**Haute Ecole**

**« ICHEC – ECAM – ISFSC »**


Enseignement supérieur de type long de niveau universitaire

# Sustainable Speed: An Analysis of the Energy Transition Applied to Luxury Cars

Mémoire présenté par :

**Réginald Van Boxstael**

Pour l'obtention du diplôme de :

**Master's degree in Business Management**

Année académique 2022-2023

Promoteur :

**Benoît Piraux**

Boulevard Brand Whitlock 6 - 1150 Bruxelles

# Summary

This thesis investigates whether the energy transition is within reach of the luxury automotive industry. While some manufacturers in this niche segment achieved record figures in 2022, environmental concerns have catalysed a disruption of the entire economy. Within this transition, the luxury automotive industry is facing several challenges, including stringent and uncertain government regulations, the need for powertrain adjustments and sustainable manufacturing practices across the entire value chain, while simultaneously satisfying the customer base.

The methodology employed to bring an answer to the research question includes an extensive literature review, critical assessment of published information from various sources, and a qualitative study providing insights into consumer perceptions related to the subject matter. Access to information proved to be the greatest challenge encountered during this thesis.

At the end of this research, recommendations are provided for stakeholders of the luxury automotive industry to navigate the challenges and capitalize on the opportunities presented by the energy transition. Transparency and accountability, particularly in relation to Environmental, Social, and Governance principles, form the foundation upon which a sustainable future for luxury automotive mobility can be built.

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# Acknowledgements

I would like to express my deepest appreciation to my promoter Benoît Piraux for his invaluable guidance, powerful support, and insightful contributions throughout my research.

I would also like to thank my internship supervisors, Ann Lefèbvre and Charles-Henry Vermeulen for providing me with the opportunity to discover this wonderful industry.

Lastly, I would like to thank my family and friends for their unconditional encouragements along this journey.

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# Introduction

On December 11, 2019, Ursula von der Leyen, president of the European commission, presented The European Green Deal in front of the Members of the European Parliament during a plenary session in Strasbourg, France. It is a plan for making the transition to a sustainable economy while transforming environmental and climatic issues into opportunities across all policy sectors. The goal is to reduce greenhouse gas emissions to net zero by 2050, making Europe the first climate-neutral continent by 2050 (European Commission, 2021).

The implementation of the Green Deal and the broader shift towards climate action has challenged the automotive industry: the sector must adhere to sustainability principles by reassessing its practices and offerings. Within this landscape, the luxury automotive niche is threatened as its relevance and viability are questioned in an evolving regulatory environment.

Driven by my longstanding passion for the luxury automotive industry, I capitalized on the opportunity presented by my master's thesis to dive deep into the subject and bring an answer to the following Research Question:

***"Is the energy transition within reach of the luxury automotive industry?"***

To address this question, this paper is structured into five chapters. Firstly, the theoretical framework and context are established. Secondly, the consumer's perspective is studied. Subsequently, the efforts of luxury car brands to achieve sustainability are explored. Then, the theme is applied to the company in which I completed my internship: the retailer of McLaren Automotive and Rolls-Royce Motor Cars in Belgium. Finally, recommendations are provided for the stakeholders in the luxury automotive industry to ensure, and ideally accelerate, the energy transition within the field.

The methodology approached in this research paper included the following steps:

1. Literature review: A comprehensive collection of existing literature and studies related to the subject topic was conducted. Given the rapid evolution of the subject matter, particularly concerning the ever-changing regulatory framework and the evolution of the automotive industry, it was imperative to stay updated with current developments.

2. Critical assessment of published information: Information published by various actors in the field was critically evaluated. This included assessing reports, industry publications, and data provided by experts and organizations.

3. Qualitative study: To gain insights into consumer perceptions, fourteen luxury vehicle owners were interviewed and answered questions directly related to the research question. This approach allowed for a deeper exploration of their perspectives and experiences.

This thesis has shed light on important insights, but it is essential to consider the limitations to ensure a balanced and informed evaluation of the research outcomes.

The main challenge encountered was the restricted availability of information within the luxury automotive industry. As the internship company acted primarily as retailer, it was not possible to gather information beyond publicly available sources. Additionally, the lack of specific figures and insights on investments beyond public discourse limited the comprehensive understanding of the industry. I would have appreciated more opportunities to engage with industry experts or individuals with expertise in the field.

