert, 2003). The risk barrier can also be carried out through the unwillingness of the company to cannibalise their current products or services. According to a comprehensive research study by Deloitte Research from 2004, established companies rather allocate their resources towards short to medium growth in order to protect their present portfolio constituents (Deloitte, 2004). For instance, in today's world of digital technology one of the most noticeable transformative disruptions occurred among the incumbent players of the photography industry. Namely, senior management of Eastman Kodak Company and Agfa-Gevaert N.V. stalled for too long to switch from their chemical film process to innovative but initially more expensive per print digital printing technology (Hill, 2012).

1.2.3 The Initialization Barrier: lack of market sensing and foresight

Generally, market research fulfils its purpose well for incremental innovation in existing markets. On the other hand, conventional market research results when utilized in the development of strong disruptive innovation, may have a devastating effect, or can even later prove to be misleading (Trott, 2001).

As a matter of fact, the market research testing for the first video recorder, microwave, fax, mobile telephone, Sony's Walkman, and FedEx turned out to be negative. Former Sony Corporation CEO, Akiro Morita at the time stated the following: "Our plan is to lead the public with new products rather than ask them what kind of products they want. The public does not know what is possible, but we do." The message sent across is that the markets that are not created yet cannot be simply analysed (Mullins, 2000).

Disruptive innovations are often underperforming in their early stages, requiring further optimization. Attempting to match the performance expectations that customers of established markets are accustomed to, will often result in a failure. At first, targeting the emerging market or low-cost applications where product or service requirements are capable of covering the largest share of the target audience, increases the chances of securing the continuation of optimization of the present design together with the manufacturing process (Gilbert, 2003).

Moreover, due to the forward-thinking principle of disruptive innovations, the lack of mandatory infrastructure may have decades separating their breakthrough from their exploitation for commercial application. Such anguishing prolongation is referred within the innovation community as the “Valley of Death”. The case of lacking necessary infrastructure is frequent, combined with an often case of underdevelopment preventing easy integration. With this in mind, infrastructure challenges can be divided into an “upstream” and a “downstream” component. The upstream component is designated by the technical aspects of a radical innovation haloed by newness, such as missing standards and processes, and the lack of production equipment. On the other hand, the downstream component considers the market aspects, such as market acceptance rate, available distribution channels, potential for strategic partners and external infrastructure (Walsh & Linton, 2000).

1.3 Key skills for disruptive business

A multitude of industries have experienced various types of transformation because of the knowledge sharing processes in organizations mostly involved with digital technology, bringing in innovative forms of digital products, services, channels and interfaces (Routley, Phaal & Probert, 2013). New businesses that decide to act upon the courageous approach of disruptive innovation should focus on coordinating the various existing economic activities together with the establishment of symbiotic relationships of growth. Because of the specific, and yet widely unapproved characteristics of the newly introduced product or service, disruptive innovation favours a growth-oriented market with a promising sustainability aspect by creating opportunities to further broaden its current activities in new ways, with new joints that will help provide a more significant economic and financial stability. The imposing question that one should ask is “What are the needed skills by entrepreneurs to manage a disruptive business?”

In order to provide an insight to this scientific inquiry, research conducted by Álvaro Rocha & Maria José Sousa analyses the concept of needed skills and in addition investigates the skills required for creating and managing disruptive digital business that can trace its roots back to the IT evolution. The identification of technologies, disruptive business theory knowledge and supporting skills imperative for entrepreneurs was acquired through content analysis of semi-structured interviews among seven Information Technology (IT) experts. Another key point to remember is that this research concretises on the role of IT as a driving force for creating business of disruptive nature which are in need of specific competencies development. The technologies that were analysed are the Internet of Things, Cloud Technology, Big Data, Mobile Technologies, Artificial Intelligence (AI) and Robotics, as technologies identified by the experts who participated in the study (Sousa & Rocha, 2019).

The three innovations that are the basis for building a model of development skills are the following: innovation skills, leadership skills and management skills. By implementing this model of development skills, a business organization is able to promote the acquisition of skills in the view of business development, complimentary to the elected strategy for future launching of market attractive products and services (Sousa & Rocha, 2019). The development skills deemed relevant for managing a disruptive business are placed and categorized in Table 1.

Table 1: Development skills facilitating growth of a disruptive business

Innovation skills	Leadership skills	Management skills
Recognition of innovation and creativity	High performance team management	New models of work organization
Search for new business opportunities	Talent management	Scrutinization of emerging technologies
Project management	Motivation & Satisfaction	Big Data analysis
Risk management	Communication	Organizational change
Work efficiency and efficacy	Career ladder management	Strategic management
Promoting networking	Directorship of multicultural employees	Social and relational acquaintance

Adapted from Sousa & Rocha (2019)

1.4 Use of proactiveness for a disruptive business

Companies that decide to take the path of disruptive innovation are often used as examples of proactiveness. The decision to act proactively, even though potentially an expensive one, may mitigate some of the risk around the disruptive innovation if the investment in market proactiveness is targeted to certain group of prospective customers.

Contrary to the reactive behaviour, triggered by the realisation of unforeseen environmental circumstances, proactive behaviour is designed to at least partially eliminate the problematic limitations, such as lack of time and insufficient options to choose from. The discrepancy in the two approaches is most prominent at the time of an economic crisis, where the company's management may experience hardship due to wrong assumptions in the moment of composing their reactive strategy (Bohn, 2000). One of the definitions of proactive strategy is the following: "One in which strategists act before they are forced to react to environmental threats and opportunities." (Glueck & Jauch, 1988). As follows, proactive exercise is a form of reactive behaviour.

In other words, instead of reacting on the environmental change as it materializes, proactive strategy ensures to take action upon the emergence of symptoms of the incoming change. If one would approach this kind of behaviour as to regulation, it would be defined as anticipatory regulation, with the goal of neutralizing the unwanted effect of the disturbance on the outcome. Similarly, anticipatory behaviour could be viewed as control of the present, because to correctly form such behaviour, historical and current information, as well as future forecasts, need to be utilized (Stacey, 1993).

Correspondingly, proactiveness is recognized to compromise both the answer to the warnings of the coming change in the company's environment and the formation of the reciprocal alterations within it. The key differentiation is the time. That said, forming a reaction plan based on the anticipated changes is not enough at times. It is essential for a disruptive company to actively stay ahead of the competition in unique ways and continuously anticipate the future outcomes that might affect their strategic positioning (Sandberg, 2002). If a disruptive company decides to accept the proactive behaviour, it may adopt different degrees of proactiveness. As its positioning on the line of this conceptualization is relative, the present placement of the company on the proactiveness – reactiveness continuum can fluctuate according to perceived goals.

Generally, the consumer market is rather undaring on the whole and even though there are innovative adopters who are willing to test new products, they only make for a small portion of the market. Usually, only the purchasing capacity of the majority is able to offset the accumulated costs of developing the disruptive innovation; thus, lowering the adoption barriers is crucial. Diffusion of a disruptive innovation therefore should be susceptible to ongoing market fluctuations, in conjunction with continuously adaptive marketing interventions (Rogers, 1983).

Introducing a market novelty carries risk, usually at its highest in the moment of the product/service launch. Making it available for the open market often is the most challenging task for the entrepreneurial team undertaking the decision of disrupting the market. In case of disruptive innovations, the framework of the technology involved may come secondary to communicating the vision of the future scenarios encompassing the technological advancement.

Therefore, market education has a role of minimising the unavoidable barrier posed to the market by the established practices and clearly presenting the understanding logic of using competitive products and service. Usually, market education is carried out through multiple means of communication; one of the most effective being opinion leaders. Unlike brand ambassadors, their judgement is not subjected to favourable incentives. Nowadays, social media is the preferable promotional channel due to its ability to target potential customers based on numerous interest points.

One of the advantages present in the world of quick flowing information is that companies can build market awareness and work on educating the market much more quickly and effectively than in the past. The proactive approach facilitates the response on the disruptive innovation, which is then processed through further market research upon the appearance of symptoms of market acceptance. Consequently, the following improvements in the innovation can be executed with higher accuracy, which is crucial for ensuring a positive market acceptance rate (Sandberg, 2002).

Taking on a proactive approach with the aim of additionally securing a successful launch of the disruption inevitably generates additional expenses. Therefore, it makes sense to target specific customer segments which have a better chance of increasing the diffusion rate. However, such action certainly caries a risk, since potentially deciding to target the wrong customer segment may inhibit diffusion; already after the money invested to marketing research and marketing promotion has been spent. The key target audience towards which disruptive innovators turn to are early adopters (later noted as EAs). EA seem to be a natural choice for targeting a group of customers which tend to test the disruptive innovation earlier than most customers. An EA favours an incremental improvement in the view of productivity and customer service which in return is able to provide them with a competitive advantage compared to their peers. With EAs, price sensitivity is a lesser obstacle because they are willing to go the extra mile in investing their money in order to profit in other fields. A complimentary addition to their willing investment is the desire to socially expose and therefore serve as a reference. That said, this target group is not to be mistaken for someone who fails to thoroughly investigate in what and why are they investing. EAs to not represent the usual customer, hence it is reasonable to limit the focus on them around the time of the launch (Chiu, Fang & Tseng, 2010).

EAs can start the flow of information by implementing the most effective communication tool: word of mouth. By openly conversing about the beneficial features of their recent investment, the distinct features of the disruptive innovation such as value for money, causal links in real world performance improvements, but also disadvantages that arise during their early test period, they are boosting the dissemination of awareness. On the other hand, in relation to later adopters which can be referred to as “general customers”, EAs may communicate the decision of buying the disruptive innovation and therefore cause imitative behaviour forming a more successful adoption.

Notably, disruptive innovations which aim to disrupt the market in a form of a platform come to portray the role of EAs as the crucial first step of dissemination. The subsequent imitation of the later adopters is a mechanism that stimulates further adoption but plays a more essential role for disruptive innovations that are non-platform based. Due to these specific behavioural patterns of the EAs, at the time of the launch companies specifically profile and target different segments of EAs in relation to the role they expected to carry out. Such decisions are taken in line with the desired future adoption rates among more conservative customers, increasing the probability of an earlier market success. In comparison, a study made by Frattini, Bianchi, De Massis, Sikimic (2013), emphasizes the importance of the characteristics of the innovation, more precisely whether the innovation is a platform based or a non-platform product. According to the study results, product and marketing managers that develop a platform based disruptive innovation should avoid targeting specific segments of EAs due to the aspect of competitive advantage that business users of the disruptive innovation are enjoying. In that instance, early adopting companies have no interest to share their objective or subjective impressions on the newly purchased innovation with other companies competing in the same industry.

Having said that, non-platform innovations chosen by the early adoption companies that are facing strong competition are operating in a highly dynamic environment in which the new product is likely to reach higher dissemination more quickly. Due to the nature of competitive behaviour, where copying existing solutions is the usual practice, players are keen to simply imitate successfully functioning solutions, therefore propelling the sequential adoption of the disruptive innovation in the mainstream market.

It is reasonable to conclude that the dissemination of effective disruptive innovation that can positively influence the competitive aspect of early adopters is different from the behavioural patterns concerning personal use of the disruptive innovation. Yet, even though EAs operating in a business environment will be wary to communicate to other companies how the innovation changed their operational activities, the clear fact that they have chosen to adopt the innovation will probably reach the outer environment through more informal channels in forms of, for instance, seminars, novelty fairs and cooperative ventures, and therefore stimulate adoption through imitation (Frattini, Bianchi, De Massis & Sikimic, 2014).

The theoretical concept that purses a clearer understanding of the adoption intention within the frame of innate innovativeness is developed as a scale for motivated consumer innovativeness that consists of social, functional, hedonic and cognitive innovativeness. The construct of innate innovativeness is crucial for an in-depth analysis on innovative behaviour because it notes that the type of innovativeness is an attribute that stands relatively consistent over time (Vandecasteele & Geuens, 2010). The disruptive innovation theory fails to predict the specific differences in how the innate innovativeness affects the adoption intention.

Presumptions about a particular disruptive innovation may contribute to mixed predictions on the effect of various innate innovativeness dimensions. For example, compared to the primary performance aspect, disruptive innovation come second compared to established market solutions but frequently outperform them in the auxiliary performance aspect. Henceforth, functional innovativeness revolves around the relative value of a performance dimension but not strictly on the distinction of disruptive opposed to sustaining innovations.

Likewise, new-fashioned performance attributes reinforce socially motivated innovativeness, but in the case of cut down primary functionality diminishes socially motivated innovativeness. This socially induced phenomenon can be influenced by disruptive companies by intervening in the form of market education. Consumers do not innately understand the practical implication of the superior auxiliary performance dimension compared to existing solutions. In order to familiarize the consumer with the benefits of disruptive innovation, companies are required to devote more resources to educate the market to increase consumer knowledge, which ultimately builds ground for mass adoption (Reinhardt & Gurtner, 2015).

2 TRANSFORMATION OF THE GLOBAL AUTOMOTIVE INDUSTRY

Looking at the automotive industry about 20 years ago, this omnipresent business surely gave the impression of a mature industry, characterized a supremely stable structure while being quite predictable according to, at the time, generally accepted theoretical concepts: innovation through evolution, efficiently managed fortification, guidance provided by the massive incumbents. Yet, for over a decade, this socially and economically extremely significant industry has witnessed noticeable turbulence due primarily to alterations in markets, emerging technologies and additional regulations.

The automotive industry has traditionally been marked as a capital-heavy industry with strong vertical integration and economies of scale. However, in the early years, before the series production gained traction, the industry was structured of many firms – reaching around 300 in 1910. Since the product concept wasn't strictly regulated, many different companies were competing for the dominant design. After about a decade has past, strong unification left only a few OEMs that were successful in establishing the essential system-integration capabilities and scale, consequently fortifying barriers of entry. This particular series of outcomes solidified evolution and stability opposed to revolution and change. More importantly, it shows a closer reflection of the industry's structure, products and innovation processes until the end of the 20th century (Schulze, Paul MacDuffie & Taube, 2015).

Automobiles are defined as relatively large, heavy, fast-moving vehicles that operate in public space (MacDuffie & Fujimoto, 2010). Due to their overall presence in modern society's environment, they are consistently regulated, in both developed and developing countries, according to steady set of public policy issues: active and passive safety, energy consumption, emissions, etc. Notably, OEMs in pursue of exporting their products on a global scale must be able to match the quality standards od developed country markets. As a result, all global OEMs are required to achieve a similarly competitive level of system-integration capability and innovation capacity (Schulze, Paul MacDuffie & Taube, 2015).

2.1 Introduction of the automobile

In the past, personal mobility was a hierarchy-bound activity. Ordinary people walked, while the members of the aristocracy rode horses. Cycling stood for the middle-class alternative to horse riding. In descriptive terms, riding a bicycle at a relaxed pace in the countryside was on par with the updated aristocracy. By the 1880s, the iconic belletrist expression formerly denoting the steam locomotive stood for bicycles: in travelogues, the average Joe kindly called their bicycle his 'iron horse' (Oldenziel, 2018).

By 1897, at the time prominent and ever so present Europe's royal families, simply had to admit they could no longer ignore the wave of modernity their neighbouring middle-class citizens carried out with their 'self-propelled voyagers'. Established newspapers openly reported how everyone who mattered in high society got along with modernity: the developing middle-class men climbing the social ladder, rights-yearning women, and progressive constituents of the aristocracy and royal families – in that particular order.

About two decades later, the same market players, pronounced civil-society characters and experts once involved in the bicycle business moved to the automobile industry – and along with them the patronage for a discourse of modern mobility. Therefore, it is no surprise that many of the pioneering automobile manufacturers like Opel and Peugeot had started out as bicycle manufacturers. In a short period of only few years, cycling was suddenly discredited as unmodern and hopelessly old-fashioned. That said, the automobile-led modernity was still highly debated in the period between two World Wars – and would belatedly develop into its full form only after the Second World War. During the 1920s, both sides the Atlantic were starting to see the motor car being broadly present on their streets. However, the looks towards the car drivers were not the ones of inclination, but rather of controversy. To give an illustration of the social climate in the day, the automobile was portrayed so badly that police units, journalists and pedestrian associations saw it as the intruder of the public space, and the speeding automobile resembled a killing machine (Law, 2012). During the 1920s, the automobile lobby used the time to alter motorists' bad reputation. The rhetoric of the new modern way of personal mobility in the form of motorized traffic played a crucial role in this transformational campaign. The debates for the updated interpretation of what is modern frequently implied contrasting arguments, for instance: 'fast' versus 'slow' traffic; motorized versus non-motorized circulation; continuous flow versus disruption; modern versus old fashioned etc. Above all, an opposing distinction between past and future mobility.

The rising interests of the automobile lobby, in conjunction with the public transit interests, campaigned a propaganda, intentionally casting a bad light on pedestrians and cyclists, deeming them as anti-modern, even illegitimate, users of the public streets. It is not surprising that both world wars had an important role in fortifying the automobile as the key innovation in the road ahead. Turning our focus towards the bicycle rather than the automobile, lets us have a perspective on how it was debated and who took control of its narrative. The story of the use of bicycles portrays particularly well how technologies which stood as modern could just as practically vanish, before being introduced as innovative again (Oldenziel, 2018).

2.2 Consumer induced refinement of the automobile

According to the general opinion; farmers, businessmen, business-owners and blue-collar workers commuters are given the credit for being the driving force in the breakthrough of the automobile. However, automobile research and development evolved in a form that was particularly geared towards grand touring, opposed to the daily-commute and the occasional weekend trip. In order to provide the necessary creature comforts for tourism, the technical aspects of the automobile had to be adjusted towards what, in the 1930s, became widely known as "the affordable family car", which from the beginning oozed with sobriety and safe levels of power. Even though Ford's Model T took the prize as the imperative 'universal car', during the 1920s newly launched automobiles of enclosed type, including Ford's own type A and larger V8 models, superseded the celebrated Model T. As well as the other comfort-oriented technologies like the telephone and the bathtub, these automobiles were solely marketed towards the continuously fortifying urban middle-class family (Mom, 2014).

As it was mentioned beforehand, the period from 1915 to 1945 was essential in the development of the automobile. In light of great human migration across the globe due to the world wars, American army force, which later became a large part of American customer base, had the chance to personally experience European automobiles. At the time, it was considered that European automobiles, as it was quoted "Our cars come in for a great deal of criticism. They say we sit on our cars while they sit in theirs, and when you ride in their cars you agree with them. We spent 10 days in different makes of European cars. They ride remarkably 'easy'. Their cars are most comfortable, and they are very low" (Beecroft, 1919, p. 521-525). One might think that the American automotive engineers began to closely follow their European counterparts, yet on the other hand, the end of the Second World War marked the beginning of distancing in automotive design. Not surprisingly, the European automotive engineers took action in same fashion, particularly by avoiding the specific values that were promoted by the American automobile technology. This partition initiated a practice of mutual stereotyping that outlines one side by representing the dissimilarity of the other.

With the today's impactful reintroduction of the electric automobile, one may ask why more early motorists did not rather choose the electric automobile if comfort was high on the priority list of traits. Besides, electrically powered automobiles were considered to have considerably lower levels of noise, while their comfortable, nicely upholstered interiors made them more appropriate for people who didn't have the desire to engage in the automotive adventure (Mom, 2003). In place of such trend, popular critics increasingly ridiculed the electric automobiles as 'feminine', while simultaneously the benefit of a soundless powertrain was used by the competitors to alleviate the petrol automobile's self-appointed adventurousness. Inevitably, manufacturers of petrol-powered automobiles started taking over the intimidatory characteristics of their soundless competitors – somewhat technological version of 'repressive tolerance'.

Automobile manufacturers and consumers alike co-constructed an automobile culture skewed towards masculinity in which the automobile was essentially defined as adventurous to senses, yet in a civilized manner. Regarding this particular issue, the concept of co-construction has two implications. It deals with the layered construction task which automotive engineers have to fulfil by first forming a product while simultaneously outlining its user-friendliness to future customers. Namely, while the engineers are working on the product, they are conjointly forming users and their thoughts as well (Mom, 2014).

Throughout the design of technical features, even though the customers' leverage was frequently indirect, it was nonetheless real. Motorists were increasingly enveloped in a cabin in which the noise, harshness and vibrations were intentionally altered. The sensation of comfort was defined as smoothness, careless flight, and, ultimately, a restraining of the adventurous automotive ride but without, after all, letting it diminish entirely, as many believed had happened with the electric automobile (Mom, 2014).

2.3 Automotive industry in the present day

While digital disruption has shown to be a gateway for many companies to launch their ideas in the automotive industry, one with extremely high barriers to entry, it has also proven itself to be a pulsating headache for other incumbent automobile manufacturers. Having said that, neither side has achieved great success. One important consumer-facing detail automobile manufacturers need to refine, is how to provide the consumers with every option they can think of, while maintaining costs within the limits so investors and stakeholders are still willing to stay in the game, hungry for profit. Naturally, nowadays there is strong competition in the rising electric mobility market as automobile manufacturers compete to lead in an expanding responsible market with more environmentally friendly request than witnessed ever before. Even though the trend is skewed towards alternatively powered and designed automobiles, the publicly scrutinized and condemned diesel engines stayed highly coveted in the world market. It is unlikely that such market share distribution will remain stable over the next two decades, but until situation goes unchanged, automobile manufacturers have to continue to put effort into innovation and radical development, together with overcoming the challenge of generating enough units to meet the demand of potentials customers (Auto Industry Prospects, 2018).

Over the past decade, the public had the opportunity to frequently hear about the macroeconomic importance of manufacturing investments prompted by the financial incentives offered by governments in order to attract automobile companies. In North America, government incentives for greenfield ventures date back to the 1960s (Anastakis, 2004). By the early 1980s, Japanese-manufactured automobiles gained traction on the global market with their competent vehicle fleet, offering more frugal engines and overall better value for money. Such a disruption in market entry unsurprisingly caught the attention of, in this case, the Canadian government.

Instead of imposing high tariff towards protecting the domestic manufacturers, the government decided to encourage investment from, already robustly represented Toyota and Honda, by introducing non-tariff barriers combined with financial incentive packages. Such foreign investment policy resulted in building of five new automotive assembly plants in Ontario, Canada. Naturally, other corporations may differ in their views towards government formed incentives. For the Toyota and Honda, the incentive was a mark of government's approval for automotive investment, a sort of salute to mutual benefit. In comparison, Ford Motor Company had considered the same government incentive exclusively as a part of their cost analysis, minding on the potential savings upon assessing Canada as a potential candidate for their next assembly plant (Yates, & Lewchuk, 2017).

Even though other factors apart from macroeconomic variables conjointly form investment decisions, cost estimate still must not be underestimated for its relevance. Cost estimate is usually the precursor to all superseding steps in the process of choosing the potential location appropriate for a new investment. Above all, automotive investments are of great potential value for the community that can recognize its multiplier effect. Therefore, various localities are competing for their prevalence, each of which has to be able to offer a quick and an effective response to any hazardous circumstance capable of discarding their potential. In other words, localities have to be prepared to offer a site-location package that coercively incorporates the value of various potential incentives. Full utilization of corporate investment opportunities will be achieved only as a product of communication and strategy, susceptible to quality of cooperation between the municipal, regional and federal government.

The chance of sealing the deal highly depends on the responsiveness of expressing concern on the importance of the investment, while clearly exhibiting the desire for automotive production. Incentive packages that are overly complicated and not designed with the needs of investors in mind may be useless, regardless of their monetary value (Yates, & Lewchuk, 2017).

The ongoing challenges in the automobile industry consist of globalization and market integration intertwined by the rapid pace of technological evolution. Although they represent many challenges, they represent the equal number of opportunities. This is especially true for firms in developing Central and Eastern European countries that undergo a lack of significant domestic market that is necessary for substantial growth, previously limited due to a relatively weak infrastructure. Acknowledging these inadequacies and potential shortcomings, some countries in the post-socialist Europe coped with this issue by promoting development of regional clusters where companies can expand on their expertise and competitive advantages against the global competition by mutually sharing resources, innovation techniques and knowledge. The emergence of transnational clusters in Central Europe has proven to be a large contributor to the socio-economic development, and served as a showcase to many new member states of the European Union in providing evidence on attracting a large investment into the region's economy (Zámborský, 2012). The importance and mutual interest of the Central European automotive clusters is supported by the relatively high share of the EU car production generated by the member states who entered the Union after year 2000. Czech Republic, Slovakia and Slovenia stand for the world's leading automobile producers per capita. In the Appendix 3 one may find the chart showing the share of direct automotive employment in total manufacturing by country for year 2018 (ACEA, 2020).

Volkswagen's production site in Slovakia was founded in 1001 and was an integral part of the corporation's strategy to make use of the political and economic disruptions following the fall of the Berlin Wall in 1989. How quickly and reliably will Central Europe develop was not evident, neither how will Volkswagen redistribute its production elements outside of its home country. By patiently forming a tactic Volkswagen initially benefited from the Slovakian production site by using it as a safety net during period of peak demand, avoiding movement of substantial resources in a voluminous manner. Today, it stands as a positive showcase of successful development strategy, signifying a welcome change and a direction for future investment policy for other recently joined EU member states. After almost 30 years from the founding of the production site, indicating gradual but consistent growth, Volkswagen's Slovakian production site is the sole location assembling group's flagships SUV models such as Audi Q7 and Volkswagen Touareg. The brave first-mover strategy in Central Europe was definitely courageous, resulting in improvement in its European and world competitiveness (Zámborský, 2012).

Volkswagen was not the sole manufacturer which decided to invest into Central Europe. French Groupe PSA (PSA Peugeot Citroën) and South Korean giant Hyundai Motors invested in Slovakia in an equivalent fashion in the 2000s, hoping to join the same highway of efficiency and cooperation. In spite of successful practice Volkswagen managed to derive, the South Korean companies implemented the means necessary for due diligence in order to closely examine the potential effects of geographic concentration and clustering of automobile manufacturers in such a small region. The transnational dimensions of the clustering are yet to be proven in terms of competitiveness since they are still in the early stage of interconnectedness and high horizontal integration (Zámborský, 2012).

2.4 The automobile for the new mobility

Abandoning the internal combustion engine and replacing it with an electric powertrain, complimented by the increase in demand for constant connectivity, inevitably confronted automotive manufacturers with arduous challenges. The rules of engagement for connected and self-driving vehicles are still being negotiated among various stakeholders, but that doesn't stop the market to evolve rapidly for the customary models of automobile ownership to be challenged more than ever before (Naughton & Cronin Fisk, 2015). Together with the recent introduction of technologies which utilize many radars and sensors in order to position the moving vehicle on the road, or even mitigate collisions under a set speed, the current research and development activities are focused on perfecting the concepts of constant connectivity, such as vehicle-to-infrastructure (V2I), and vehicle-to-vehicle (V2V). Even though many of these innovative ideas are still in their early stages of development, in addition to the lack of consumer testing and potential acceptance, the impact on the architecture of the automobile is visible. Usage of electronic components marks has increased substantially; automobiles are now able to run under higher voltage systems, and advanced electrochemical based energy storage systems such as lithium-ion batteries are designated to play an important role in the upcoming automobile evolution. Specialist suppliers have been favoured by the automobile industry for decades, yet automobile manufacturers and their suppliers are starting to deem certain technologies and proprietary components as part of their key competencies. Hence, they are directing their investment towards projects which will enhance their capabilities, and therefore give them a competitive advantage in the market shaken by the uprise of new players (Minarcin, 2016). Because of the increase in complexity and number of components built-into new automobiles, manufacturers are searching for new fail-safe mechanisms to support detailed traceability and accountability. As a result, the assembly floor gained additional instruments that enable better tracking, vision and measurement values that provide data to use in further fine tuning of the complete process.

Drivetrain electrification and vehicle systems supporting greater and more complex levels connectivity are members of a larger task that also focuses on less obvious components of an automobile such as materials, infotainment and the electrical infrastructure. Drivetrain alterations and newly developed materials make up strategic plans for automakers to attain better performance and utility while obtaining regulatory target values. Most of the changes in automobile architecture can are directly connected to the improvements in semiconductor technology over the last six decades. Nowadays, it is the most powerful driver of change in the automotive industry, encompassing virtually every innovative feature in automotive design. Rapid development of electronics directly benefits the even faster implementation of connectivity services in automobiles, today viewed as an obligatory luxury feature (KPMG, 2015). Seen through various perspectives, the modern automobiles have already become a form a supercomputer. In what now seems to be distant 2015, in terms of electronic component development, at the Consumer Electronics Show in Las Vegas, IT company Nvidia already introduced two new computing units designed for use in an automobile – one unit designated for the instrument cluster and one for use in autonomous driving systems (Minarcin, 2016).

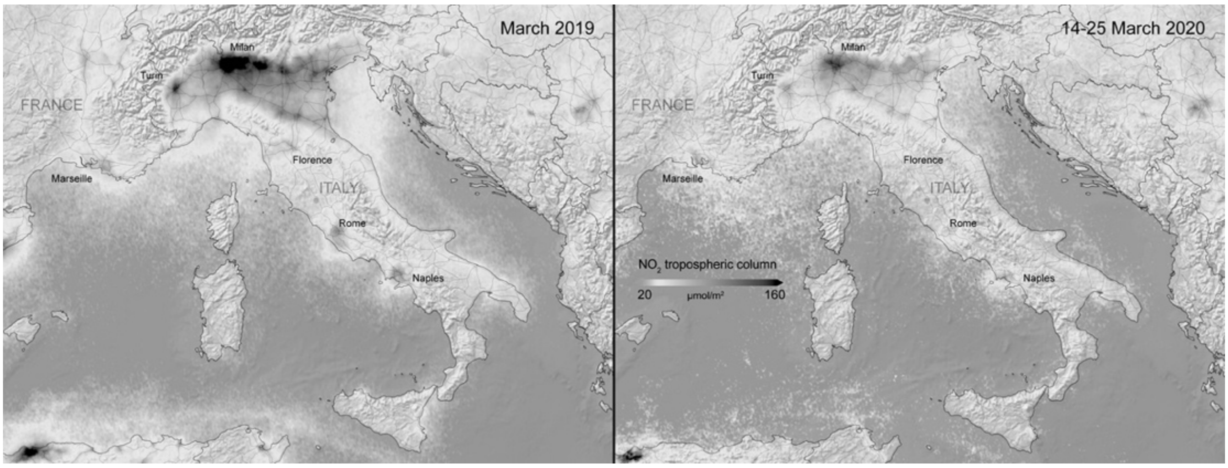
The automobile industry is characterized by heavy capital investment; thus, manufacturers are inclined towards developing platforms which can be used for multiple models. In order to build a successful platform, an automaker must balance the right mix of electronic drivetrain, practical features, user control and battery efficiency to meet the optimal proportion of utility and design features to deem attractive compared to its close competitors. Such level of component complexity, the role of big data comes in handy. However, when considering the role of big data in automobile assembly of electric and connected vehicles, it is crucial to understand that the term big data can largely deviate from the meaning usually adopted and marketed for promotional purposes. The function of big data in automobile manufacturing strongly depends on the use of advanced intelligence and information processing, being present on the assembly line, in-vehicle and in the broader infrastructure. To maximize the use of the technology, a competent manufacturer must be able to use the data to reinvent and restructure incentives, decision possibilities, information circulation and organizational capital.

To illustrate the gravity of big data managed by auto manufacturers and their supplier network, it is sufficient to observe the average number of data collection points and the amount of data generated. The average internal combustion engine or transmission assembly line of a comparable North American automobile manufacturer contains upwards of 50 data points where data is noted for regulatory purposes exclusively. The assumption stands as following: each workstation on the line has a cycle time of 55 seconds and the single average information output contains two kilobytes of information. Therefore, it is possible that over two trillion bytes of data are recorded within a period of a single year (assuming the assembly line runs two shifts per day, during the usual week of five workdays). In conclusion, the trend towards flexible manufacturing systems and vehicle architectures is likely to be continued due to its strategic advantages. Having said that, upper management have to harness their appetite for development in relation to fully understanding the intrinsic and extrinsic costs of systemic architecture (Minarcin, 2016).

2.5 Isolation of the combustion engine from the EU

Passenger automobiles and light transport vehicles are responsible for around 15% of European Union greenhouse emissions and directly contribute do excessive concentrations of air pollutants in many cities across Europe. The pandemic of the COVID-19 virus had a role in temporarily decreasing emissions from passenger cars and vans as a result of a drop in people’s need to commute, therefore decreasing the volume of greenhouse gasses emitted into the atmosphere. Data from March 2020 shows that that, on a local scale, air pollution from harmful gasses like nitrogen dioxide (NO2) substantially decreased in several European metropolitan areas due to strict measures affecting mobility or a broader range of economic and social activities in order to limit the virus expansion. Figure 1 depicts the difference in the atmospheric concentration of nitrogen dioxide greenhouse pollutant over Italy.

Figure 1: Yearly comparison of nitrogen dioxide concentration over Italy



Source: European Space Agency (2020).

However, these restrictive measures are time limited and in relation to extent of the coronavirus pandemic. Exemption of a long-term air-pollution policy will make little to no difference on the effect of greenhouse gases, and the level of air-pollution is likely to return back on the levels prior to the pandemic outbreak. In addition to the general harmful effect of excess air-pollution, research from June 2020 indicates a negative cause-effect relationship between air-pollution and spread of COVID-19, therefore underlining the importance of reducing greenhouse emission emitted by automobiles and other vehicles (Pozzer et al., 2020).

In the last few years, a noticeable number of local and national governments across Europe have officially proclaimed their decision to totally phase out internal combustion engine powered vehicles. At the moment, combustion-engine powered vehicles still stand as the most frequent choice of new vehicle buyers in the European Union. In 2019, petrol powered automobiles registered for 59% of new passenger automobile registrations, diesel powered automobiles for 31%, conventional hybrid electric automobiles (HEVs) for 5.9%. The least popular choice of combustion fuel is ethanol, liquefied petroleum gas (LPG), and compressed natural gas (CNG) – amounting to only 1.7%. Electric cars, including battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV) was still short of any significant impact on the total market share, accounting for just 3% (ACEA, 2020).

In order to reduce the threatening impact of global warming and improve the quality of air in metropolitan areas, numerous local and national governments across Europe have announced year specific milestones to exclude pure combustion-engine vehicles. Administration that set the most audacious mark is, not surprisingly, Norway. One of Europe's most developed countries, yet not a member of the European Union, has set year 2025 as a threshold as part of their 2017 Transport Plan which states that sales of passenger automobiles and light commercial vehicles must not discharge any emissions. The plan attainment is backed by preconditioning improvements in technological utility so zero-emission vehicles stand competitive next to conventionally powered vehicles (Norwegian Ministry of Transport and Communications., 2017). More common threshold is the year 2030; chosen by: Denmark, Slovenia and Sweden, among others. Among countries that officially declared a plan to ban combustion powered vehicles, France and Spain stand the furthers with year 2040, which can be deemed as less ambitious (ICCT, 2020).

The United Kingdom just recently changed its target year. It initially set the target for 2040, but in February this year their prime minister Boris Johnson declared that he is advancing a ban on the sale of new petrol-, and diesel-powered automobile for five years, in other words, from 2040 to 2035. However, in November this year Mr. Johnson was expected to move the date to 2030 as a proactive measure to spur up the market for electric vehicles in the UK, thereby propelling the nation towards its plan of net zero emissions by 2050. A clear decision is yet to be made due to focus being shifted towards dealing with the COVID-19 crisis (Campbell & Pickard, 2020). Favourably, electric automobile sales have in the past year have more than doubled but are still below 7% of all new vehicles sold in the UK (SMMT Driving the Motor Industry, 2020). The British automobile industry holds accountable insignificant funding for infrastructure that is required to help redirect motorist from combustion engine powered cars to electric cars, which are at the moment noticeably more expensive to purchase than petrol or diesel cars (Campbell & Pickard, 2020).

Denmark chose 2030 as the target year in which they expect zero sales of new petrol and diesel automobiles, together with 2035 as a year in which they will ban PHEVs, as a part of their October 2018 Climate and Air Plan. To facilitate the execution, the plan details specific measures, including incentives for buyers and future owners of electric vehicles. Per example, upon purchasing a new electric automobile, the owner is exempt from tax upon registering the car. Moreover, the transition is helped by decreasing the periodical ownership taxes, cutting down the company car tax when opting for an electric car, parking benefits, as well as use of bus lanes. The plan also contains suggestions for improved consumer convenience through the quickened addition of fast-chargers and securing opportunities for private parties to install sufficient charging stations in metropolitan areas (ICCT, 2020).

Slovenia, a much smaller economy, took a less audacious but more gradual approach in dealing with the excess of greenhouse gases emitted by operating vehicles. Their plan is divided targeting two time points, 2025 and 2030. According to the government's Market Development Strategy from May 2017, they aim to ban registration for new passenger cars and vans which produce more than 100 grams of carbon dioxide per kilometre (g of CO_2/km). As of 2030, the limit would become more restrictive, dropping to 50 grams of carbon dioxide per kilometre. Even though the government carried out various measures to reach this goal, including positioning the charging infrastructure and the promotion of alternatively fuelled vehicles, their approach can be interpreted as rather passive (ICCT, 2020). Sweden on the other hand, will examine the feasibility of phasing-out new petrol and diesel automobile sales as of 2030 under the December 2019 Climate Policy Action Plan. The plan specifies 131 additional measures that assist the progress of reaching national climate goals. About a year ago from now, in December 2019, a study was commissioned to inspect the necessary conditions for a nationwide phase-out. Also, the study was designed to further question the gravity of exempting vehicles that run on renewable fuels, the impact of electric hybrid vehicles, and how to prepare an EU-wide phase-out (ICCT, 2020).

In addition to nation specific targets for cutting down on carbon emitting vehicle fleets, EU member states are also required to outline climate and energy objectives, air pollution targets, environment policies, and measures to the European Commission in the form of a 10-year strategy named the National Energy and Climate Plan (NECP) for 2021-2030. In its current format, the European Union consists of 27 Member States, but 23 of them provided final National Energy and Climate Plans by the beginning of May 2020. Furthermore, only Denmark, France and Spain specified the time point at which they will terminate the sale of all new combustion engine cars by 2030 and 2040, respectively. The Appendix 4 contains figure of a map that depicts national governments targets for phasing out new internal combustion engine cars (ICEs) as far as 2040 as of April this year. Notice that Slovenia is unique among its Central European neighbours.

Additionally, the Appendix 5 also contains a figure that shows the map of European cities that plan to ban combustion-engine vehicles in certain city areas, such as particular zones within city centres, as well as cities that are part of the C40 global network, that have outlined their ambitions through detailed timelines for restricting combustion-engine vehicles. The C40 Fossil-Fuel-Free Streets Declaration was signed by the local governments of 20 European cities: Amsterdam, Athens, Barcelona, Berlin, Birmingham, Copenhagen, Heidelberg, Istanbul, Liverpool, London, Madrid, Milan, Moscow, Oslo, Oxford, Paris, Rome, Rotterdam, Tel Aviv and Warsaw (C40 cities, 2020).

Nonetheless, the dilemma of compatibility of EU rules with the individual member states' phase-outs of combustion engine vehicles remains. Not only whether the phase-outs are configured within the correct time frame, but also their feasibility and modularity, taking into account the significant differences in the socio-economic standard across the two poles of the EU, i.e., Luxembourg versus Bulgaria (ICCT, 2020).

What's more, despite the claims of some governments that their phase-out targets are a noteworthy signal pushing auto manufacturers towards cleaner products, they all miss out on implementing concrete legislation making the targets irrefutable, such as penalties or withholding licences for more new petrol and diesel ran vehicles. To say nothing of global deficiency, in the moment only two administrations outside of Europe stand as decisive in their intention. First is Hainan, an island province in Southern China, disclosed official targets as a part of their Clean Energy Vehicle Development Plan for the trade of multiple types of electric vehicles, including battery electric vehicles (BEVs), fuel cell electric vehicles (FCEVs), plug-in electric vehicles (PHEVs) – and clean alternative-fuel vehicles, primarily compressed natural gas (CNG) and liquefied petroleum gas (LPG). In the year

2020, for passenger automobiles, the sales target set for 40% of electric vehicles, 80% in five years and 100% in 10 years (ICCT, 2020).

The second non-European administration is British Columbia, which was also the first one worldwide to enact a 100% zero-emission vehicle sales target, undoubtedly regulation auto manufacturers and their supplier network. This Canadian province constructed a plan detailed in the Zero Emission Vehicles Act in May 2019, specifying phased-in targets for all passenger and commercial vehicle sales and leases amounting to 10% by 2025, 30% by 2030, and total vehicle sales by 2040. As of April, British Columbia started to process the adoption of enforcement arrangements that may include penalties in case of compliance failure (The B.C. Ministry of Energy, Mines and Petroleum Resources, 2019).

Timed phasing-out of vehicles that solely rely on the combustion-engine through targets set by the national and local governments imposes more pressure on automobile manufacturers to curb their engineering solutions towards regulation compliancy. Demand for action clearly manifests itself through numerous future practices, such as national combustion-engine bans coming into power in a decade or two, limited access zones in highly frequent metropolitan areas starting within less of a year, combined with current, stricter EU emission regulations for passenger cars and light commercial vehicles are asking for ready-made solutions from the automobile industry.

Volkswagen Group, PSA Group, Renault Group, Hyundai Motor Group, BMW Group, Daimler, Ford, Fiat Chrysler Automobiles Group, Toyota Group, and Volvo Group released their plans to augment their sales share in the EV game, either by partially integrating electric powertrains across their existing model portfolio or by completely abandoning the fossil fuel powerplants over the next 10 years (ICCT, 2020).

The number of automobile manufacturers taking decisions to step away from designing and selling combustion-engine based platforms is raising. While some decided to invest into completely new platforms as a part of their electrification strategy, others opted for product adaptation in order to increase their share in the electric vehicle sales. Moreover, some highly acclaimed and traditional manufacturers outreached to industry newcomers as a response to the disruptive demands from the political administration, but more on that instance in the following pages.

2.6 Turmoil and surprises in the automotive industry

In December 2020, British manufacturers of sportscars Aston Martin found itself in a middle of a scandal dubbed "Astongate", due to a controversial undertaking in a form of a study titled "Decarbonising Road Transport: There Is No Silver Bullet" (Clarendon Communications, 2020). The study was issued by a PR company Clarendon Communications, that was co-commissioned by the auto manufacturer. The climate lobbying polemic became suspicious due to surprising findings on the carbon footprint of electric vehicles, which are at the forefront of transportation evolution. The aforementioned car maker became the object of scientific and public scrutiny after revealing that the PR company, which published the research study, was registered to the spouse of an executive officer employed at the renowned manufacturer. The dubious exercise, which has been criticized by leading experts shortly after it was published, was marketed as 'trendsetting' third-party research and appeared to prove that electrically powered cars would have to clock-in as far as 78,000 kilometres before matching the carbon output of a petrol-powered model.

Furthermore, Aston Martin is not the only sound name that commissioned the report; next to it stand world famous companies not known for their leading strategies in mobility electrification such as Bosch, Honda Motor Company and McLaren Automotive. Interestingly, the research study was published quickly after the UK prime minister, Boris Johnson, declared the government's call for a phase-out of new combustion-engine vehicles from 2030 (Ambrose, 2020).

According to Michael Liebreich, the founder of Bloomberg's clean energy research arm BNEF, it is no mystery that the 'integral emissions' involved in manufacturing an electric vehicle are noticeably higher than those of an equivalent combustion-engine powered vehicle (Liebreich, 2020). The largest contributor to the high initial score of the carbon dioxide figure is the battery assembly, therefore it is clear that one has to cover a number of kilometres before an electric powertrain starts returning its investment from an emissions perspective. Taken into account that the average UK car clocks around 11,000 kilometres per year, the figure of 78,000 kilometres would mean that an electric vehicle would achieve break even after seven years, questioning the legitimacy of electric drive (Liebreich, 2020). It is important to note that, before the research study in question was debunked by accredited scientific researches, many leading press sources ran the story, therefore reaching millions of people and possibly affecting their stance on credibility of electric vehicles. Some of them include of Sunday Times publishing "Electric cars only greener than petrol after 50,000 miles" (Paton, 2020), Daily Mail reported "Electric cars shock: Manufacturing green vehicles churns out more CO2 than making fuel models" (Payne, 2020), Telegraph came out with "Electric cars need to be driven 50,000 miles before carbon footprint is better than petrol model, new report suggests" (Gatten, 2020) and Metro published a short article headlined with "Electric cars need 50,000 miles before they're greener than petrol ones, report claims" (Parsons, 2020).