The qualitative study conducted encountered the following limitations:

- The small sample size (14 respondents) and specific demographic (all male respondents from Belgium) make it challenging to generalize the findings to larger populations. Participants' responses may have been influenced by social, cultural or regional factors.

- The study relied on participants' self-reported information, which can be subject to social desirability bias or recall bias, impacting the accuracy and reliability of the data. Additionally, some participants did not accurately interpret some questions as intended, since the study was conducted remotely.

- The analysis and findings may be influenced by my own biases, preconceptions, and personal experiences.

Finally, some scientific aspects of this paper were beyond the scope of a business management degree. The expertise required to address such technicalities exceeds the knowledge within the field of business management.

Despite these limitations, this thesis offers significant contributions and valuable insights into the subject matter. By acknowledging the identified limitations, it becomes possible to identify specific areas where additional investigation can address the gaps and overcome the constraints that were encountered. These limitations can thus be considered as catalysts for further exploration.

Throughout this research paper, I hope to pass on not only the insights and findings of my thesis but also the passion that fuelled this academic study.

# Chapter 1: The fundamentals

The aim of this first chapter is to introduce the fundamental concepts that will be studied during this thesis to delineate the scope of the research. The defined concepts will be subdivided in three chapters: Luxury, Sustainability, and the link between both in the "Sustainability-Luxury paradox".

## 1.1 Luxury

### 1.1.1 Luxury in General

Despite extensive scholarly attention, a consensus regarding the definition of luxury has yet to be established among academics (De Barnier, Falcy, & Valette-Florence, 2008). Luxury goods are linked to emotions (Kapferer, 1997), the elevated price is generally not related to the production costs (Nueno and Quelch, 1998) and they exceed what is strictly necessary (Berry, 1994). The subjective nature of luxury raises a significant problem for its definition and quantification. (De Barnier et al, 2012). While luxury is not a physical value, it serves as a symbol for social status (Lauria, 2018).

However, scholars commonly incorporate four dimensions to define luxury products: superior quality, endurance, rarity, and exclusivity (Dekhili & Achabou, 2016). The two dimensions of superior quality and endurance play an essential role in explaining the consumption of luxury goods as they satisfy functional consumer motivations (Vickers & Renan, 2003). Rarity can be achieved through limited editions or customized approaches, while exclusivity can be obtained through the use of limited natural resources or exploiting unique combinations (Catry, 2003). These dimensions satisfy the needs of consumers who consume luxury products for symbolic interaction, social belonging, or status affirmation (Vickers & Renan, 2003).

Furthermore, De Barnier et al. (2012) created a new comprehensive scale for luxury that encompasses the following dimensions: elitism, distinction, rarity, reputation, creativity, power of the brand, hedonism, and refinement. To distinguish luxury, each requirement is necessary (Kapferer and Bastien, 2012).

Luxury products are non-essential items that contribute to luxurious living beyond the indispensable minimum (Kivetz & Simonson, 2002b), and their high price is a symbolic value (Nueno & Quelch, 1998). Luxury's association with feelings and sensual experiences, going beyond the necessary, and elasticity to income make it a unique concept that contributes to economic growth (Lauria, 2018; Nunes, Bennett, & Shaw, 2016).

The benefits of luxury as a source of wealth for societies have been examined by prominent theorists and philosophers such as Mandeville, Hume, Smith, and Voltaire (Berry, 1994). These experts contend that luxury can be a good and ethically admirable phenomena when it

contributes to economic growth (Lauria, 2018). The luxury market is projected to reach a value of € 1.5 trillion by 2025 globally (Forbes, 2019).

### 1.1.2 Luxury Vehicles

Luxury vehicles are a niche within the automotive industry that aim to exceed conventional mobility necessities and provide a distinctive and exclusive product. This market is characterized by exceptional design, engineering, and branding that seeks to establish an image of prosperity and refined fashion. Luxury car manufacturers may employ traditional manual craft-based production methods or innovative materials to enhance the car's heritage or legacy (Nunes, B., Bennett, D. A., & Shaw, D. 2016).

Beyond fulfilling the intrinsic value of transportation and a minimum level of comfort and elegance, luxury cars offer additional aesthetic value, exceptional comfort, and even a noble origin (Lauria, 2018).

Luxury cars represent a small market segment within the larger mass vehicle market. According to Oz et al. (2023), while about 93.6 million new cars were sold in 2018, only about 30.000 luxury cars were sold globally (Circa 0.032%). However, this small market size has not discouraged luxury car companies from pursuing innovation and setting new standards in design and engineering, with many of them introducing hybrid or electric models to cater to growing environmental concerns.

This thesis delineates luxury automobiles as a niche within the automotive industry that strives to attract customers through outstanding design, engineering, and branding that goes beyond basic mobility necessities (Nunes, B., Bennett, D. A., & Shaw, D. 2016). As a results of the superior craftmanship, advanced materials and technologies and exclusivity, the price of these cars is high. In addition to fulfilling the inherent value of a car, namely transportation as well as a minimum level of comfort and elegance, luxury cars possess an additional aesthetic value, exceptional comfort, and perhaps even a noble origin, such as the Ferrari brand (Lauria, 2018). Luxury goods often possess an extra value that surpasses the inherent worth of the object itself (Mortelmans, 2005).

The luxury car industry and the broader global car industry differ significantly in almost all aspects of their operations, such as design, research and development (R&D), marketing, branding, sales, distribution, and business strategy. Both industries have different core drivers. Luxury car brands are highly profitable, with huge influential power over the industry and customers (Oz et al., 2023).

Rezzano et al. (2021) proposed a model that aims to identify the critical successful factors (CSFs) in the luxury automotive industry. The model is designed to delineate the characteristics that define a luxury car.

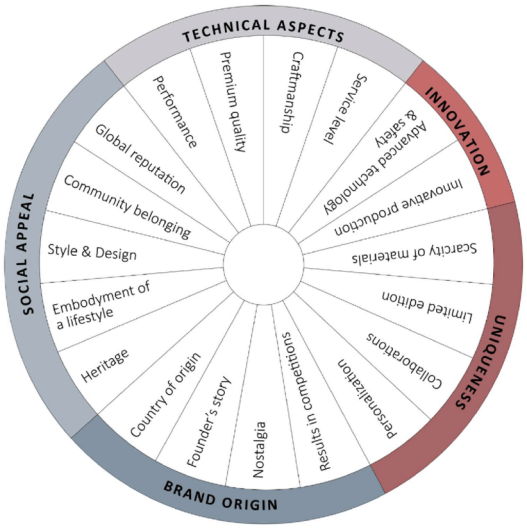



*Figure 1 : Critical Success Factors model to define luxury automotive (Rezzano et al., 2021)*

## 1.2 Sustainability

Sustainability can be defined as meeting the requirements of the present generation without sacrificing the ability of future generations to satisfy their own needs (Brundtland Report, 1987). Moreover, sustainability is perceived as a triple bottom line that includes social responsibility, environmental stewardship, and economic prosperity (Johnson, 2009).

Sustainability is considered a strategic issue and essential to the purpose of automotive organizations (Capgemini Research Institute, 2020).

### 1.2.1 Sustainable development

Sustainable development is a holistic approach to development that seeks to give the ability to future generations to meet their requirements. This principle of human organization is grounded in three interdependent dimensions: environmental, social, and economic (ADEME, 2020).

The long-term success of sustainable development is contingent upon economic efficiency, social equity, and environmental sustainability (ADEME, 2020). In the present context, sustainable development is a pressing issue that encompasses not only conventional industries but also the luxury sector, since luxury Represents the expansion of consumerism driven by other factors than functionality (Mason, 2000). As a result, activists seeking symbolic victories for their cause tend to target luxury brands with a high iconic status. (Kapferer & Michaut, 2015).

### 1.2.2 Circular Economy

The circular economy is a concept founded on the following principles, according to Ellen Macarthur (2023):

- Eliminate waste and pollution
- Circulate products and materials (at their highest value)
- Regenerate nature

The concept is reinforced by a shift towards renewable energy and materials. The circular economy aims to dissociate economic activity from the depletion of finite resources. It is a resilient system that benefits not only businesses, but also society and the environment (Ellen Macarthur Foundation, 2023).