The report referenced two Volvo passenger car models: Volvo's compact SUV XC40 and the newest model of their sister company Polestar, the Polestar 2. Two vehicles are comparable in size and vehicle segment. The report was shortly after noticed and analysed by one of the world's leading experts on the issue of life-cycle emissions of vehicles, regardless of their source of power, is Aueke Hoekstra, who is a Senior Advisor on Electric Mobility at the Eindhoven Technical University. The omission of key criteria, according to Hoekstra (Twitter, 2020), resulted in miscalculating the emissions breakeven for staggering

51,000 kilometres or 67 per cent. To put it another way, the correct number of kilometres for emission breakeven is closer to 26,000 kilometres.

Figure can be found in the Appendix 6 depicting the corrected break-even value expressed in kilometres driven between electrically propelled and petrol-powered models, based on the graphical presentation contained in the auto manufacturer's own life cycle emission report (Polestar, 2020), adjusted for more realistic values as seen in the Appendix 7 (Auke Hoekstra's Twitter account, 2020).

According to multiple reports (Hoekstra, 2019; Hoekstra & Steinbuch, 2020) there are couple of critical misconceptions often misused on various reports on the total greenhouse gases emitted into the atmosphere during the complete cycle of car's manufacturing process and use.

- The fuel consumption figures are subject to WLTP test cycle, which are marginally more reliable than the previous NEDC test cycle, but still consistently underestimate realistic fuel consumption figures by a wide margin due to unrealistically prolonged time-windows in which a vehicle can gradually accelerate and build speed under low load un (Fontaras, Zacharof & Ciuffo, 2017).

- Production of fossil fuels and their further refining of oil is often found to be lacking or be misrepresented in reports (Masnadi, El-Houjeiri, Schunack, Li, Englander et al., 2018)

- Production of electricity will get cleaner through time. Today's electricity is made of a mix of sources, but renewable energy sources will continue gaining more traction as they did in the past two decades. Reports fail to accept that assumption, therefore overestimating the future share of carbon dioxide emitted by power sources (Hoekstra & Steinbuch, 2020).

- Battery production is inherently introducing heavier levels of emitted carbon dioxide, but the production process keeps improving significantly through scaling and cleaner electricity (Emilsson & Dahllöf, 2019). Furthermore, most studies use obsolete and therefore unrealistic representative values regarding battery manufacturing emissions (Hoekstra & Steinbuch, 2020).

2.7 EU regulation

Automobiles account for around 12 per cent of total EU emissions of carbon dioxide, the main component of greenhouse gas. In order to systematically act against prolonging the poisoning the atmosphere, in 2009 the regulation (EC) 443/2009 set mandatory emission reduction targets for new automobiles. The first target value fully applied from 2015 onwards, with the new target phased in this year, and finally fully applying from 2021 onwards (European Commission, 2020).

In line with the latest global trends, in April 2019 the regulatory bodies of the European Union, the European Parliament and the Council adopted Regulation (EU) 2019/631 that introduces carbon dioxide emission performance standards applicable to new passenger automobiles and light commercial vehicles for 2025 and 2030. The newest regulation came on power from January 1st this year, therefore replacing and revoking previous Regulation (EC) 443/2009. From 2021, introduced from this year, the EU emission target for new automobiles across the entire manufacturer's fleet will amount to 96 grams of carbon dioxide per kilometre. To illustrate, emission target corresponds to an average fuel consumption figure of about 4.1 litres of petrol per 100 kilometres or 3.6 litres of diesel per 100 kilometres. The required emission targets for automobile manufacturers are imposed accordingly with the average mass of their vehicles, with respect to a limit value curve.

This translates to allowing the manufacturers of heavier cars to manifest higher emission than manufacturers of lighter cars. The limit value curve is stipulated in a way that the targets for the EU average emissions are achieved across the complete vehicle fleet. The phase in stage set for 2020 means that the emission targets refer to manufacturer's 95 per cent least emitting new cars (European Commission, 2020). From 2021, the five per cent tolerance ceases to apply, meaning that the average emission of all newly registered cars of a particular auto maker must below the maximum value of 95 grams of carbon dioxide per 100 kilometres (European Commission, 2020).

After a consistent decline in carbon dioxide emissions from 2010 to 2016, by almost 22 grams of CO2 per kilometre (g CO2/km), average emissions form new passenger automobiles took a turn, increasing in 2017 and 2018 by 2.8 grams of CO2/km in total. According to data provided by the European Environment Agency (European Environment Agency, 2020), the upward trend continued with an additional surplus of 1.6 grams of CO2/km in 2019, totalling to 122.4 grams of CO2/km. Such result remains subpar with respect to the target value of 130 grams of CO2/km valid until 2019 but significantly above the EU target value of 95 grams of CO2/km that was introduced this year. One of the key reasons for the increase in average exhaust emissions include the continuous growth of the sport utility vehicle (SUV) segment. The antidote, electric vehicles, still failed to significantly penetrate the market. In the Appendix 8 is a figure that shows the average carbon dioxide emission from new passenger cars from 2000 to 2020, including the EU target values until 2030.

Light commercial vehicles registered in the EU, Iceland, Norway and the United Kingdom in 2019 emitted on average 158.4 grams of CO2/km, which is, again, an increase compared to 2018 for 0.5 gram of CO2/km. Such score remains well under the target of that previously applied until 2019, however, it is still 11 grams pf CO2/km over the EU target 147 grams of CO2/km implied in the Regulation (EU) 2019/631, valid from 2020 (EEA, 2020).

In order to compel automobile manufacturers to invest into developing drivetrain components which can comply with the set limit on the level of carbon dioxide emitted into the atmosphere, the EU regulation policy also includes penalty payments in case of exceeding the maximum value. Regulation (EU) 2019/631 implies that, if the average carbon dioxide emission of a manufacturer's fleet accounts over its target in a given year, the auto manufacturer is obliged to pay an excess emissions premium for each vehicle registered. Since 2019, the penalty amounts to €95 for each gram per kilometre over the target value (European Commission, 2020). Such stringent penalty policy is greatly mitigated by allowing the manufacturers engage in pooling agreements, by grouping together and possibly balance any excess emissions. Upon forming such a pool, manufacturers are obliged to respect the rules of competition law.

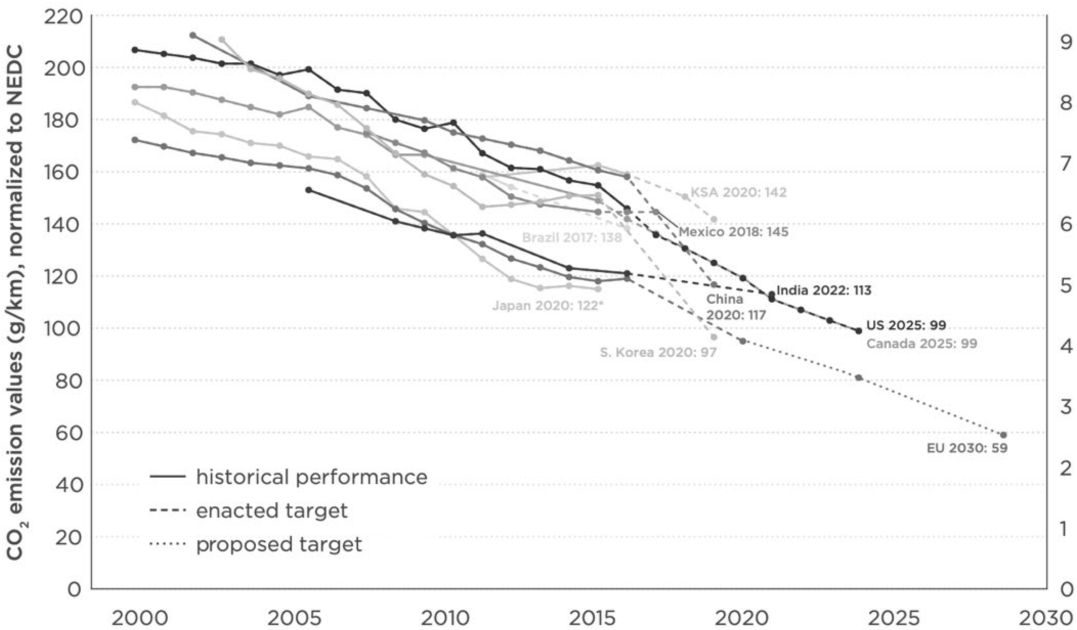
An example of pooling emissions in order to avoid penalty fines, is a deal from February 2019 where Fiat Chrysler Automobiles (FCA) pooled their fleet emission with Tesla. The advantageous clause of the EU regulation allowed FCA to compensate for exceeding emissions, by agreeing to have Tesla's zero-emitting vehicles to be counted in FCA's fleet and therefore avoid considerable fines. A deal worth hundreds of millions of euros enabled FCA to neutralize carbon dioxide emission, lowering its average figure to a permissible level. As stated in the table x, FCA is planning to invest into hybrid and electric vehicles in the next ten years, but is regarded the least adaptive amidst other auto manufacturers in this part of the global market (Campbell & McGee, 2019). That said, form December 2019, FCA is part of a newly formed corporation Stellantis, created in a 50:50 merger of Groupe PSA and FCA, thereby allowing to the companies to intertwine their resources as well as research as development to create benefits in their respective market segments (Groupe PSA, 2019). A declaration on the European Commission website states that FCA formed an open pool with Tesla in February 2019, declaring that Tesla joins in the fleet of brands that include their least environmentally friendly brands: Alfa Romeo, Jeep and Maserati. Under EU rules, automakers are allowed to pool their emissions among their corporate brands, making it possible for Volkswagen Audi Group (VAG), per example, to outweigh Lamborghini and Porsche emissions against those from Skoda and Seat (Campbell & McGee, 2019).

Likewise, for this year Honda Motors joined Fiat Chrysler in pooling its fleet emissions with Tesla to offset their exceeding emissions and therefore comply with stricter emissions for passenger cars in the EU for the year 2020. Even though Honda entered the European market with their e model, the underperforming sales results probably motivated the company to undertake a decision of jointly meeting exhaust emissions standards (Stock, 2020). Moreover, Ford Motor Company teamed up with Volvo Cars AB to comply with the regulation limiting the exhaust gasses on all new registered passenger vehicles in the EU. Unlike Ford, once the owner of the Swedish brand, Volvo and its affiliate Polestar have successfully managed to meet the target figure and it is therefore able to sell its surplus to Ford for an unknown sum (Stock, 2020). From the managing point of view, an interesting insight was provided by the managing Director of Vauxhall Motors and Opel Ireland, Stephen Norman, who oversees guiding the company to meet its CO_2 target in the UK in order to help Groupe PSA in reaching its EU regulation targets. From his comment given for an accredited press source, he was very adamant in openly deconstructing the operational rationale deemed necessary to keep the emissions under the cap: “If the demand we’re able to create for low-emission vehicles is below the required percentage of the predetermined mix, the consequence would be a limit to the number of vehicles we’re able to sell.

If the amount of pure combustion engines goes up and we go beyond our CO2 target, the financial penalty is so great the company cannot afford to take that risk (McNamara, 2020). A similarly radical viewpoint is shared by Kia’s Senior Vice President for Global Brand & Customer Experience, Artur Martins who stated: “If you don’t have the powertrains, the only way to sell cars in Europe is to reduce your volumes. And if you reduce your volume, there’s an impact on production.” (McNamara, 2020).

By accepting the new regulation, the European Union becomes a world-exclusive market that calls for obligatory new car CO2 targets up to the year 2030. In the next five years, the EU’s CO2 target of approximately 81 grams per kilometre is close enough to compare with 99 grams per kilometre that Canada and the U.S. aim for. However, the chart presented in the Figure 2 below does not consider any discrepancies in real-time enforcement or penalty measures. Also, the chart equalizes all regulatory programmes to New European Driving Cycle to make them comparable, withholding the programme’s design faults and its obsolescence (Mock, 2019).

Figure 2: Observation of worldwide carbon dioxide regulation for new passenger cars



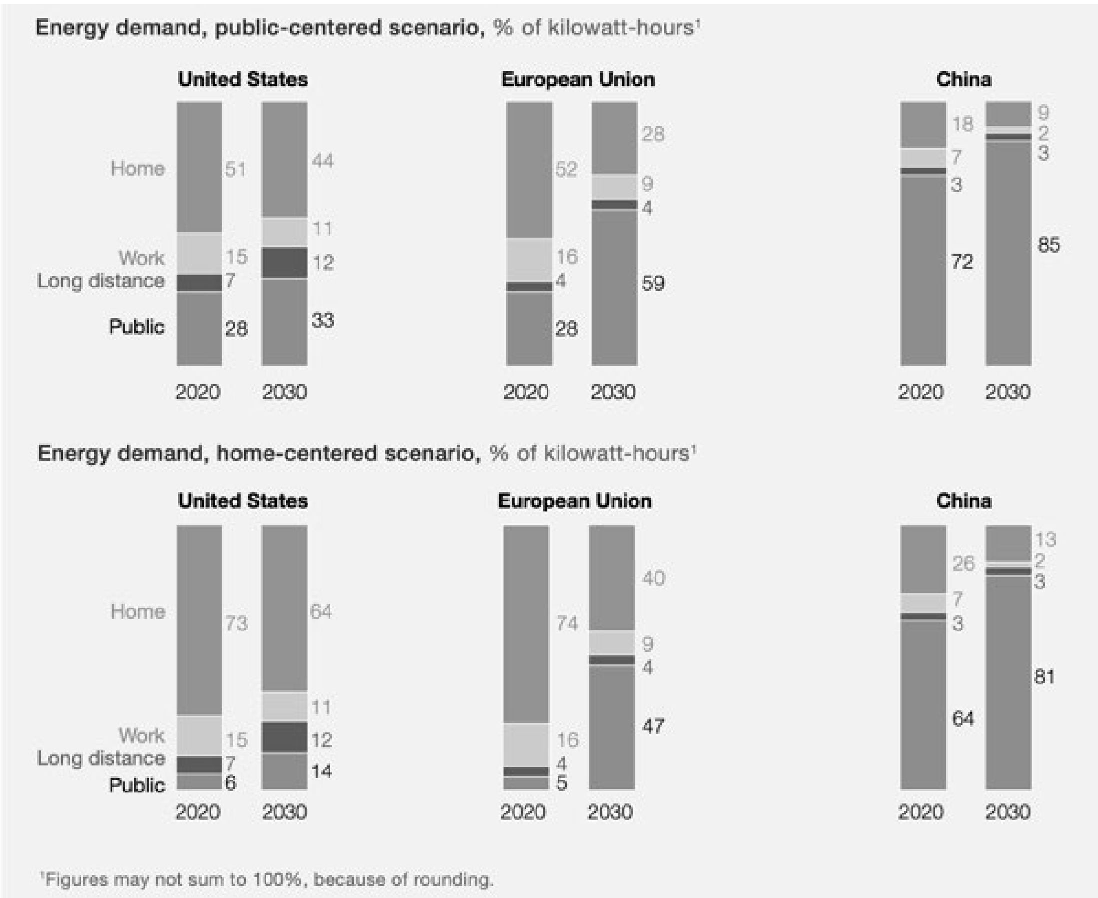
Source: Yang & Bandivadekar (2017).

2.8 EV charging technology

One of the key barriers in effectively transforming mobility is the access to efficient charging solutions. Even nowadays with a rapid pace of technological improvements, out of all concerns in the world of EV shoppers, two arguments stand as most prominent: relatively poor range and a limited market offering of affordable electric vehicles that can confidently compete with their ICE counterparts. However, with more than 350 new EV models to be launched by 2025, finally backed up by the necessary resources to become relevant and interesting proposals to the potential buyers, and with battery technology advancements that provide a range on the right side of 200 miles, these market deficiencies are gradually becoming secondary to a larger challenge: the lack of charging infrastructure.

According to McKinsey's forecast on the infrastructure demand (McKinsey, 2018), EV adoption will see approximately 120 million electric vehicles throughout China, the European Union and the United States. Moreover, a more daring-case scenario proposes a further 100% increase over the aforementioned figure. Specific adoption rates of different regions will likely correspond to many socio-economic variables, thereby it is reasonable to expect the distribution of charging stations to be greatly localized.

Figure 3: Probable EV charging infrastructure scenarios by different world regions



Source: McKinsey (2018).

Figure 3 shows the energy demand for a public-centred scenario and a home-centred scenario at the moment and in 10 years. It is visible that the EU is about to experience a much more severe shift towards public charging infrastructure, contrary to China and the United States (McKinsey, 2018). Across the European Union, as EV gain significant traction on the market, charging options will likely rely more on the public options and less on private homes over time, with the share of home chargers decreasing from approximately 75 percent in 2020 to around 40 percent by 2030. The reasoning behind such forecast hides in the assumption that more middle-income and lower-income households without the ability to charge at home will shift to EVs from 2020 onwards.

On the subject of the size of the investment of the charging infrastructure, this promising industry may require building north of 40 million chargers across China, Europe and the United States, which translates into $50 billion of cumulative capital investment through 2030. The European Union, more specifically, is likely to require a cumulative 25 million chargers and roughly $15 billion worth of investment during the same period. Another key point to remember is that the gravity of the shift, caused by the transition to electric vehicles, will demand an ecosystem of industries that have to come together to enable broader use of EVs. In light of the rapid appearance of properly developed electric vehicles in the past few years, it is reasonable to expect that the demand for EVs will continue to grow and therefore consider future EVs as viable alternatives to now dominant ICE automobiles (McKinsey&Company, 2018).

Because of the specific market focus of this thesis, it is important to add that the Europe's public charging EV market is about to enter the disruption phase. Even though the market is still at its elementary stage, Europe's economy is ready for recognizing charging services as a commodity. Therefore, market players must innovate in multiple directions to ensure their long-term profitability. Today, the European market is highly fragmented, and subject to fluctuation due to fierce market competition battling for market shares and direct customer access.

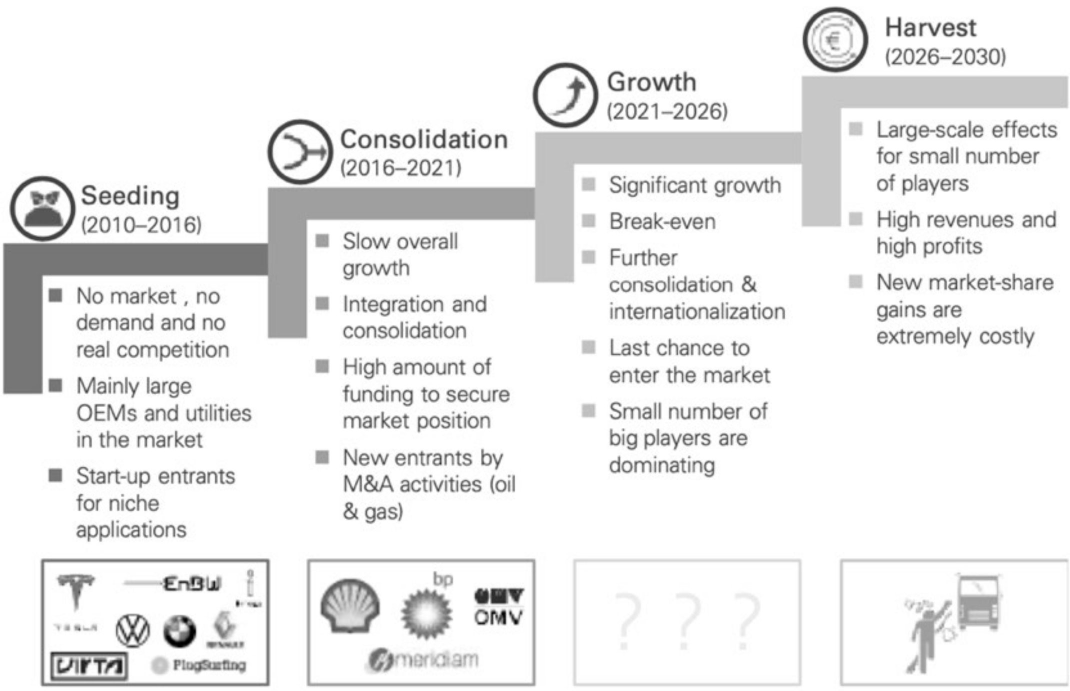
In order to keep up with the rising sales of EVs, infrastructure and end-customer solutions are trying to follow. A bright example are the North European countries, have invested significantly into an impressive charging infrastructure which was greatly facilitated by the industry agreed European plug standard CCS (Combined Charging System). For example, the Netherlands alone has at its disposal more than 40,000 public charging points, which translates to a charging station on the road for every three kilometres, on average. Another point worth mentioning is the broad variety of charging cards that EV customers may use, which allow them to access more than 100,00 charging points across Europe. The real benefit of extensive choice of charging cards is all but clear because of the number of cases in which the consumers were faced with practical inefficacies, consequently failing to easily charge their vehicles.

Nowadays, consumers are faced with many business models that are difficult to distinguish, making choosing between suppliers extra difficult. It becomes clear that small, independent player will only be able to withstand the market pressure if they can ensure innovative and easy-to-use solutions that distinguish them from their competition. Electric vehicle charging alone is still failing to account for any reliable profitability, but profit margins are expected to increase as business models become more streamlined and the market volume rises.

There are four vital market stages of EV charging in Europe. The first seeding phase is placed in the period from 2010 to 2016, and was defined by lack of real market demand and practically non-existent competition. Costly initial investment was frequently publicly funded and backed by automotive manufacturers or large utility companies invested to assist in launching the EV market or gain public recognition. At the moment, we are in the consolidation stage. Consumers are able to choose between numerous relevant mass-market EVs that can compete with price and range, hence we are seeing gradual but consistent market growth (Krug, Knoblinger & Bauer, 2020). Figure 4 on the next page shows four stages of expected public EV charging market development (Krug, Knoblinger & Bauer, 2020).

Having profound, future-proof understanding of specific local needs in the early stages of demand and adaptation will be of essential importance for ensuring effective targeted investments, matching demand and supply, and providing quick return on investment (McKinsey, 2018).

Figure 4: Vital market stages of public EV charging in Europe



Source: Krug, Knoblinger & Bauer (2020).

2.9 EV charging practice in 2020

One of the most pronounced critiques encompassing the electric vehicle introduction is range anxiety, which revolves around an exhausting equation: remaining usable battery range (according to the car's user interface) minus distance to destination equals to piece or disruption of travel. To make the experience slightly more unpredictable, the result of the equation varies by minute because of the undulations in terrain type and accelerator application (Stock, 2020). Kyle Stock in an article from Bloomberg.com continues to describe the practical struggle of EV consumers in the following fashion: "Desperate battery-powered travellers can be easy to spot: They are often sweaty (no air conditioning), driving slowly and – when going uphill – instinctively leaning forward in their seats." (Stock, 2020).

United States is the home of one of the largest markets that will welcome the EV revolution. Before the general socio-economic disruption caused by the COVID-19 pandemic, the U.S. auto industry planned to invest at least $140 billion over the next few years to adjust supply chains in a momentous transition from internal combustion to battery-powered automobiles. The financial background for such decision is supported by the forecast that approximately one-third of U.S. vehicle owners will choose an EV as their vehicle in their next round of vehicle purchasing.

The auto industry responded with future launches of dozens of new EV models, out of which most claim a range over 300 kilometres, finally giving a somewhat comforting answer to a, now well-known, issue of battery's power density. With that in mind, it is important to note that the limiting factor of range-anxiety now banishing from the showrooms does not mend the problem of lacking charging stations. To illustrate, huge portions of the U.S. are without charging stations, which may be one of the most severe barriers to mass EV adoption in America. Additionally, the velocity of charging a car's battery is another issue. Out of 64,000 vehicle-charging stations in the U.S., only 20 per cent can fully charge an average battery in less than 60 minutes (Stock, 2020). In the Appendix 9 one may find a figure that shows the distribution of fast-charging stations (excluding Tesla's proprietary Superchargers) across the United States of America, illustrating the scarcity of fast-charging points outside of U.S. metropolitan areas.

On the electric charging market, Tesla Motors is one company that managed to stand out from the competition. The automaker is unique for their early decision on building its proprietary charger network, upon recognizing the lack of financial incentive for the private sector to take a capital-intensive risk on a market that was practically created by a Tesla on its own. Cunningly, Tesla made its charging club available only to Tesla drivers.

The company continues to be the market leader in the charging segment, but its chargers are proprietary and cannot be used by vehicles of other brands. However, adapters for the car's inlet plug are available, making Tesla's cars in sync with other charging systems. Interestingly, in the U.S., the number of Tesla charging points is slightly larger than all other fast-charging station combined. To give an example of Tesla's upper hand, in the state of Wyoming there are 10 Tesla charging stations, yet only one fast-charging point that can be used by a Jaguar I-Pace (Stock, 2020). In the Appendix 10 one may find a figure that shows a distribution of Tesla Superchargers fast-charging points across the United States of America, illustrating a competitive advantage created by better positioning of fast-charging stations.

The superior infrastructure of Tesla plays a strategic role in the game of customer attraction. It is believed that its physical infrastructure footprint positively influences the customer experience, reduce friction points and play a crucial role in the fleet management of millions of Tesla cars in use by private and third-party commercial fleets (CNBC, 2019). Looking from a layman's perspective, building an architecture from the grounds-up may seem an easy strategy to imitate, but it was confirmed that it can be rather uneasy: it requires time and effort for incumbents because it often demands forgetting the present ways and replacing them with new capabilities, as in Furr & Dyer (2020). Furthermore, a senior auto executive commented: "It's just hard for us because historically we have been great mechanical engineers, not great software engineers. But we need to become software engineers.". Tesla's systemic approach also accounts for the portfolio of individual component for its products.

We know from research work by Hatch (2001) that the profit in the industry has a tendency to increase until it faces a bottleneck – the components that put a cap on the performance of the system. Applied on an EV, batteries account for the bottleneck because their power capacity limits the performance of the whole system. Through investing directly into battery R&D, producing them at scale with a better design, Tesla is betting that they will dictate the circumference of the bottleneck, and therefore the profit centre, for the industry's tomorrow. Above all, Tesla's strategy reaches into all system levels: it offers the complete set of complements necessary for the consumer to use its product. That is the true argument behind Tesla's decision to build out a network of fast chargers for its products across the United States (Furr & Dyer, 2020).

3 CROATIA'S ENTRANCE TO THE ELECTRIC CIRCLE

As one of the youngest and least influential member states of the European Union, Croatia is lacking any considerable influence on passing the of legislation that will encompass all car drivers that are looking to purchase a new vehicle in the next 20 years. The average automobile in Croatia is above age compared to the EU statistic, which alone makes the reach towards electrification even more challenging. In the following chapter, I examined the current market state, outlined the market shares of different powertrains and their growth trends, and examined key organizations that account for diffusion of innovation on the Croatian market.

3.1 Key attributes of the Croatian automobile market

To meet the European Union's energy and climate goals for 2030, all EU Member States are required to form a 10-year integrated national energy and climate plan (NECP) for the period from 2021 to 2030 (European Commission, 2020). In the final NECP submitted to the European Commission, which considered the analysis and the recommendation of the Commission, Croatia defines "policies and measures for achieving low-emission mobility (including transport electrification)". The policy outlines and structure 13 measures, among which is the TR-3: Special tax on motor vehicles. The measure claims to be formed on the 'polluter pays' principle where the final taxation corresponds to the carbon dioxide emitted to the air from the vehicle's exhaust system. Furthermore, the special tax is calculated on the basis of the sales or market price of the vehicle, engine volume, carbon dioxide expressed in grams per kilometre and the level of other greenhouses gases.

This fiscal measure came in power in 2014, yet Croatia, unlike its neighbour Slovenia, still hasn't defined a clear policy aimed towards actively decreasing the greenhouse gas emission emitted into its atmosphere. This rather passive stance can be read from Croatia's planned activities, and I quote: "Conducting a detailed analysis to determine the need to modify and improve the existing payment system. This will consider the possibility of additional taxation of vehicles of certain environmental categories, the possibility of eliminating the depreciation of the calculated special tax on used vehicles, and the possibility of redefinition of fees in view of the declared measurement cycle of fuel consumption and exhaust emissions (WLTP or NEDC) of a specific vehicle." (Ministry of Environment and Energy of Republic of Croatia, 2019).

Additional measure keen on achieving low-emission mobility is the TR-5: Regulatory framework development for cleaner transport. Its implementation begins as of 2021, with an objective to amend the legal framework to ease the development of renewable energy sources and cleaner transport. With a clear and decisive mindset to change the fleet characteristics of Croatian transport, it is surprising (or rather not) that the policy exclusively covers the market shares wished upon the future requirements, without mentioning any threshold values which can serve as benchmarks, as I quote: "The objectives of the measure are to increase the share of RES in traffic by 2030, 37% of the share of light vehicles meeting the set requirements in the overall public procurement of light vehicles at the national level by 2030, 13% of the share of light vehicles meeting the set requirements in the total public procurement of heavy vehicles at the level states by 2030 and 65% of the proportion of buses that meet the set requirements in the total public procurement of buses at the state level by 2030.".

This measure is backed up by five activities that do not rely on a single KPI (key performance indicator) but rather build their content on promises with reference to various EU regulations (Ministry of Environment and Energy of Republic of Croatia, 2019).

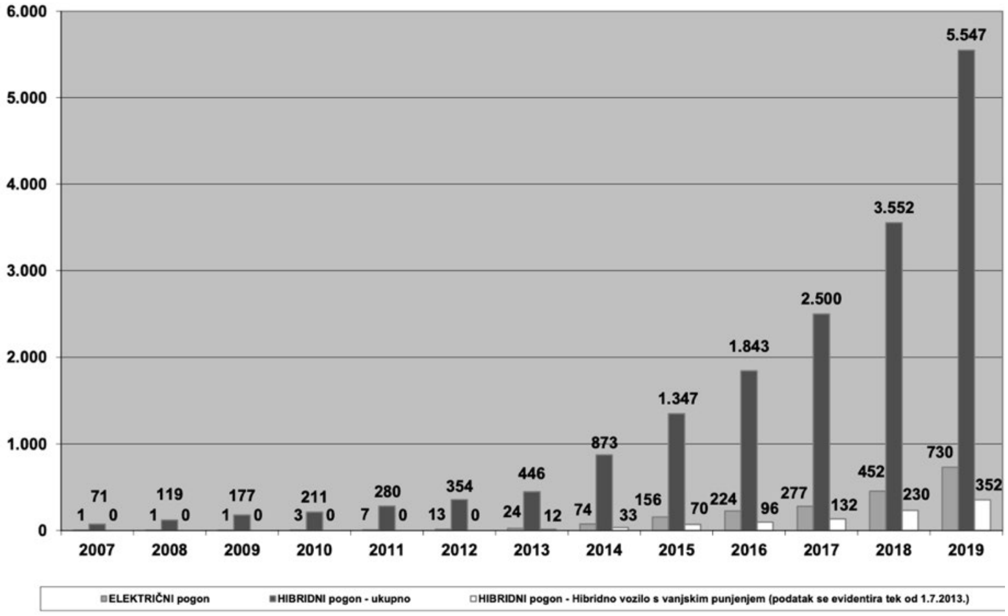
3.2 Croatian versus European market trends

In order to better understand the key characteristics of the Croatian electric vehicle market, market insights for neighbouring EU member states shall be observed first. Firstly, we must understand that the Croatian current demand for electric vehicles is so small that it is practically irrelevant in the grand scheme of progress. Croatia's vehicle fleet by fuel type is still strongly dominated by fossil fuels, with hybrid electric vehicles marking up to rather poor 0.2 per cent for 2018.

On the other hand, the Croatian market may be seen as rather reluctant to accept the electrification of personal transport due to the price premium that is still a strong market characteristic of electric vehicles, especially fully electric – battery powered vehicles. A supporting argument to slow market demand for EVs is the average age of a personal vehicle in Croatia, which has risen for the past 10 years, signifying a slower transition to newer technologies. The electric transformation clearly won't be possible without publicly accessible EV charging infrastructure. Contrary to previous survey responses, the opinion structure on who should be the leader in building EV charging networks rather varies across the several European markets. A key fact to remember is that Croatia's economy used to operate under a socialist regime, consequently still carrying a burden of large, inflexible, government owned companies that are traditionally slower in recognizing market trends.

Having said that, Croatia marks a positive trend in the electric vehicle sales, with sales figures doubling from 2017 to 2019. Figure 5 shows a steady positive trend in sales for electric, hybrid and plug-in hybrid vehicles over the past 12 years.

Figure 5: Sales trend of registered vehicles equipped with hybrid and fully electric powertrain



Source: Centar za vozila Hrvatske (2020).

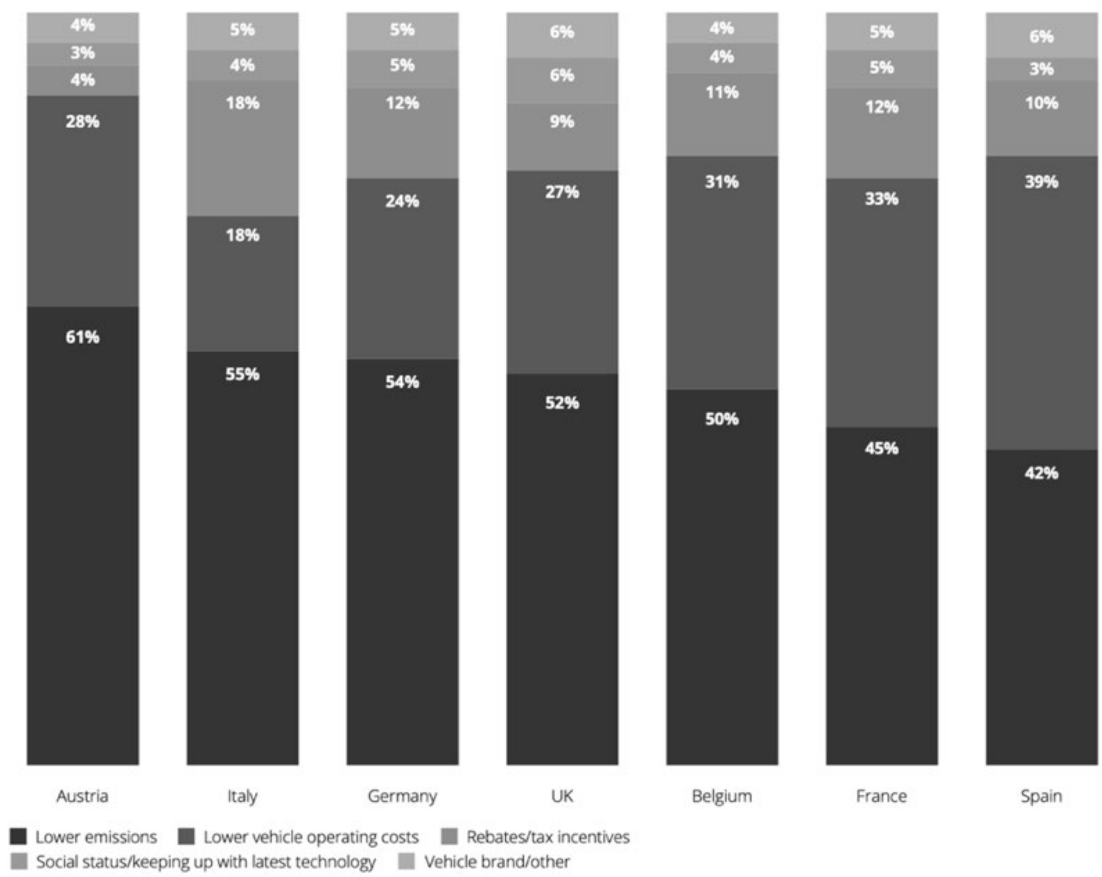
3.3 Croatian consumer preferences

Deloitte's European study from 2020 has dealt with automotive consumers' opinions and attitudes towards the electrification of personal transportation and revealed some interesting viewpoints that can be assumed for the Croatian market.

The utopian vision of the future mobility is composed of frictionless, automated, personalized travel on demand. A world where connected, autonomous, shared, and electrified vehicles have managed to essentially eliminate any significant problems of today, like traffic congestion, car accidents, and fossil fuels. Even the most highly accepted traits of modern mobility like vehicle ownership are viewed upon as soon to be history books. Naturally, for the society to accept it, consumers have to overcome some deeply accepted behavioural patterns.

Figure 6 depicts the reasons behind considering hybrid and battery electric vehicles and their shares in several European markets. The study names five reasons for considering an alternative powertrain: lower emissions, lower vehicle operating cost, tax incentives, social status, and vehicle brand.

Figure 6: Consumer arguments for considering hybrid and battery electric vehicles



Source: Deloitte (2020).

It is important to note that the Croatian economy is significantly weaker than either Austria, Belgium, Germany, United Kingdom, France, Spain, and Italy. However, it is the closest call to a relatable consumer study for Croatia. It partially gives a point of reference of the future intentions of Croatian consumers as their purchasing power grows over the next decade. In the Appendix 11 one may find a figure that depicts consumer powertrain preferences for the countries. In five out of seven countries, the traditional ICE lost traction compared to available alternative powertrains. More importantly, this trend continued according to the survey data from year 2019 – which can be seen in the year over year comparison in the two right columns.

Also, to comprehend the concept behind such transition in their future personal transportation, it is crucial to understand the reasoning that made the consumers lean more towards alternative powertrain options. Deloitte's research study has shown that lower emissions, as well as lower operating cost, are the strongest arguments for considering hybrid or fully electric vehicles. Also, even though tax incentives are not integral to the purchasing decision, they are taken into consideration and attented to.

The electric transformation clearly won't be possible without publicly accessible EV charging infrastructure. Contrary to previous survey responses, the opinion structure on who should be the leader in building EV charging networks rather varies across the several European markets. A key fact to remember is that Croatia's economy used to operate under a socialist regime, and therefore still carries a burden of large, inflexible, government owned companies that are traditionally slower in recognizing market trends.

In the Appendix 12 one may find a figure that depicts consumer opinions on whom they think is responsible for providing publicly accessible EV charging stations and other necessary infrastructure. The opinion structure for each European market consists of following responsible parties according to the automotive consumers: vehicles manufacturers, government, existing fuel companies, electric utilities, and others.

3.4 Development of the charging infrastructure in Croatia

Momentarily, electric car charging service in Croatia is offered by multiple companies. With the market still on the verge of its earliest development, the battle for customers is ran by the following competitors:

- E-mobilnost by Hrvatski Telekom
- ELEN by Hrvatska Elektroprivreda
- IONITY
- OneCharge by Petrol Slovenia

However, the market is largely dominated by two companies: Hrvatski Telekom and Hrvatska Elektroprivreda. Others include Tesla, which installed their Superchargers across eight locations, and with Ionity and Fastened that conjointly amount to only three charging stations (Plugshare, 2021). According to the European Alternative Fuel Observatory, there are currently 584 charging stations across the country, which seems ample when considered that there are 730 electric vehicles in the whole state. In the Appendix 13 one may find a figure out of which it can be seen that the number of fast charging stations (where the charger is powerful more than 22 kW) per 100 kilometres of motorway is only 11, still nowhere close to enough, though rising.

Hrvatski Telekom currently operates with 330 charging stations in over 90 cities across the country, which puts them on the top of Croatian EV charging network. Over 50 per cent of all publicly available charging points are integrated in the system of Hrvatski Telekom. Their price list is published on their website (Hrvatski Telekom, 2021a). For 53 out of 330 charging points, the battery charging service is not exempt from payment. Map locations along with the list of all publicly accessible charging points are available on the central regional website named ‘rechargespoTs’, as shown in the figure detailed in the Appendix 14. The website offers a filter feature which enables the user to specify a location, minimum outlet power, plug type, and to book a charging session. The map preview illustrates the centralized nature of charging points i.e., lack of coverage outside major city areas.

In order to activate the right to access charging services, end users can choose between two options: and RFID card or a smartphone application named ‘espoTs’. Unfortunately, their pricing policy lacks standardization: amount payable is partially determined by the number of minutes for some charging points, while for others the measurement unit is Kwh. The charge rate varies from 0,15 kn to 2,84 kn per 1 kWh according to the latest pricelist dated to October 22nd 2020 (Hrvatski Telekom, 2021a).

The second largest provider of EV charging services is the Croatian national electricity provider HEP through its subsidiary named ELEN. Project “eMOBILNOST” is a development project by which HEP group aims to be in tandem with the energy strategy of the European union. The core idea of the project is using the electric energy from renewable energy sources to power electric cars in Croatia. Currently, there are around 200 charging stations placed across Croatia with charging power ranging from 22 kW to 175 kW. The most common are 50 kW charging stations, while there are only two fast charging station capable of offering charging power of 175 kW. At the moment, all charging stations operate exempt from payment for service use (Elen, 2021).

In an interview for a Croatian media company, Domagoj Puzak from HEP’s Department for Strategy and Office for Business Development and Acquisitions highlighted that Croatia’s national electricity provider HEP with their project of e-mobility made one of the largest leaps in Europe. He continued by stating that they have successfully built over 200 charging stations by 2021 by independently managing the investment strategy, while funding the investment from their own budget but as well sourcing funding from the EU development funds.

Moreover, according to Mr. Puzak, all planed locations have been realized, including the most demanding ones in terms of financial, legal, organizational and technical work (Telegram, 2020). That said, even though one might find reassuring that the national electricity provider is strongly engaged with setting up the necessary infrastructure to support the electrification of personal mobility, the website of the brand ELEN is aesthetically outdated. Relying on basic features like a map of charging stations without live updates of their availability, this sole communication channel is rather poor in attributing trust in the effectiveness of the service (Elen, 2021).

At the moment, the most powerful charging point is under the operator Ionity, offering four charging slots able to charge an electric vehicle with up to 350 kW of power. Situated around 30min from Zagreb, it is the only charger with such power in Croatia. It is significantly more expensive than many other charging stations, charging 5,60 kn per 1 kWh. More importantly, as EVs will continue to evolve especially in the area of battery technology, this type of charging stations has the largest utility rate but are withheld by their high initial capital investment (Plugshare, 2021).

Croatian EV charging market is further developed by an additional player, the Slovenian oil distributing company 'Petrol'. As a part of their 'OneCharge' programme (Petrol.hr, 2021), the company installed 11 charging points across Croatia, including 22 kW AC chargers, and more powerful DC chargers ranging from 50 kW to 150 kW of power. Some charging points are available for use, but still in lack of company's official market channel for the Croatian market. A smartphone application is to be launched in the first quarter of 2021, yet until then charging service will be exempt of payment (Interviewee from Petrol d.d.).

3.5 Key organizations in the charging industry in Croatia

The most influential stakeholder dealing with electrification of personal mobility in Croatia is the Croatian Electric Vehicle Drivers Association "Strujni Krug" i.e., "Electric Circle". Apart from representing electric car drivers in Croatia, this non-profit organization is keen on actively participating on projects set up by the Croatian government, automobile industry and other key organizations. Their website contains a guide on different available charging systems and standards, as well as an EV buying guide on new and used electric models with details on market prices, range and battery capacity (Strujni krug, 2021).

To illustrate the value of such organization in a relatively inactive country regarding personal mobility electrification and the essential nature of a sufficient infrastructure, the proof is one of the most far-reaching projects currently at hand. In an interview for a Croatian media portal in December 2020, the president of "Strujni krug" Hrvoje Prpić revealed a project with an aim to install 100 thousand chargers for electric vehicles on existing street light posts in major Croatian cities. It is estimated that the project is value for around 150 million euros, finalized within three to five years. So far, this revolutionary project involves five potential operators and two equipment manufacturers, along with 'smart city' associations.

Prpić revealed that the charging services won't be excluded from payment, but the fee will remain affordable. The goal is set so that the service cost of vehicle charging remains under 10 kn for 100 kilometres of range. Moreover, he highlighted the sustainability and the scalability of the solution through minimal necessary technical upgrades in a form of a dedicated gauge that acknowledges the separation of different tariffs for public lightning versus electric vehicles charging. What's more, the financial background of the investment is sound, as Prpić further explained: "Total cost of the project is estimated to be around 150 million euros, with the goal of sourcing funds from the Covid-19 pandemic European recovery fund. Assuming that everything goes according to plan with the project's finalization, Croatia would have complete coverage of EV charging point, along with all light posts using LEDs instead of traditional light bulbs – without a single kuna spent from the Croatian national budget. Cities already have interesting locations, and are ready to put them in use in order to develop their communities and therefore raise the life standard of citizens which won't have to bear the cost of the investment." (Bičak, 2020).