The Ellen MacArthur Foundation is widely regarded as a prominent figure in the global dialogue on sustainability. Similarly, the French Environment and Energy Management Agency (ADEME) is recognized as an important participant in this discussion. As such, ADEME 's perspective on the concept of circular economy is presented below, starting with three domains and seven pillars that constitute the circular economy in its entirety (ADEME, 2017).

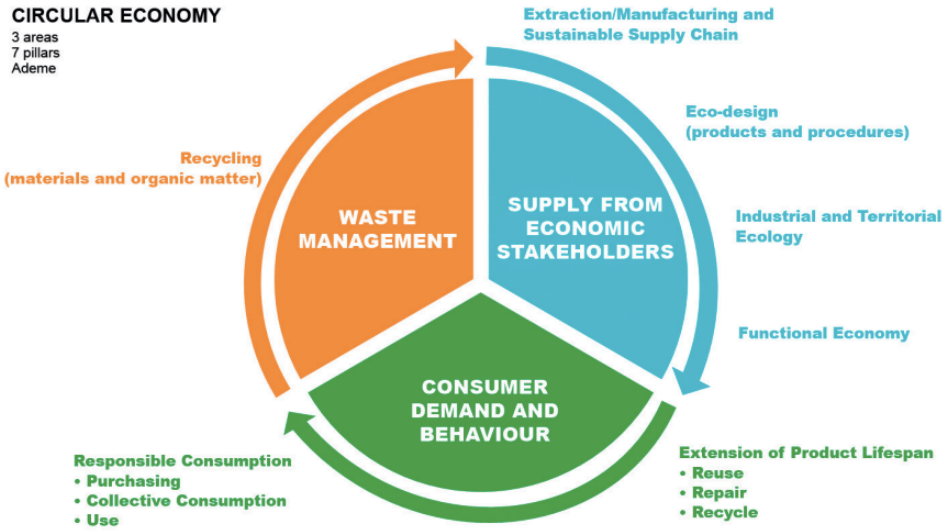



*Figure 2: 10 Key Indicators for Monitoring the Circular Economy (ADEME, 2017)*

Circular economy is an economic model that is based on the principles of reusing resources, products and waste. The model aims to limit resource consumption, waste production, and greenhouse gas emissions. The linear model of take-make-dispose has led to a significant increase in waste production, which in turn contributes to pollution and additional depletion of resources. Waste, once considered unusable, can be mobilized as a resource in the circular economy. Reducing environmental effects and securing resource supply are both achieved through the conversion of waste into resources (ADEME, 2022).

### 1.2.3 Energy transition

The energy transition can be defined as a shift in the primary form of energy consumption within a society. This shift can be interpreted by the historic transition from wood to coal, and then to

oil and gasoline during the industrial revolution. Today, the energy transition is the shift from fossil fuels to renewable electricity (Dictionary of Energy, 2015).

In this paper, the implementation of the energy transition involves the adoption of cleaner means to fuel engines. A small number of car manufacturers have made significant efforts in introducing alternative fuel vehicles (AFVs). AFVs offer significant opportunities for the advancement of eco-friendly transport solutions. (Robert et al., 2016). To achieve a carbon-neutral operation, ICEs need to be compatible with sustainable fuels. Ethanol, methanol and hydrogen, offer promising prospects (Schoeffmann et al., 2023).

It is estimated that transportation accounts for about 15% of the global carbon emissions (Möller & Schaufuss, 2022).

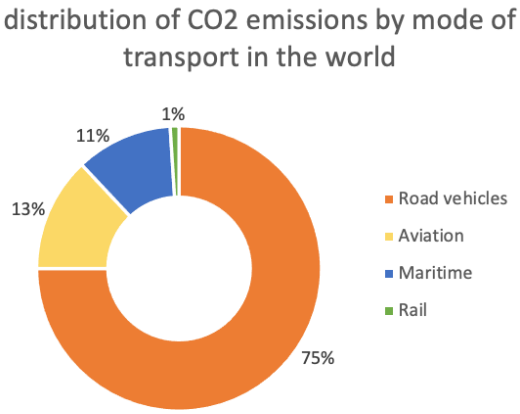



*Figure 3: Distribution of CO2 emissions by mode of transport in the world in 2022 (by the author, based on Bonnie M. et al., 2020; Hannon et al., 2022)*

Road vehicles are responsible for approximately 75 percent of that share, (Bonnie M. et al., 2020) followed by aviation, with 13 percent, then maritime transport with 11 and 1 percent from rail transport (Hannon et al., 2022).