Last but not least, from November 2020, Croatian public can for the first-time purchase models from the palette of the current EV market leader – Tesla Motors. As it was already mentioned in this paper, Tesla drivers are estimated to profit the most from the benefits of electric powertrains due to a high level of automatization of Tesla's proprietary charging network. At the moment there are around 55 Tesla owners in Croatia, and with a recent opening of a Tesla store in Zagreb the market share if the Californian EV manufacturer will continue to rise (Milčić, 2020). At the moment, Tesla's drivers can rely on eight charging locations with 48 'Superchargers' which support fast charging speeds with up to 150 kW per charger. Momentarily, Tesla Motors charges 2,12 kn per kWh (Tesla.com, 2021), which is considerably less expensive than the price per kWh charged by other comparable service providers such as Hrvatski Telekom for slower charging of 50 kW. If, per example, a dedicated Tesla Supercharger is not on the drivers' travel route, they are backed up by 70 destination chargers that do not support DC fast charging but can at least partially charge the vehicle over night between (Tesla.com, 2021).

3.6 Government role and subsidy policy

One of the key decisions of the Croatian government aimed towards strengthening the position of electric vehicles on the roads was to subsidize the purchase of EVs. The Environmental Protection and Energy Efficiency Fund for 2020 ensured 44 million kuna intended for co-financing the purchase of energy efficient vehicles.

The total fund was divided 50/50 for business and non-business parties, therefore 22 million kuna each. Up to 40% of the total vehicle cost was to be co-financed, under the condition of no previous registration upon import or sale in Croatia. The vehicle can be purchased in

Croatia, within the EU or the rest of the world, but it has to be registered in Croatia (Fond za zaštitu okoliša i energetsku učinkovitost, 2021). In the Appendix 14 and Appendix 15 one may find vehicle categories which undergo potential co-financing and the maximum subsidy for private and business parties.

Note that the following vehicle categories (CVH, 2021) can be applied for government subsidies:

- Vehicle category ‘L’ is comprised of mopeds, motorcycles and quad cycles,
- Vehicle category M is comprised of automobiles and buses
- Vehicle category N is comprised of commercial vehicles

Despite of concrete financial incentives aimed to quicken the transition to alternatively powered vehicles, a deeper insight in the realization of available funds reveals a systematic weakness that limits consistency in the execution of government’s subsidizing policy. All applicants are welcome to send their application forms on line, with a fixed date and time schedule. It is important to mention that funds allocation functions on the ‘first come, first serve’ basis. In less than three minutes from the start of application receival, on July 2nd, 2020, the system received 546 applications from private parties, out of which 470 refered to battery electric vehicles.

As a result, the Environmental Protection and Energy Efficiency Fund for 2020 amounting to 22 million kuna for private parties, was almost instantly drained of all available funds. An additional fund amounting to 22 million kuna intended for business parties, was subject to 307 applications, and was completely exploited. Both funds were fully utilized in record time (FZOEU, 2020).

4 RESEARCH METHODOLOGY

In the following chapter, I further examine the research questions and goals that help to streamline the acquisiton of primary and secondary data and provide the methodology behind the data analysis.

4.1 Research goals and research questions

The following are the research questions:

1. What are the attitudes and preferences of Croatian new car buyers with regard to the upcoming EV transformation of the Croatian new vehicle market?
2. How do non-car company owned EV chargers compare to available EV chargers installed by auto manufacturing companies in terms of pricing, availability and diversity?

3. Would current and potential EV users consider a commercial service designed to solve the problem of insufficient number of public EV chargers while increasing the efficiency of underused asset such as third-party owned EV chargers?

4. What are the key attributes in creating a value stream attractive to EV users?

The research goals of the master thesis are:

- To explore consumer attitudes and preferences usage of electric vehicles based upon the relatively recent introduction of EVs on the new vehicle market in Croatia;

- To analyse the pricing, availability and diversity of private and publicly available EV chargers in Croatia;

- To determine whether current users of EVs and those who are likely to purchase an EV in the following five years would consider a commercial service based on principles of bundling products as services such as EVs with charging services;

- To provide a general recommendation regarding a potential new business model for the EV market in Croatia.

4.2 Primary data collection

Compiling the research segment of this master thesis is done by applying a qualitative research method. The literature review is based on the information from secondary data sources found in articles, web sites, books, and similar sources. The collected data shaped the theoretical framework and gave way to the second, empirical part of the research which is based upon the primary data that I collected and analysed, with the aim of developing a proposition for a business model. Insights gained from the secondary data such as official statistics and consumer reports were aimed to give answer on the two first research questions. Additionally, the primary data from the second part of the research was acquired to give an answer on the latter three research questions concerning consumer attitudes. Throughout this process, the goal was to get a better understanding of what Croatian drivers thought of the disruptive changes in the automobile industry, how keen are they to consider an electric vehicle in the nearby future and what do they see as the weakest links in the transition from fossil fuelled to battery powered automobiles. Considering the social circumstances at the time, an online survey was evaluated to be the best way to approach primary research. The online survey was executed with the help of a web service “1ka”, a tool that was previously proven to be reliable for creating questionnaires and ultimately analysing the responses. This form of primary research was chosen for its ability to cover a broader audience. Also, it is complimented by features that allow for a better understanding of the target audience because of a more unambiguous assessment of particular market segments.

The sample was defined through online sampling since all respondents were reached by email invitations and social media posts. Besides directly reaching out to people by email, the sample size further benefited in a collaboration with the Croatian electric vehicle drivers' association "Strujni Krug". In order to make the sample representative, a restriction had to be placed in the questionnaire's intro, requiring from the respondents to take part only if they have a valid driver's licence.

The online questionnaire was open to potential respondents for three weeks, i.e., for 21 days from February 2nd 2021 to February 23rd 2021. The system counted for 712 respondents, but less than half completed the survey – totalling in 313 valid respond units. In the intro of the questionnaire, the respondents were introduced with the survey's overseeing academic institution, its purpose, privacy security and disclaimed limitations. Because the targeted market is within the borders of Croatia, the questionnaire was communicated in Croatian.

In total, the survey included 19 questions and 60 variables, with an intent to cover various degrees of interest in electric cars of the Croatian public. The questionnaire was designed so that the first questions were focused on the driving habits of Croatian drivers, questions in the middle of the questionnaire on perceptions and attitudes, and demographic characteristics were placed at the end of the questionnaire to avoid fatigue and loss in interest for completing the survey.

4.3 Data analysis

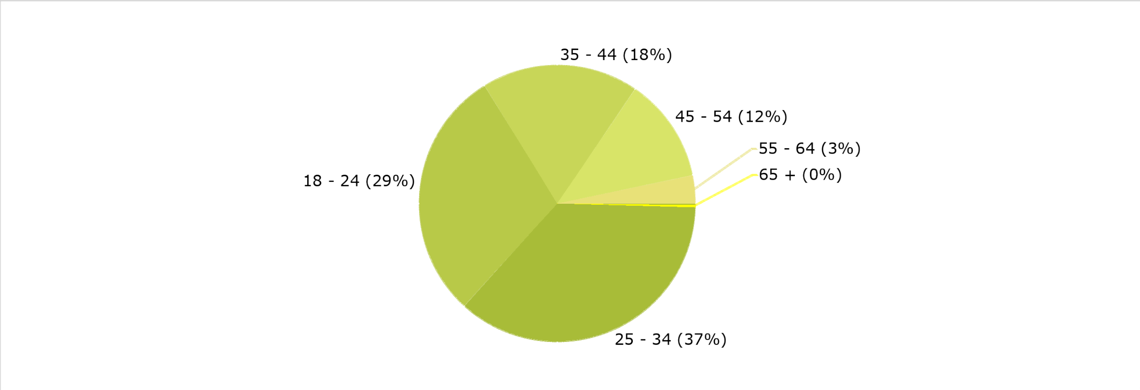
In order to facilitate the data analysis, the same online survey platform "1ka" was used. Data analysis was carried out predominantly with the use of descriptive statistics. Results from the empirical research guided in forming the general recommendation for approaching the customers from the suppy side of the market.

4.4 Sample description

In the following three figures, we can find information on the demographical statistics of the sample. Purschasing a new vehicle, for much of the general population in Croatia, represents a significant investment, therefore in I defined the research sample according to its age, level of education and their net monthly household income to outline as in their key demographic characteristics. As electric vehicles are often associated with the general trend of adopting new technology, delivering the survey to various age and income groups was important. Data is formatted into simple charts so one can easily understand the results.

Regarding the respondents age, as shown in Figure 7, more than 84 per cent of the sample is bellow the age of 50 years. More precisely, as much as 37 per cent of respondents are between the age of 25 and 34 years, and 29 per cent of respondents belong to an age between 18 and 24 years. Furthermore, 18 per cent are aged between 35 and 44 years, while only three per cent of the sample is aged above the age of 55.

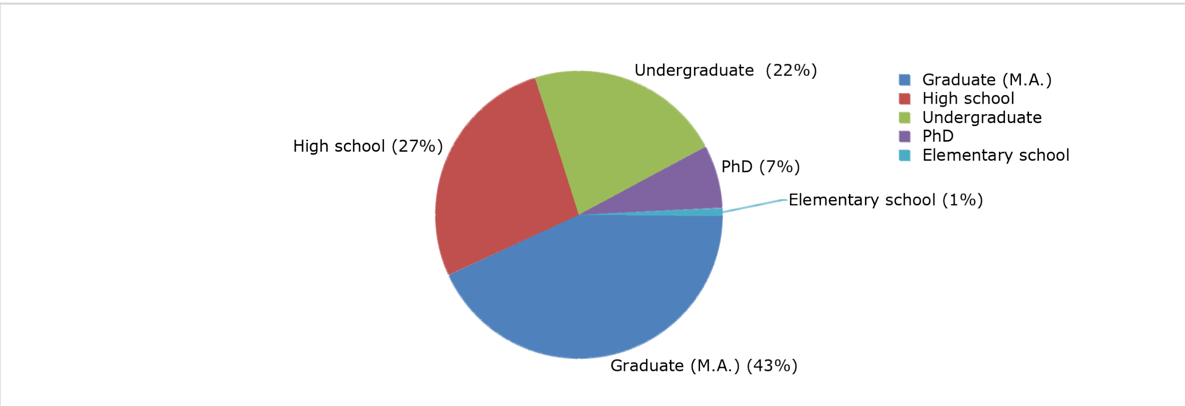
Figure 7: Age of respondents (N=313)



Source: Own work.

When it comes to the level of education, Figure 8 shows that most of our respondents, 43 per cent of them, have a graduate degree, followed by high school education for 27 per cent of respondents, while 22 percent of respondents have an undergraduate degree. The smallest shares are carried by respondents which have a PhD or an elementary school degree, with 7 per cent and 1 per cent respectively.

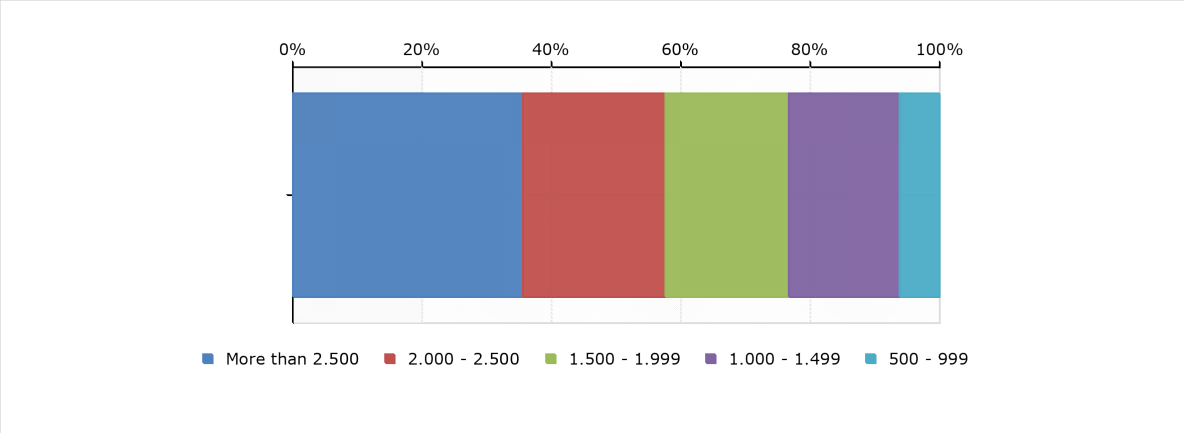
Figure 8: Level of education of respondents (N=313)



Source: Own work.

Finally, the last question on the subject of demographics regarded the monthly net income in EUR of the respondents' households. Survey analysis has shown that most of respondents, 35 per cent of them, have a monthly household net income of over 2.500 EUR per month. They are followed by those earning between 2.000 EUR and 2.500 EUR monthly, and 1.500 EUR and 1.999 EUR, with 22 per cent and 19 per cent respectively. The smallest share in the Figure 9 is taken by respondents whose household earn between 500 and 999 EUR monthly, with only 6 per cent. From the share distribution of income one can see that further research should be done encompassing a broader population sample to examine a more representative income structure in the average Croatian household.

Figure 9: Net monthly household income in EUR (N=309)



Source: Own work.

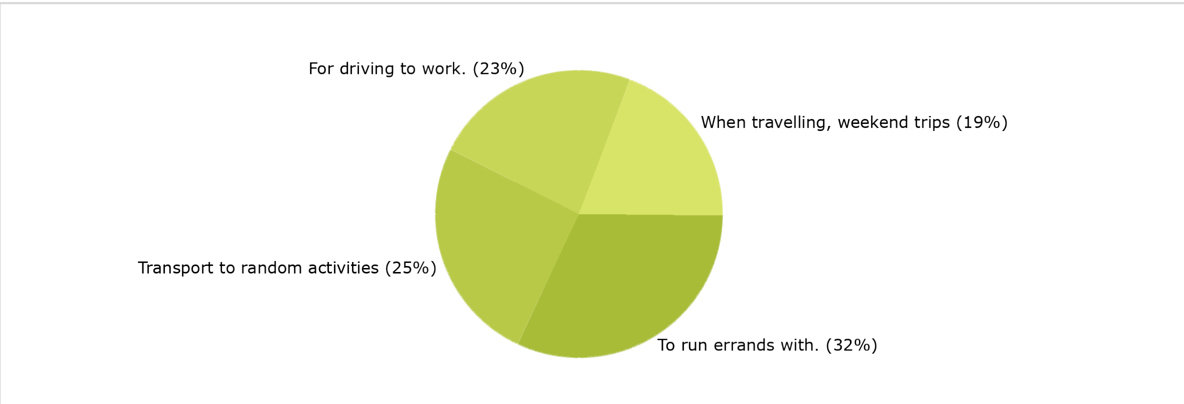
5 RESEARCH FINDINGS

In this chapter, I provide the findings from the research, followed by my recommendations.

5.1 Current habits regarding automobiles

Figure 10 below provides an overview of the result on the question of habits of using a car according to proposed practices that were assumed to be the most frequent. 313 respondents could choose multiple answers. When combined, 32% said that they use a car for running errands, 25% for transportation to various activities, 23% for work commute, and 19% for longer and weekend trips.

Figure 10: The most common reasons for driving a car (N=313)

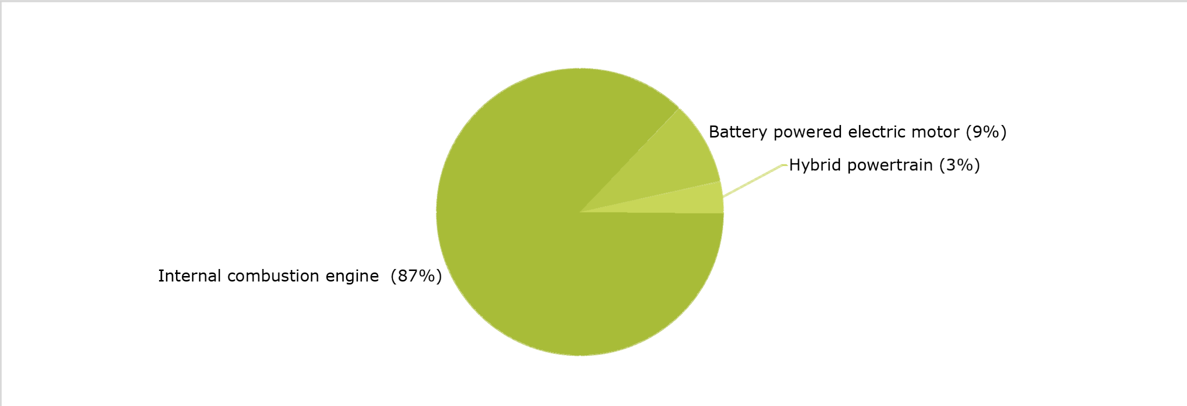


Source: Own work.

For the analysis to be more accurate, the questionnaire requested from its respondents to state their current powertrain of choice. An assumption based on the secondary research proposed a strong supremacy of internal combustion cars. Not surprisingly, as noted in the

Figure 11, the sample confirmed that assumption, with internal combustion engine having the largest stake amounting to 87%. Contrary to expectations, a fully electric powertrain placed second with 9%, and hybrid powertrains amounted to 3%.

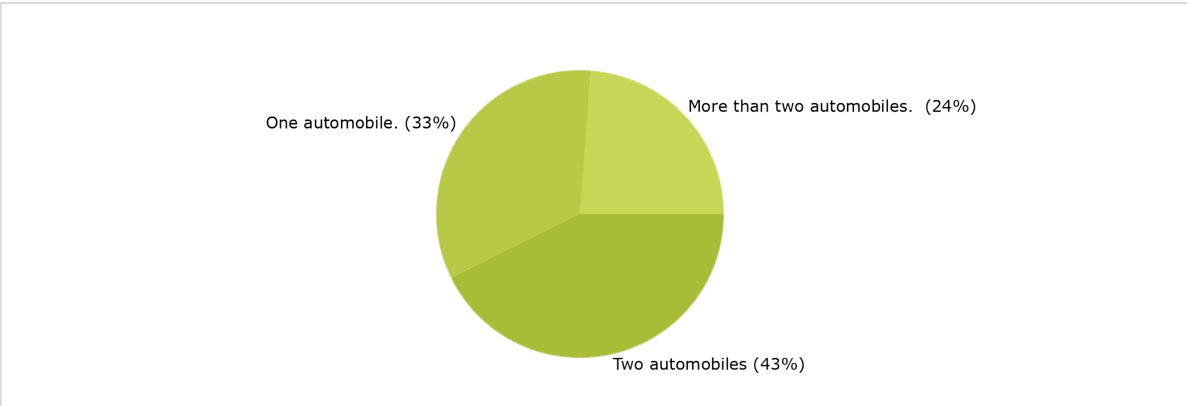
Figure 11: Types of powertrains in vehicles currently owned (N=288)



Source: Own work.

Below displayed Figure 12 shows the answer of respondents when asked to state the number of cars in their current ownership. A statistic that is important for the analysis due to somewhat unpopular opinion that the decision to acquire an electric car can only be rational if it is used as the "second car" in the household. The pie chart below shows that 43% of households represented in the sample own two cars, one third of households own a single car and less than a quarter own more than two cars.

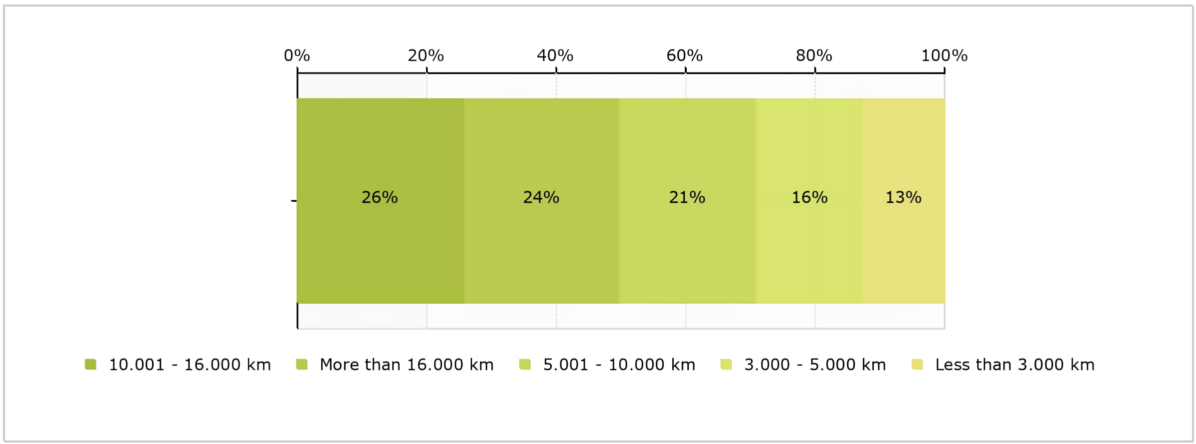
Figure 12: Number of cars in a household of the sample audience (N=311)



Source: Own work.

In order to acquire a better understanding of the respondents' mobility habits, the questionnaire covered the inquiry for the average yearly range of driving kilometres of each survey participant. Relating to a present level of scepticism towards electric vehicles, secondary research has discovered that one of the main worries is convoluted behind the longevity of the car's batteries, making a point for the primary research. Interestingly, the share of different answers on the question of annual average driving distance of respondents has shown to be quite balanced. 26 per cent of respondents have said that they annually drive between 10 thousand to 16 thousand kilometres, 24 per cent said more than 16 thousand kilometres, and 21 per cent said between 5 thousand and 10 thousand kilometres. Also, 16 per cent said that they annually drive between 3 thousand and 5 thousand kilometres, while only 13 per cent of the respondents said they drive under 3 thousand kilometres annually on average, as it is seen on Figure 13 bellow.

Figure 13: Annual average driving distance of respondents (N=279)

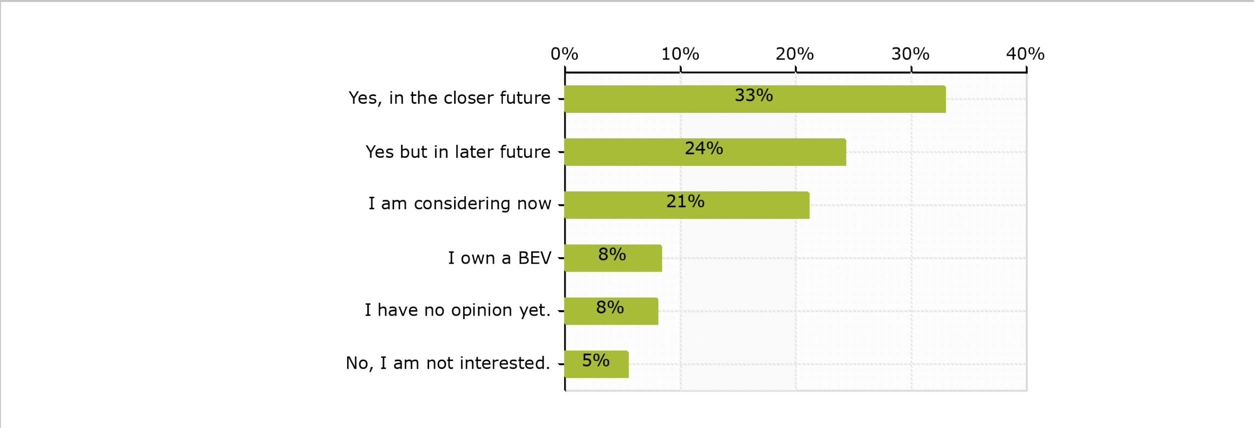


Source: Own work.

5.2 Attitudes regarding future purchase of an EV

Figure 14 below provides an insight of the sample's current projection of their future direction regarding the powertrain selection for their next vehicle. Out of 313 respondents, around a third of them noted that they would consider an electric vehicle in the near future (e.g., within the next five years), revealing a noteworthy degree of consumer awareness on the technological advancement of the electric car in the automotive industry. Whether the incentive comes from the regulatory advancements acting in favour of electric vehicles or as a self-initiative is to be further researched. Furthermore, 24 per cent of respondents noted that they would consider an electric vehicle, but not in the immediate future (e.g., within the next ten years), and 21 per cent of the respondents noted that they are considering an electric car as of now. From this finding, there is sufficient evidence to support the assumption that electrification of personal vehicles is something that is fairly recognized in the Croatian drivers' community. Interestingly, eight per cent of total respondents already own an electric vehicle, which makes the sample more representative in terms of reccuring experiences. Finally, thirteen per cent in total of the respondents haven't considered an electric car or are not interested in electric cars.

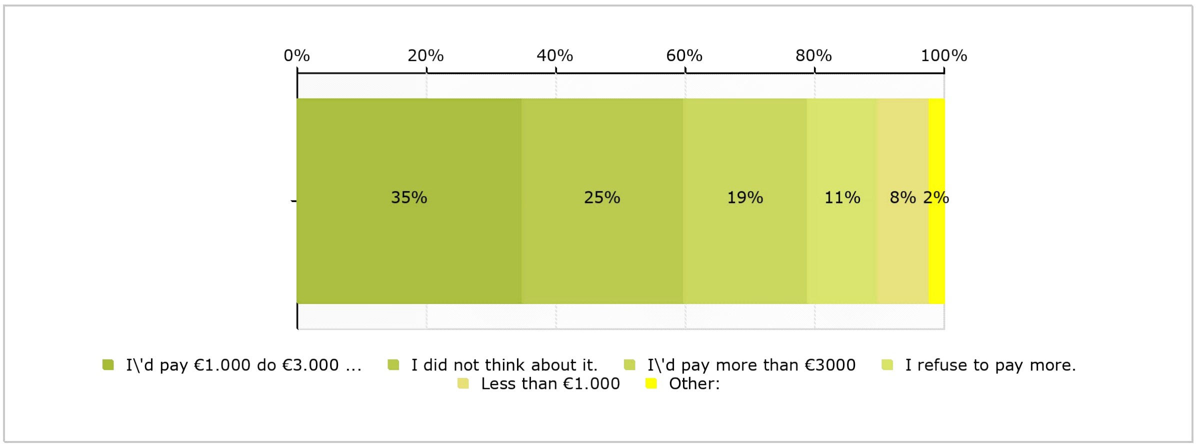
Figure 14: Likelihood of purchasing an electric car as their next vehicle (N=313)



Source: Own work.

Following the inquiry on the likelihood of purchasing an electric car as their next vehicle, the respondents were questioned about their attitudes towards the pricing of electric vehicles. More precisely, they were asked to assess their willingness to pay a premium over a conventional vehicle powered by an internal combustion engine. Deriving from the response structure in the Figure 15, it is distinguishable that 35 per cent of the respondents stated that they would be willing to pay somewhere from 1000 EUR to 3000 EUR more for an electric vehicle, while a quarter of respondents stated that their judgment on the subject of pricing is yet to be given some thinking. Surprisingly, around 19 per cent of respondents stated that they would be willing to pay more than 3000 EUR for an electric vehicle compared to its traditional counterpart, exceeding the total share of respondents who are reluctant to pay a premium or even deny paying more.

Figure 15: Consumer willingness to pay extra for an electric car (N=313)



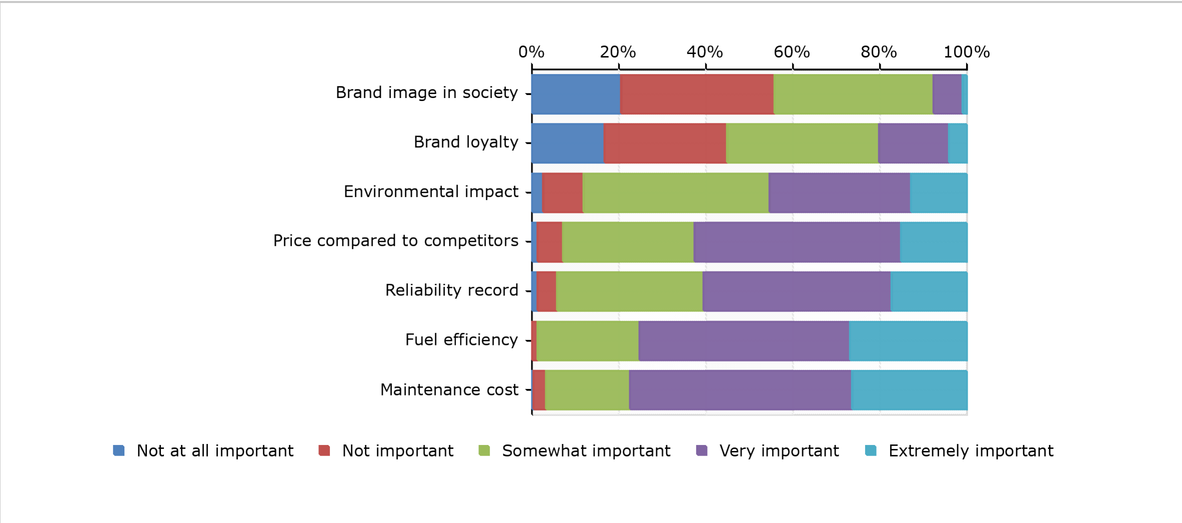
Source: Own work.

5.3 General preferences regarding vehicles

In order to get a better understanding of general car preferences of Croatian consumers, as well as how consumers prioritize certain aspects of vehicle ownership, the respondents were asked to rate how important their find the following purchasing factors when buying a new car: price of the car compared to its segment competitors, brand loyalty, fuel efficiency expressed in litres per 100 kilometres, maintenance costs, reliability record, environmental impact and the car brand's social image. Figure 16 depicts how important an individual aspect is with the help of a Likert scale, ranging from "Not at all important" to "Extremely important". From the Figure below, one can see that the strongest degree of cohesion is noticeable at the two far right columns: fuel efficiency expressed in litres per 100 kilometres and maintenance costs. For these two factors, around 75 per cent of respondents unambiguously marked them as important aspects when choosing a new vehicle.

Furthermore, when asked to rate the importance of the reliability record and the price of the car compared to its segment competitors, more than half of respondents clearly mark identify them as important. On the other hand, when observing the response structure for one of the strongest advantages of an electric vehicle, the environmental impact, there is a lack of a clear bias towards the degree of importance among respondents. For this variable, more than 40 per cent of respondents stated that the vehicle's environmental impact is somewhat important for them, indicating a less radical degree of eco-awareness among the Croatian driving public. Finally, in the two far left columns one can notice the strongest discrepancies in the answer structure. That said, it is clear that the car brand loyalty and the car brand's image are on the bottom of the priority list when choosing a new car.

Figure 16: Consumer emphasis of various purchasing factors when buying a car (N=310)



Source: Own work.

5.4 Consumer perception of EVs

Based on the response on the question concerning the notion of respondents' likelihood of selecting an electric powertrain as in their next vehicle of choice, the respondents were systematically divided into two segments. Respondents who selected one of the response options which directly implies a degree of interest for purchasing an electric vehicle, regardless of its constituent aspect of action immediacy, constructing a segment subject to further analysis. 267 respondents out of 313 in total, or approximately 85% of the sample, took part in one of the most important components of the questionnaire, which is presented in the Figure 17 below.

Containing 15 statements on the subject of the perception of electric cars among the Croatian drivers. Again, respondents were offered to agree or disagree with a set of statements according to an appropriate degree of agreeability. Aggregated response on the proposed statements suggests a perception that is biased towards the electrification of personal vehicles in Croatia. Statements with the strongest cumulative base of strongly agreed and agreed responses, with over 75 per cent of agreeable responses, concern the welcoming of electrification of motorized mobility, clear understanding of usage and maintenance expenses of electric vehicles, evasion of significant disruption in daily mobility habits, importance of simplicity of using car charging services within the sphere of electric vehicle ownership, and accessing and paying for the charging service as easily as refuelling a conventional vehicle.

Also, the statement which took notion of whether the respondents perceive electric car manufacturers which focus on the systematic support of charging services as more serious, managed to cumulatively acquire around 65 per cent of agreeable responses, as well as the notion of expressing interest for electric cars.

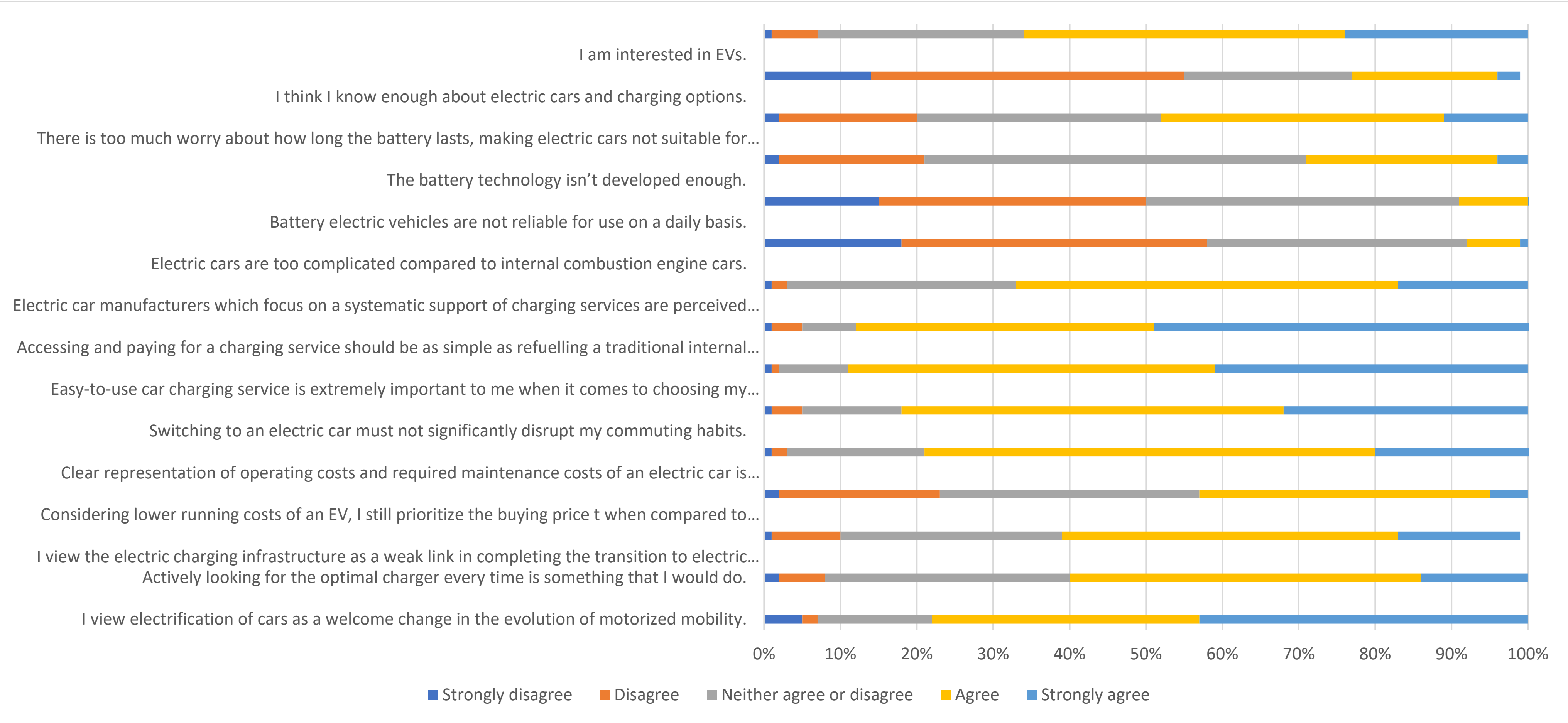
Statements whose responses resulted in a more varied structure regarded the practice of choosing the optimal charging point upon insufficient battery charge, recognizing the charging infrastructure as the weakest link in completing the transition to electric cars, prioritizing the purchasing cost when compared to traditional competitors, and feeling unease due to a plethora of variables that constitute the use of an electric car, thus making them inadequate for longer trips.

That said, it is important to note that in spite of a somewhat lesser consistency in agreeing with the statements compared to the former series of statements, the share of agreeable responses holds around 50 per cent cumulatively per statement, with disagreeable responses peaking at 20 per cent cumulatively, per statement. What's more, the statement with the comparably largest share of uncertain responses (identified in the questionnaire as "neither agree or disagree"), at 50 per cent, is one regarding the current state of technological development of electric car batteries and their daily usability prospect.

On the other hand, around 50 per cent of respondents disagreed with the statement that electric cars powered by rechargeable batteries are not reliable for daily use, in contrast to cumulative 10 per cent of respondent that agreed. A quick comparison shows an inconsistency in the sample's perception of the daily usability of electric cars, or rather a call for additional due diligence to further outline the silver lining of consumer scepticism.

Furthermore, statements which cumulatively acquired approximately 55 per cent of disagreeable responses have to do with the notion that electric cars are overly complicated compared to internal combustion engine cars, and the notion of sufficient education on electric cars and comparable charging options.

Figure 17: Consumer perception of electric cars (N=267)



Source: Own work.

5.5 Attitudes regarding charging options

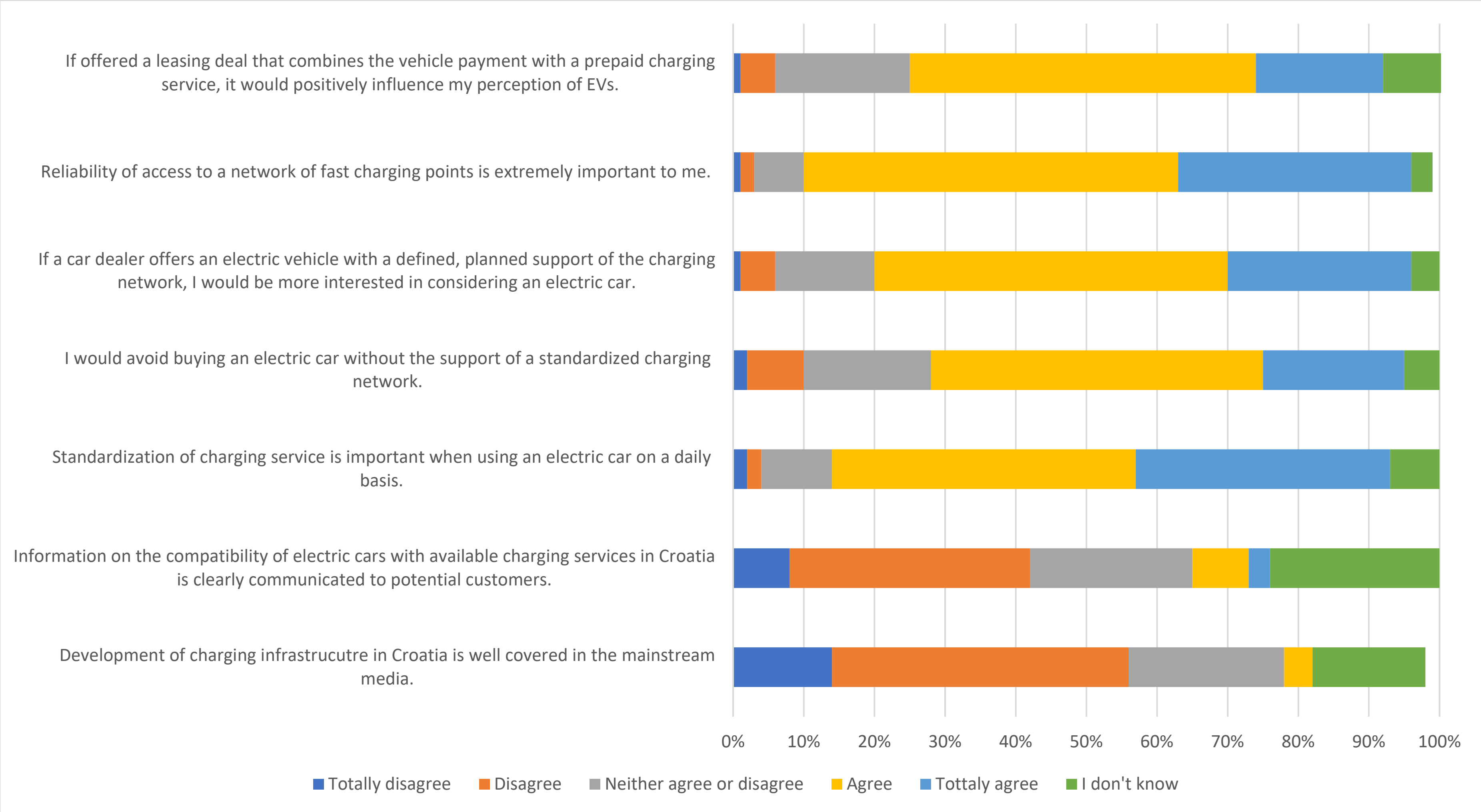
Ultimately, in the closing part of the questionnaire, the respondents were faced with seven statements that referred to the perception of charging options in Croatia. More specifically, this part of the questionnaire was aimed at illuminating different aspects of electric vehicle: assessing consumer awareness of the target audience, testing the importance of standardizing the charging options across the electric vehicle industry, and assessing the consumer attitude towards incorporating the charging service in the current electric vehicle market offering. Furthermore, this element of the questionnaire was aimed conclusively towards outlining a business model that is presented in the latest chapter of this paper.

Statements with which the respondents strongly disagreed and agreed were shaped to highlight the lack of consumer awareness for electric charging points in Croatia, and the complementary, potentially causal relationship with the current media coverage of the aforementioned. Drawing a conclusion from the descriptive statistics found below in Figure 18, we can deduce that 56 per cent of respondent, cumulatively, think that the infrastructural development of electric charging points in Croatia lacks sufficient coverage. Also, 42 per cent of respondents think that there is insufficient clarity in informing the public on the compatibility of electric cars with electric charging points in Croatia, in addition to comparably high 24 per cent of respondents who responded with “I don’t know”.

Statements which cumulatively acquired the largest share of agreeable responses with 79 per cent, and 86 per cent respectively, regard the importance of standardized charging points upon daily use of an electric car, and secondly, the importance of a reliable access to a network of fast charging points. Moreover, the statement referring to the potential consumer response on a dealer created, “product-service” bundle, combining the lease of an electric vehicle with a planned support of a charging network, cumulatively acquired 76 per cent of agreeable responses.

Similar response structure was found in the statements further testing the market growth aspect of product-service bundling: testing the hypothesis of how likely is one to avoid buying an electric car without the support of a standardised charging network and testing the hypothesis of would one be positively influenced if a car dealer was to offer a financing (leasing) deal that combines the vehicle expense along with a standardized and guaranteed car charging support. Both, former and latter, acquired 67 per cent, cumulatively per statement, of agreeable responses, while around 18 per cent of respondents claimed to be indecisive in their answer.

Figure 18: Consumer perception of the charging infrastructure for electric cars (N=311)



Source: Own work.

5.6 Summary of research findings

The aim behind this subchapter is to sum up the key findings collected from the survey whose respondents represent a sample of the driving public in Croatia that is yet to be confronted with abandoning the familiar conduct of owning and using an ICE vehicle. Key observations will be outlined with respect to research questions defined earlier in the thesis.

What are the attitudes and preferences of Croatian new car buyers regarding the upcoming EV transformation of the Croatian new vehicle market?

Croatia's driving public is still on the verge of contemplating the electrification of personal vehicles, in spite of significant technological advancements that were developed and delivered by automotive industry disruptors, as well as incumbent automotive manufacturers.

Changing the drivers' perception of all inputs necessary to use the motor vehicle coincides with an undesirable disruption of a well-practiced routine. Such, often unreasonable, resistance towards transitioning to electric vehicles compliments a rigid, mainstream notion of vehicle ownership built on decades of internal combustion engine domination in personal transportation. Automotive companies predominantly hold to traditional business models by channelling their value proposition solely through their vehicles, which implies that they are disregarding the fundamental premises of a technological transformation on a platform level. An exception is the case of Tesla Motors, that adopted a much riskier, capital-intensive strategy that disrupted a very traditional, incumbent heavy industry, and consequently allowed them to become synonymous with the modern understanding of an electric vehicle.

What are the key attributes in creating a value stream attractive to EV users?

Automotive companies predominantly hold to traditional business models by channelling their value proposition solely through their vehicles, which implies that they are disregarding the fundamental premises of a technological transformation on a platform level. An exception is the case of Tesla Motors, that adopted a much riskier, capital-intensive strategy that disrupted a very traditional, incumbent heavy industry, and consequently allowed them to become synonymous with the modern understanding of an electric vehicle. Regulatory changes that were adopted by the European Parliament and Council seem to be influencing the supply side of the market but are yet to affect the public mindset on the issue of local and global emission of greenhouse gasses, and its ubiquitous effect on the quality of living.