According to a report by the World Resources Institute, low-carbon energy needs to rise six times faster to keep global warming to targeted levels. The International Energy Agency (2022) predicts that fossil fuel use will peak this decade.

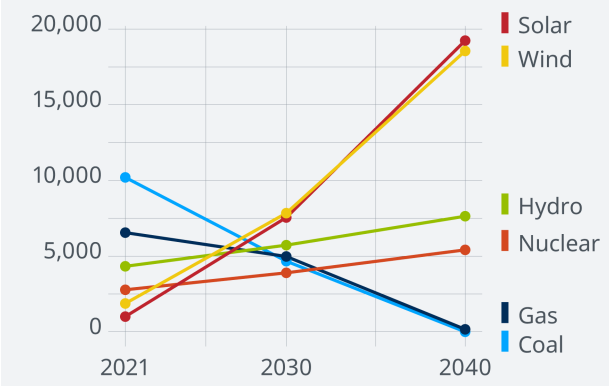



*Figure 4: Terawatt Hours of electricity generated to meet 1.5 °C (International Energy Agency, 2022)*

The energy transition can be classified as disruptive to the luxury automotive industry because it involves a paradigm shift that impacts the entire economy. Existing practices across the whole value chain necessitate reassessment. The energy transition necessitates a revaluation of the industry's operational strategies (B. Piraux, personal communication, May 16, 2023).

### 1.2.4 Hydrogen

As actors of the automotive industry are pursuing cleaner ways of fuelling cars, the use of hydrogen has gained growing attention and can have significant implications for the energy transition in the luxury car industry. The luxury automotive market niche is seen as a catalyst for an economy that embraces greater utilization of hydrogen (Ekins and Hughes, 2009).

E-fuels are synthetic fuels made by combining hydrogen and carbon dioxide (CO2) through electrolysis. These fuels are compatible with internal combustion engines (ICEs). The advantage is that they offer a way to store excess renewable electricity, but they require significant amounts of energy to produce and the supply is limited (Manning, 2023).

Fuel cells, one of the most common applications of hydrogen are less prevalent than batteries in passenger cars, primarily due to the current high production costs and logistical challenges associated with hydrogen transportation (Hannon et al., 2022).

Hydrogen's price is projected to drop through the establishment of the H2MED hydrogen project, a large-scale undertaking to support decarbonization of European industry. The H2MED project involves building two pipelines, one of which running from Portugal to Spain, and the other is running from the Catalonian coast to Marseilles, France to supply hydrogen. The Iberian Peninsula is a natural location for renewable energy production, including green hydrogen, due to its geography and lower energy production costs (Berretta, 2022). The H2MED project marks a significant milestone in the establishment of hydrogen infrastructure in Europe (En:former, 2023).

This project could make hydrogen more accessible and lower its price. This would increase its use in the automotive sector by incentivizing manufacturers to invest in the technology and develop more hydrogen powered vehicles. The implications are vast. In the future Europe's main energy source might come from the south of Europe. Disrupting the market and bringing an unprecedented energy transition (B. Piraux, personal communication, February 2, 2023). While hydrogen fuel cell technology is still in its early stages it is a promising energy source for the future.

### 1.2.5 Lithium-ion Batteries

The Nobel Prize in Chemistry was awarded to John Goodenough, Stanley Whittingham, and Akira Yoshino in 2019 for their contributions to the development of lithium-ion batteries. (Xie & Lu, 2020). The rechargeable lithium-ion batteries are the preferred technology for electric

vehicles (EVs) and play a crucial role in facilitating the integration of renewable energy sources into energy infrastructures, contributing to a more sustainable future (Xie & Lu, 2020).

A study commissioned by a committee of the European Parliament, regarding the future of the automotive sector, emphasized the urgent need to prioritize the development of lithium-ion batteries (as well as hydrogen) as vital components for achieving sustainable environmental solutions (Brown et al., 2021).