Around 66 per cent of households in the survey own more than one automobile, which matches the share of households in which the automobile is used by multiple household members. Considering that around half of respondents stated that they are considering an EV in the next five years, it indirectly implies that the EV would, in most cases, be used as the secondary vehicle in the household. Electrification of automobiles is welcomed in Croatia, but for it to take its full swing at a rather inert economy, the technological transition is hampered by inefficiencies seen mostly in lacking communication on the aspects of EV running and maintenance costs, long term reliability and long-term savings versus the high purchasing cost.

One may argue that the generational gap within the distribution of wealth is still too great to exert a significant change in the share of electric vehicles, if assumed that the key disadvantage of electric automobiles is their relatively higher price. When in fact, from the survey results, participants outlined that the largest barrier is insufficient information on aspects of daily usage and ownership.

Would current and potential EV users consider a commercial service designed to solve the problem of insufficient number of public EV chargers while increasing the efficiency of underused asset such as third-party owned EV chargers?

Practically speaking, current market conditions fail to incentivise potential customers by failing to systematically transcend cost cutting benefits in a form that is easily understandable to customer segments which engage much later in the diffusion of market innovation but make most of the customer pool. Identified obstacles largely concern the level of awareness on technological components of electric vehicles and their charging infrastructure. Acting passively on the subject of designing a financial plan that includes the cost of charging, increases the level of uncertainty and allows for sub-optimal performance for all components of the offer. Recognizing the need to offer a more assuring, logistically and profitably sound service can alone motivate the consumers to purchase the EV sooner than originally planned, leaving the competitors to catch up as the more competitive player builds his customer base.

Market players competing in the automotive industry, enforced by the European governing legislation, have a very difficult task of overcoming the shadowing pressure of, often deal-breaking uncertainty, by influencing the public mindset and changing customers' habits. Their goal should be to avoid the specific risk by meeting the opportunity to facilitate the process of transitioning by creating a safety net that combines readily available resources to cut down on risk of losing against market disruptors, as seen with Tesla Motors.

How do non-car company owned EV chargers compare to available EV chargers installed by auto manufacturing companies in terms of pricing, availability and diversity?

As detailed in the chapter 3, one can see that the pricing of different vendors can vary extensively, as the quality of service largely depends on the speed of the charge. Car company owned chargers are designed and built to so they are compatible with the proprietary vehicle. Newer units can charge more quickly as the technology moved forwards but most importantly – proprietary power stations are able to provide a consistent and a reliable service for one's money. At this stage of charging infrastructure development, coverage and consistency are strongest weaknesses. Since the sales share of new EVs in

Croatia is less than 5 per cent, there lies a massive opportunity to further examine consumer attitudes and behaviours, and perhaps try and combine the two sides of the spectre of the automotive market, to finally come out with a unique proposition that binds different benefits of an EV, not to be let down by overly complicated registration procedures and malfunctioning control units.

5.7 Research limitations

Primary research has been conducted online, providing the strongest nominal reach but lacking in-depth quality. The questionnaire's design and content took into account the limited focus span of the respondents, meaning that open-ended questions were mainly omitted from it. Out of total 712 respondents, less than half fully completed the survey – totalling in 313 valid responses. Future research must capture a much larger sample to solidify its credibility – an automobile is a commodity and a mobility asset taken for granted in the modern European society, therefore the research sample should be exponentially enlarged. Future research should include a larger share of respondents in age groups from 35 to 44 years and age group from 45 to 54 to achieve a greater representativeness of the sample. The questionnaire was distributed using social media, and considerably supported by a Facebook post of the Croatian electric vehicle drivers' association "Strujni Krug". Also, an omnichannel approach to the research would be able to grasp various perspectives to a larger extent.

Another key research limitation is the use of descriptive statistics for data analysis. While it provides a convenient statistic, the use of regression analysis would help to reveal the correlation between multiple variables, facilitating the segmentation and therefore better articulating market opportunities. Moreover, a broader research focus can be put on the technical aspect of viable business model proposals, since the question of sustainable growth is knocking on our doors, without a clear distinction of the responsible party. In addition, more relations can be analysed between particular socio-economic, demographic, behavioural and other groups in ways they experience new mobility solutions.

CONCLUSION

The pillar of this master thesis revolves around the automobile – an indisputable personal mobility solution facing its biggest alteration since its creation in the late 19th century. Electrification of the motorcar signifies a change much further reaching than substituting fossil fuel for electricity to propel the vehicle. The automotive industry is facing a level of transformation that surpasses the changes in design and technology built into the product itself and emphasises the platform perspective of data integration that is capable of supporting the users' needs unison to the supply of electrical energy.

In this thesis, I attempted to analyse consumer attitudes and behaviours in order to better understand the current state of the automotive market in Croatia, how market trends shape the consumer preferences and compare the market response on various legislation on the example of other EU member states. In order to acquire primary data, I created a survey to further gain knowledge on the research topic, approaching the drivers as the target audience. The survey helped me to understand the demographic characteristics of my audience but also helped me to outline the strongest pain-points of Croatian drivers, as the potential buyers of EVs. Research findings indicate that key concerns have their roots in still unproven technology, yet to be argued against by incumbent auto manufacturers who's EV portfolio is questionably price-competitive against its ICE counterparts, that the Croatian drivers know so well. One of the key findings materialized itself in the importance of defining the charging service in terms of its availability, pricing and guaranteed access.

The key dilemma behind the concept of the electric car concerns our present understating of it as the form of personal transportation: it only works if it can offer infinite flexibility to the user. At the moment the user has to make allowances for the vehicle, then is no longer a car, but an obstacle in one's way. Consistent narrative in the primary research results saw the key issue in the uncertainty of the development of the charging infrastructure, more specifically on the number and location of charging points throughout Croatia, as well as the doubtfulness in their compatibility with the vehicle of choice. The crucial statistic in the primary research of this master thesis is found behind more than 75 per cent respondents that reacted positively on the notion of vehicle financing that would include a guaranteed access to the charging stations in terms of overall EV perception.

Automotive tech companies such as Tesla Motors and Rimac Automobili, exceed their position of market disruptors which they quintessentially represent. As organizations on the opposite sides of the automotive industry spectrum, both characterized by strong growth and direct, industry-wide influence, they have created tech product bundles as a result of unparalleled capital investment and intelligence accumulation capable of delivering the expected performance. All things considered, regardless to who will come out as the winner in the race for seamless life-routine integration with their electric vehicle, the real challenges revolve around raising the awareness on EV ownership and maintenance expenses, but above all mastering the intuitiveness of powering the electric vehicle, erasing all doubts in their simplicity of use.

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APPENDICES

Appendix 1: Povzetek (Summary in Slovene language)

Prodorne inovacije v gospodarstvu še nimajo poenotenega razumevanja, zato je težko napovedati ali zagotoviti njihovo učinkovitost znotraj posamezne organizacije (Thomond, Herzberg, & Lettice, 2003). Pogoj za uspeh tovrstnih inovacij je jasno razumevanje specifične panoge gospodarstva, obenem pa je potrebna prisotnost domišljije in ustvarjalne miselnosti, ki spodbudi razvoj kreativnih rešitev. Slednje lahko uspejo z razumevanjem obstoječih rešitev konkurenčnih ponudnikov in večjo dodano vrednostjo za kupce (Lettice, & Thomond, 2008). Tržna prednost prodorne inovacije se tako doseže ob vzpostavitvi proaktivne poslovne strategije, ki temelji na pričakovanju in napovedovanju morebitnih izzivov v prihodnje, medtem ko se nasprotujoča reaktivna strategija na dogodke odziva šele po tem, ko se ti zgodijo (Thompson, 2019).

Panoga električnih vozil je v zadnjem desetletju že šla skozi izrazito preobrazbo, a so kljub temu na obzorju konceptualne spremembe, zato ostaja zrela za inovacije (Ili, Albers, & Miller, 2010). Primer stalne inovativnosti je razvoj električnih vozil in predvsem napredek na področju baterij, hkrati je panoga električnih vozil z vidika finančnega vložka na področju raziskav in razvoja tretja največja porabnica. V letu 2017 je panoga električnih vozil skupno porabila 15,5 odstotka denarja, ki ga je svetovno gospodarstvo namenilo za raziskave in razvoj (Lall, 1980). Velika mera inovativnosti v panogi električnih vozil je sicer tesno povezana s težkim vstopom novincev. Visoki stroški oblikovanja, potreba po zagonu proizvodnih obratov in velika odvisnost od poznanstev s trgovci so namreč zahtevali nenehne novosti izzivalcev na področju avtomobilske panoge (Howard, Vidgen, & Powell, 2003).

Znatno rast trga električnih vozil na baterije je v zadnjih desetih letih zabeležila Norveška, kjer imajo električna vozila daleč največji tržni delež med vsemi vozili, v primerjavi z ostalimi konkurenčnimi državami (Bjerkan, Nørbech, & Nordtømme, 2016). Velik potencial za rast trga električnih vozil medtem beleži Hrvaška, kjer narašča potreba po polnilnih postajah za električna vozila, kar je tudi osrednja skrb potencialnih kupcev električnih vozil na Hrvaškem. Cene zasebnih električnih priključkov za zdaj ostajajo previsoke za posamezne kupce (Egbue, & Long, 2012). V luči napisanega magistrsko delo naslavlja ravno razvojne možnosti električnih priključkov za vozila.

Raziskava v magistrskem delu koristi avtomobilski panogi, ki jo trenutno najbolj zaznamuje prehod z motorjev na notranje izgorevanje na električna vozila. Trenutne razmere spodbujajo nadaljnji razvoj sodobnih tehnologij, kot je internet stvari, napredni sistemi asistence vožnje ter deljena mobilnost. Raziskava med drugim koristi tudi trenutnim in prihodnim lastnikom električnih vozil. Oboji lahko bolje razumejo tako stroške nakupa električnega vozila, kot tudi omejitve teh vozil pri vsakodnevni rabi, ki so posledica nespodbudnih socialnoekonomskih politik.

Appendix 2: Research questionnaire exported from 1ka.si

An analysis of a disruptive business model on the Croatian electric vehicle market

Survey short title: Disruptive EV charging

Question number: 19

Number of variables: 60

Status: Active from: 02.02.2021 Active until: 02.05.2021

Author: PAVAO KAŠTELAN, 29.01.2021

Edited: PAVAO KAŠTELAN, 23.02.2021

Bok! Moje ime je Pavao Kaštelan, student sam diplomskog programa International Master Programme in Business and Organization (IMB) na Ekonomskom fakultetu Univerze u Ljubljani. Svrha ove ankete je istraživanje povodom mog diplomskog rada na temu "Analiza disruptivnog poslovnog model na tržištu električnih vozila Hrvatske". Bio bih vam veoma zahvalan za 5 do 8 minuta vašeg vremena koliko traje rješavanje ove ankete. Svi odgovori su anonimni i bit će korišteni isključivo u svrhu istraživačkog dijela diplomskog rada. Kako bi vaši odgovori bili validni, jedini preduvjet je da imate važeću vozačku dozvolu. Iskreno hvala za vaše vrijeme i strpljenje!

Q1 - Vozite li automobil?

Moguće je odabrati više odgovora.

☐ Da, moj vlastiti automobil.

☐ Da, koristim car sharing uslugu.

☐ Da, povremeno posuđujem automobil od roditelja i/ili prijatelja.

☐ Ne vozim automobil.

Q2 - Kojom prigodom najčešće vozite automobil?

Moguće je odabrati više odgovora.

☐ Putovanje do radnog mjesta.

☐ Za duža putovanja, vikend izlete.

☐ Obavljanje svakodnevnih zadataka.

☐ Prijevoz do raznih aktivnosti.

Q3 - Kakav pogonski sklop koristi vaše trenutno vozilo?

Moguće je odabrati više odgovora.

☐ Motor s unutarnjim izgaranjem (e.g. benzin, dizel, LPG)

☐ Hibridni pogonski sklop: kombinacija elektromotora i motora s unutarnjim izgaranjem

☐ Elektromotor napajan isključivo punjivim baterijama

Q4 - Koliko kilometara godišnje napravite kao vozač automobila?

○ Ispod 3.000 km

○ 3.000 - 5.000 km

○ 5.001 - 10.000 km

○ 10.001 - 16.000 km

○ Više od 16.000 km

Q5 - Koliko je automobila u vlasništvu vašeg kućanstva?

○ Jedan automobil.

○ Dva automobila.

○ Više od dva automobile.

Q6 - Koliko drugih ljudi također koristi automobil/e u vašem vlasništvu?

○ Nitko osim mene.

○ Koristi još jedna osoba.

○ Koriste još tri osobe.

○ Više od tri osobe koriste moj automobil.

Q7 - Bi li kao opciju pri sljedećoj kupovini automobila, razmotrili električan automobil?

○ Nisam razmišljao o toj opciji.

○ Ne, nisam zainteresiran za električne automobile.

○ Razmotrio bih, ali tek u daljoj budućnosti (e.g. kroz 10 godina)

○ Razmotrio bih u bližoj budućnosti (e.g. kroz 5 godina)

○ Razmatram već sada.

○ Već sam vlasnik električnog automobila.

Q8 - U usporedbi s automobilom pogonjenim klasičnim motorom na unutarnje izgaranje, koliko više bi bili voljni platiti za električan automobil istog segmenta?

○ Nisam razmišljao o tome.

○ Odbijam platiti više.

○ Manje od €1.000

○ Platio bih €1.000 do €3.000 više

○ Platio bih i više od €3000 više

○ Other:

Q9 - Kada se odlučujemo za kupnju novog automobila, koristimo više faktora kako bi se pomnije odlučili za odgovarajuću ponudu. Na ljestivici ispod označite koliko važnim smatrate sljedeće faktore:

	Nije mi najmanje važno	Nije mi važno	Donekle mi je važno	Vrlo mi je važno	Iznimno mi je važno
Cijena automobila u odnosu na modele iz istog segmenta	○	○	○	○	○
Lojalnost marki automobila	○	○	○	○	○
Potrošnja goriva (energije) na 100 km	○	○	○	○	○
Troškovi servisa i ostalog održavanja	○	○	○	○	○
Povijest pouzdanosti marke	○	○	○	○	○
Utjecaj na okoliš	○	○	○	○	○
Društveni imidž automobila	○	○	○	○	○

Q10 - U sljedećem dijelu ankete pronaći ćete izjave čijim ćete ocijenjivanjem pomnije približiti vaše viđenje elektroautomobila. Procijenite vaše slaganje sa sljedećim izjavama koristeći raspon ocjena od "U potpunosti se ne slažem" do "U potpunosti se slažem".

	U potpunosti se ne slažem	Ne slažem se	Niti se slažem niti se ne slažem	Slažem se	U potpunosti se slažem
Smatram da je elektrifikacija automobila dobrodošla	○	○	○	○	○

promjena u evoluciji motoriziranog prometovanja.					
Voljan sam birati i precizirati optimalnu dostupnu elektropunionicu svaki puta kada želim puniti svoj automobil.	○	○	○	○	○
Infrastruktura elektropunionica najslabija je karika u procesu tranzicije na elektroautomobile.	○	○	○	○	○
Kada uspoređujem bilo koji elektroautomobil s tradicionalnom konkurencijom, prednost dajem nabavnoj cijeni automobila, unatoč značajno nižim troškovima korištenja elektroautomobila.	○	○	○	○	○
Jasna percepcija troškova korištenja i održavanja elektroautomobil	○	○	○	○	○

a iznimno mi je važna.					
Prelazak na elektroautomobil ne smije značajno utjecati na moje dnevne navike kretanja.	○	○	○	○	○
Jednostavno korištenje usluge punjenja elektroautomobila od iznimne je važnosti kada bih kupovala/o elektroautomobil.	○	○	○	○	○
Korištenje elektropunionice te plaćanje usluge punjenja trebalo bi biti jednostavno kao i nadolijevanje goriva kod tradicionalnih automobila.	○	○	○	○	○
Proizvođači elektroautomobila koji nude sistemsku podršku elektropunionica percipirani su kao ozbiljniji tržišni igrači.	○	○	○	○	○
Elektroautomobili su previše	○	○	○	○	○

komplicirani u odnosu na automobile s motorom na unutarnje izgaranje.					
Elektroautomobili pogonjeni punjivim baterijama nisu pouzdani za svakodnevno korištenje.	○	○	○	○	○
Tehnološki razvoj baterija u elektroautomobilima ne zadovoljava trenutne potrebe.	○	○	○	○	○
Stvaran doseg elektroautomobila predstavlja prevelik problem u praksi, čineći elektroautomobile nepogodnima za bilo kakva dulja putovanja.	○	○	○	○	○
Mislim da znam dovoljno o elektroautomobilima i opcijama punjenja.	○	○	○	○	○
Zanimaju me elektroautomobili.	○	○	○	○	○

Q11 - U sljedećem dijelu ankete pronaći ćete izjave čijim ćete ocijenjivanjem pomoći u razumijevanju nužnih promjena, ujedno i razvoju zaključka. Procijenite vaše slaganje sa sljedećim izjavama koristeći raspon ocjena od "U potpunosti se ne slažem" do "U potpunosti se slažem" ili "Ne znam".

	U potpunosti se ne slažem	Ne slažem se	Niti se slažem niti se ne slažem	Slažem se	U potpunosti se slažem	Ne znam
Razvoj infrastrukture električnih punionica u Hrvatskoj dobro je pokriven u mainstream medijima.	◯	◯	◯	◯	◯	◯
Kompatibilnost elektroautomobila s elektropunionicama u Hrvatskoj jasno je prezentirana potencijalnim kupcima.	◯	◯	◯	◯	◯	◯
Standardizacija usluge punjenja iznimno je važna prilikom svakodnevnog korištenja elektroautomobila.	◯	◯	◯	◯	◯	◯
Izbjegla/ao bih kupovinu	◯	◯	◯	◯	◯	◯

elektroautomobila bez podrške standardizirane mreže punionica.						
Kada bi trgovci automobilima ponudili elektroautomobil s unaprijed definiranom i planski podržanom mrežom elektropunionica, prije bih razmotrila/o elektroautomobil.	○	○	○	○	○	○
Osiguran pristup i pouzdano korištenje mreže brzih elektropunionica bili bi mi od iznimne važnosti kada bih razmatrala/o elektroautomobil.	○	○	○	○	○	○
Leasing ponuda koja bi kombinirala trošak kupovine elektroautomo	○	○	○	○	○	○

bila te garantiranu podršku standardizirane mreže elektropunionica, pozitivno bi utjecala na moje viđenje elektroautomobila.

Q12 - U sljedećem dijelu ankete pronaći ćete izjave čijim ćete ocijenjivanjem pomnije približiti vaše viđenje elektroautomobila. Procijenite vaše slaganje sa sljedećim izjavama koristeći raspon ocjena od "U potpunosti se ne slažem" do "U potpunosti se slažem".

	U potpunosti se ne slažem	Ne slažem se	Niti se slažem niti se ne slažem	Slažem se	U potpunosti se slažem
Elektroautomobili su previše komplicirani u odnosu na automobile s motorom na unutarnje izgaranje.	○	○	○	○	○
Elektroautomobili pogonjeni punjivim baterijama nisu pouzdani za svakodnevno korištenje.	○	○	○	○	○
Tehnološki razvoj baterija u elektroautomobil ima ne	○	○	○	○	○

zadovoljava trenutne potrebe.					
Stvaran doseg elektroautomobila predstavlja prevelik problem u praksi, čineći elektroautomobile nepogodnima za bilo kakva dulja putovanja.	○	○	○	○	○
Mislim da znam dovoljno o elektroautomobilima i opcijama punjenja.	○	○	○	○	○
Zanimaju me elektroautomobili.	○	○	○	○	○
Prijelaz s tradicionalnih automobila na elektroautomobile pozitivno će utjecati na kretanje ljudi te roba i usluga u Hrvatskoj.	○	○	○	○	○

Q13 - Spol:

○ Muški

○ Ženski

Q14 - Dob:

○ 18 - 24

○ 25 - 34

○ 35 - 44

○ 45 - 54

○ 55 - 64

○ 65 +

Q15 - Završen stupanj obrazovanja:

○ Osnovna škola

○ Srednja škola

○ Dodiplomski studij

○ Diplomski studij

○ Doktorski studij

Q16 - Koliko je broj stanovnika mjesta u kojem živite?

○ Manje od 10.000

○ 10.000 - 50.000

○ 51.000 - 100.000

○ 101.00 - 500.000

○ Više od 500.000

Q17 - Uključujući sebe, koliko ljudi broji vaše kućanstvo?

○ 1

○ 2

○ 3

○ 4

○ Više od 4

Q18 - Koliki su netto mjesečni prihodi vašeg kućanstva (u EUR)? Uzmite u obzir sve vrste prihoda vašeg kućanstva.

○ 500 - 999

○ 1.000 - 1.499

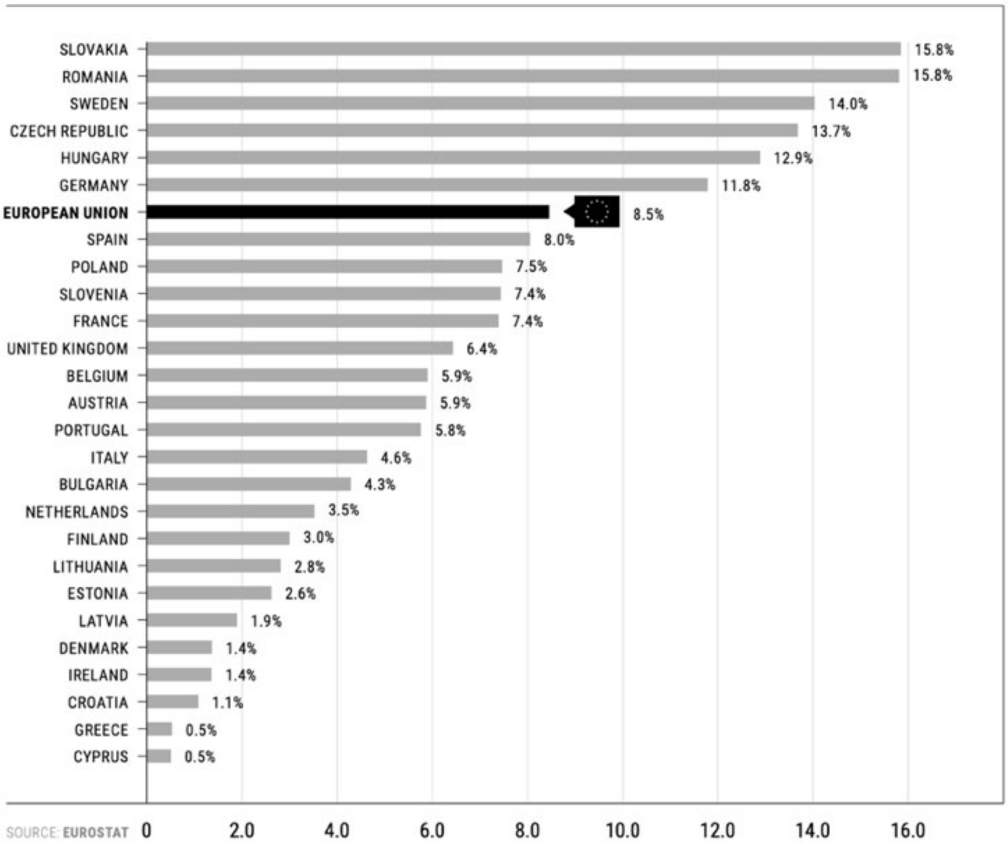
○ 1.500 - 1.999

○ 2.000 - 2.500

○ Više od 2.500

Q19 - Želite još nešto dodati na temu električnih automobila u Hrvatskoj?

Appendix 3: Share of direct automotive employment in total manufacturing by country for 2018

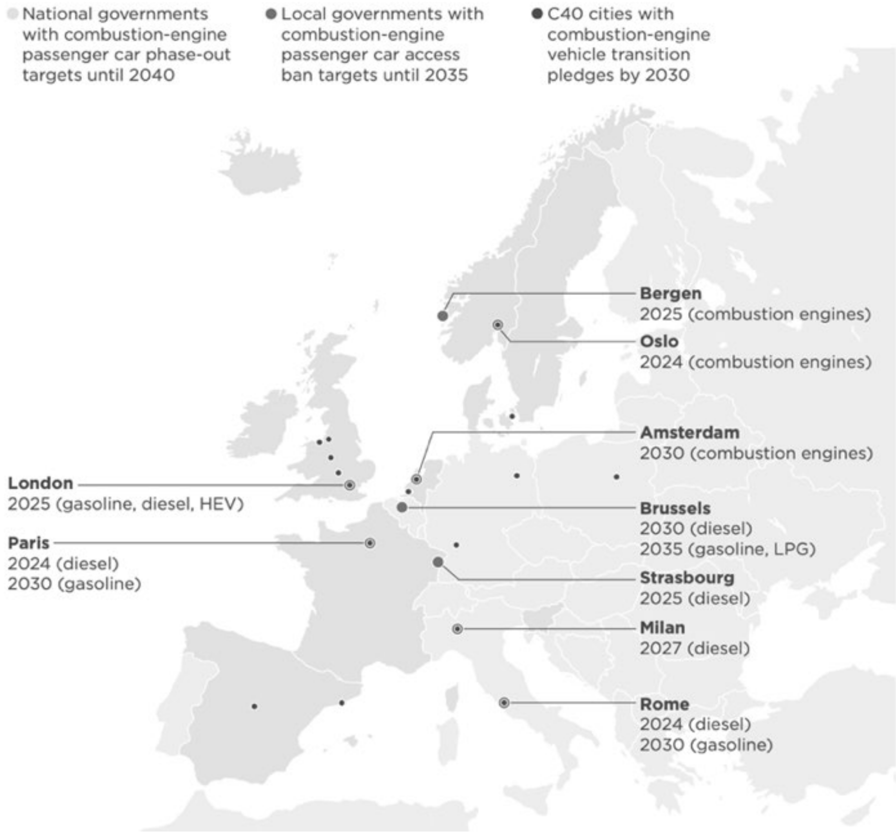


Source: European Automobile Manufacturers' Association (2020).

Appendix 4: Time specific targets of European countries aiming to decarbonize new vehicle fleets

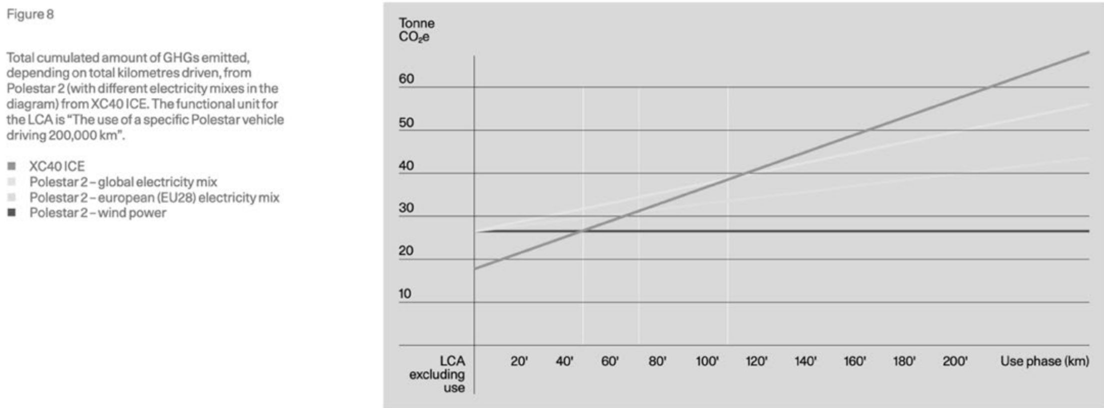
Source: ICCT (2020).

Appendix 5: Specific local government targets for fossil fuel vehicles phase-out as of April 2020



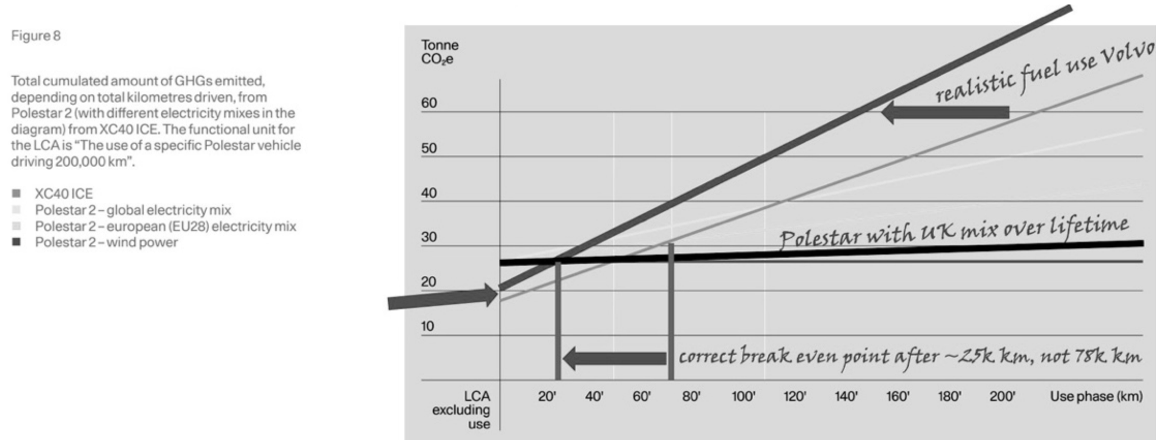
Source: C40 cities (2020).

Appendix 6: Diagram of greenhouse gasses emitted by vehicles Volvo XC40 and Polestar 2



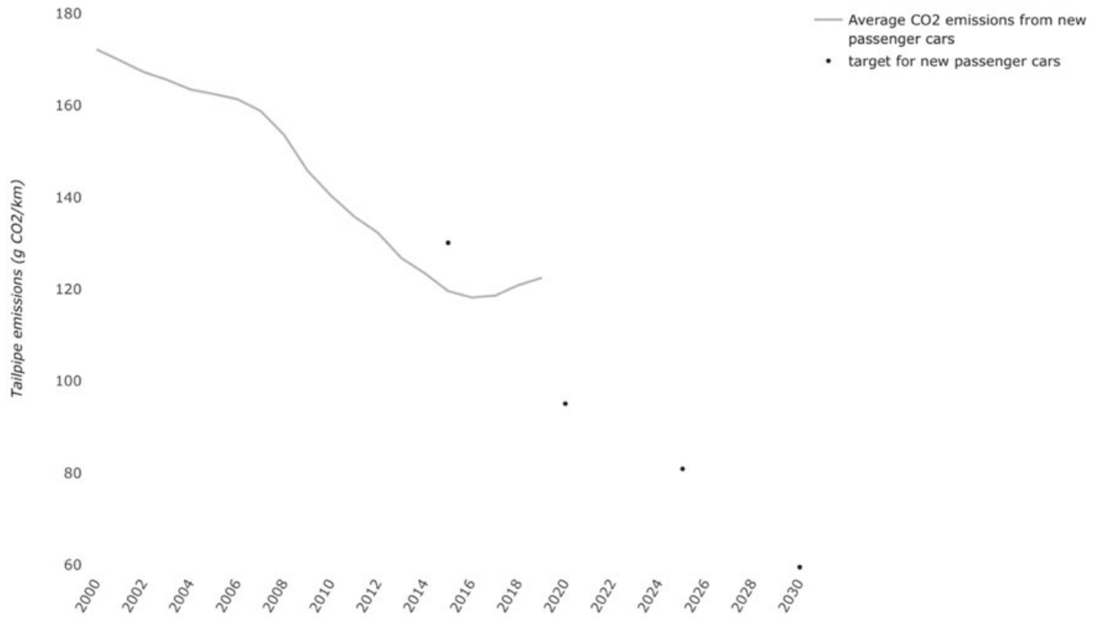
Source: Polestar (2020).

Appendix 7: Corrected diagram of greenhouse gases emitted by Volvo XC40 and Polestar 2



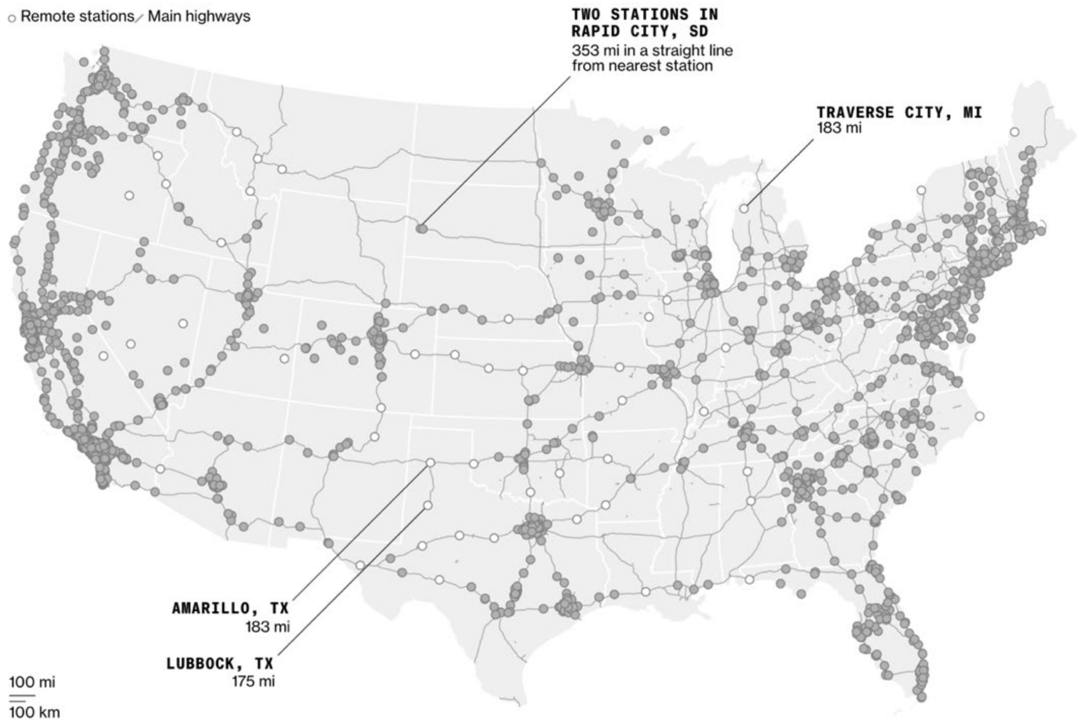
Source: Twitter (2020).

Appendix 8: Average CO2 emissions from new passenger cars in the past 20 years



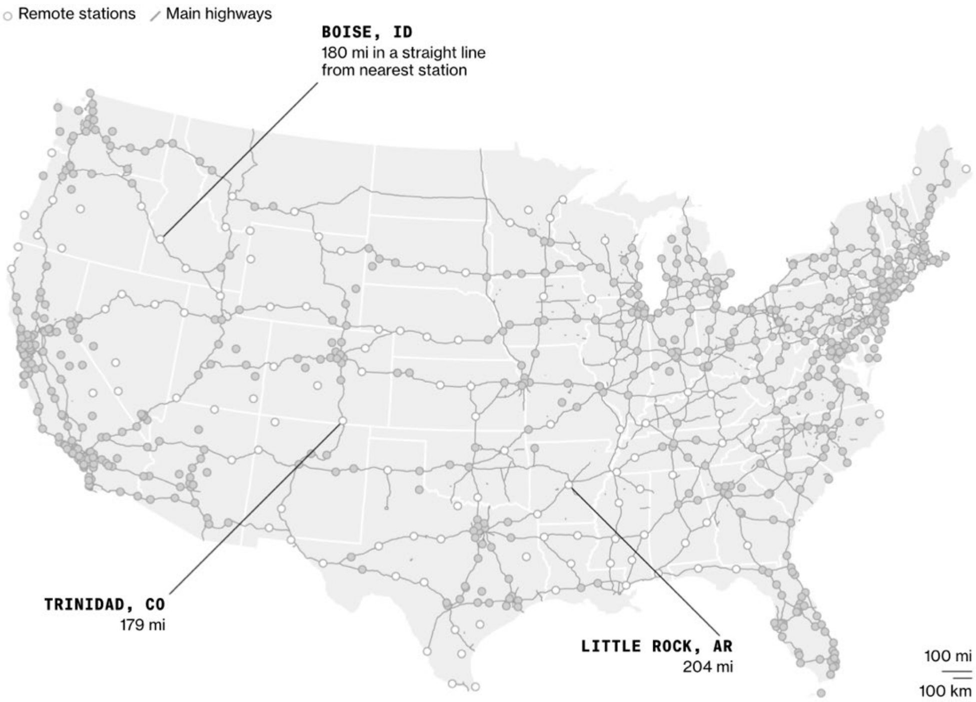
Source: EEA (2020).

Appendix 9: Map of the United States indicating the geographical concentration of fast-chargers



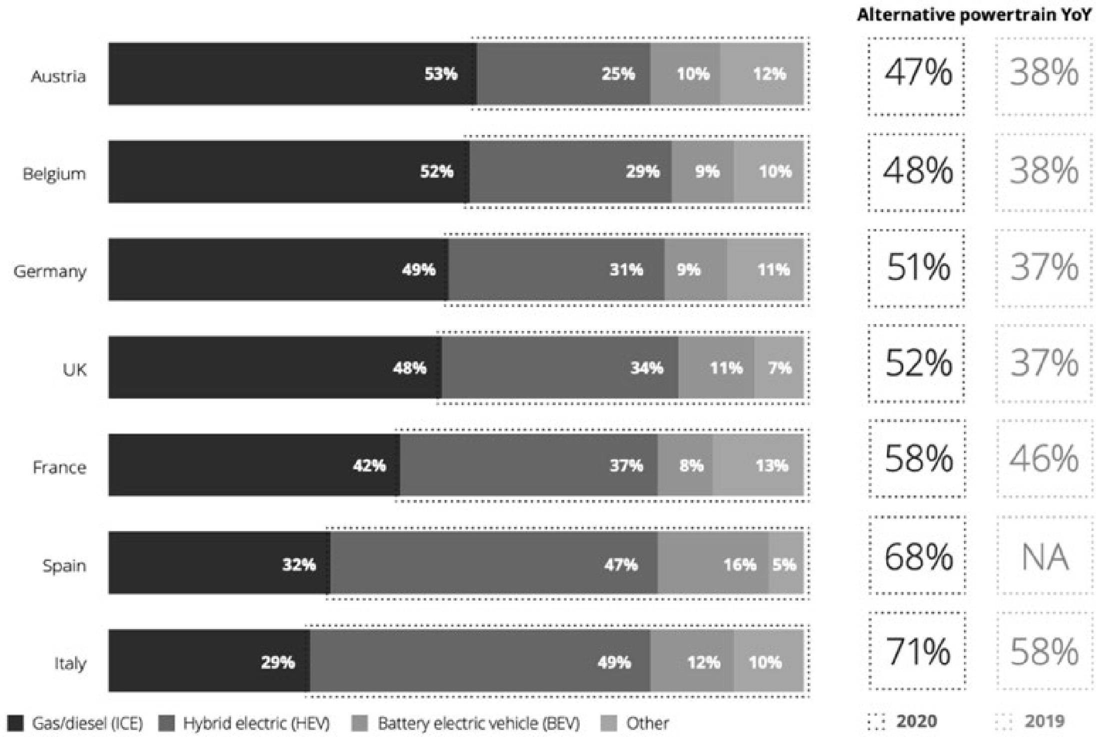
Source: Stock (2020).

Appendix 10: Map of the U.S. indicating the geographical concentration of Tesla chargers



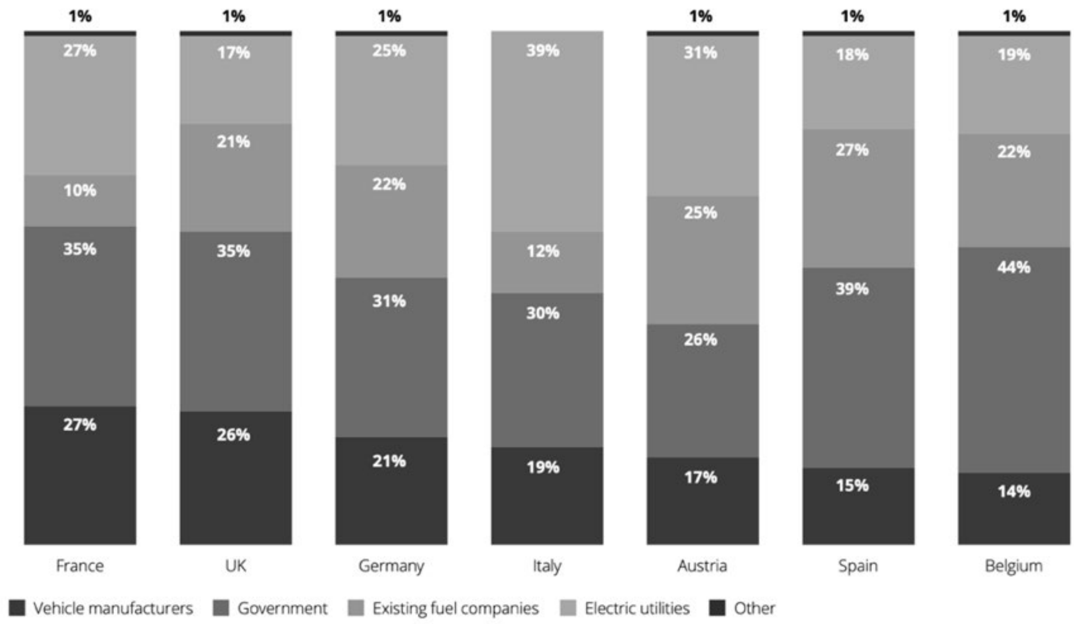
Source: Stock (2020).

Appendix 11: Consumer powertrain preferences for next vehicle in some European countries



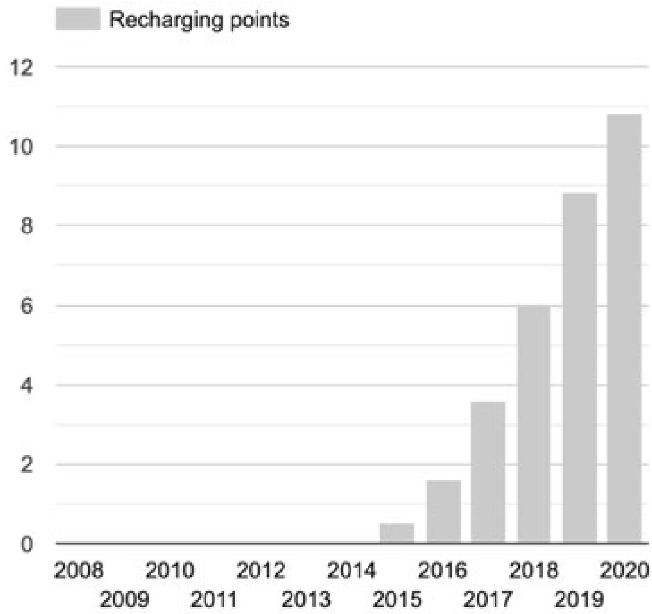
Source: Deloitte (2020).

Appendix 12: Consumer opinions on responsible parties for building the EV charging infrastructure



Source: Deloitte (2020).

Appendix 13: Fast public charging stations per 100 kilometres of motorway in Croatia



Source: European Alternative Fuel Observatory (2020).

Appendix 14: Regional map preview of charging points in the system of Hrvatski Telekom

Source: Hrvatski Telekom (2021b).

Appendix 15: Croatian government alternative fuel subsidies for business subjects

Vehicle type	Powertrain technology	Maximum subsidy amount
Electric bicycles (5-15 units)	Electric drive	Up to 5.000,00 kn per unit
Electrical vehicle category L1, L2, L3, L4, L5, L6 and L7	Electric drive	Up to 20.000,00 kn
Vehicle category M1 and N1	Plug-in hybrid drive	Up to 40.000,00 kn
Vehicle category M1 and N1	Electric drive	Up to 70.000,00 kn
Vehicle category N2, N3, M2, M3	Electric, plug-in hybrid, hydrogen drive	Up to 400.000,00 kn

Adapted from FZOEU (2020).

Appendix 16: Croatian government alternative fuel subsidies for private subjects

Vehicle type	Powertrain technology	Maximum subsidy amount
Electrical vehicle category L1, L2, L3, L4, L5, L6 and L7	Electric powetrain	Up to 20.000,00 kn
Vehicle category M1	Plug-in hybrid powertrain (CO2 emission up to 50 g/km)	Up to 40.000,00 kn
	Electric powertrain (CO2 emission 0 g/km)	Up to 70.000,00 kn
	Hydrogen powertrain	Up to 70.000,00 kn

Adapted from FZOEU (2020).