An important example of the recent investments in lithium-ion technology is the establishment of the first “Gigafactory” of low-carbon battery cells in France, Verkor. The French company’s mission is to make Europe a key player in the production of low-carbon batteries to meet the growing demand for electric vehicles. With the support of major shareholders, such as the European Institute of Innovation and Technology, Schneider Electric, Renault Group and many others. Verkor's mandate is to accelerate the large-scale industrialization of batteries in Europe and deploy intelligent and sustainable production processes (Verkor, 2021). Verkor's efforts are in line with the European Battery Alliance, discussed later in this chapter.

With the increasing demand for electric vehicles, the establishment of low-carbon battery factories, such as Verkor, is critical for achieving the European Union's ambitious decarbonization targets.

### 1.2.6 Carbon Offsetting

Carbon offsetting is a strategy for organizations to take part in projects that either remove carbon dioxide from the air or reduce CO2 emissions from other operations. The aim is to compensate for the produced carbon emissions by supporting initiatives that help reduce or remove carbon dioxide from the environment (Hyams & Fawcett, 2013).

The emphasis on carbon offsetting by the luxury automotive sector is a noteworthy initiative, in which businesses support or carry out initiatives that lower or eliminate carbon emissions from the environment in order to balance their own emissions. By encouraging the development of renewable energy projects, making investments in energy-efficient technologies, and supporting conservation and forestry programs, these initiatives hope to aid in the sustainable transition of society.

Examples carbon offsetting by luxury automotive brands will be discussed in the third chapter of this research paper. The luxury automotive industry's efforts in this field reflect a commitment to lowering its environmental impact and promoting a more sustainable future, even though the efficiency of carbon offsetting is still up for debate.

## 1.3 The Sustainability-Luxury paradox

The Sustainability-Luxury paradox is a central theme in this research paper. Sustainability issues have a significant impact on luxury brands because of their prominent visibility and dedication

to delivering high-quality products. (Kapferer & Michaut, 2015). In order to bring an answer to the research question: “Is the energy transition within reach of the automotive industry?”, exploring how luxury automotive companies navigate this paradox can provide valuable insights into the broader efforts to promote sustainability in the automotive industry.

A few studies investigating the correlation in luxury and environmental sustainability have suggested that the concepts are contradictory (Davies et al., 2012). Luxury is frequently coupled with surplus and abundance, while sustainability is more closely linked to modesty and fairness. (Cristini et al., 2017). Luxury often creates barriers to make products inaccessible and thus create desire (Kapferer and Bastien, 2009). On the other hand, sustainable development generates ideas related to sharing and challenges the role of possession (Özçağlar-Toulouse, 2009). Sustainable development may also be associated with the idea of consuming less and having to forego personal pleasure (Lochard and Murat, 2011) while luxury consumption often creates a feeling of self-indulgence.

A study conducted by Achabou & Dekhili (2016) highlights the contrast between luxury and sustainability. Luxury is associated with exclusivity, possession, and obstacles that make the products inaccessible, while sustainable development is linked to sharing, recycling, and accessibility. Luxury products are perceived as high quality, while sustainable luxury products are viewed as lower quality. The consumption of luxury products is often impulsive, whereas sustainable development calls for reflective analysis of the environmental and social impact of products. The study also shows that luxury consumption is associated with fulfilling the ego, while sustainable development is associated with others, such as future generations, workers, and animals. The study indicates that the luxury industry is associated with unreasonable consumption, waste, and exploitation of natural resources (Achabou & Dekhili, 2016).

However, the luxury industry has been reconciling the contradictions with sustainability. Luxury companies have started to provide eco-friendly products. Luxury manufacturers play a pivotal role in driving changes in production methods and inspiring consumers to adopt more sustainable consumption (Kunz et al., 2020).

The Sustainability-Luxury paradox serves as a crucial analytical framework for understanding the challenges and opportunities in the luxury automotive industry's adaptation to the energy transition.

### 1.3.1 The European Green Deal

The European Green Deal is a package of policy initiatives presented by the European Commission in December 2019 with the goal of achieving a sustainable transition to a climate-neutral economy by 2050. The plan aims to transform environmental challenges into opportunities. It encompasses all sectors of the economy, including transport and energy (European Commission, 2021). Several policies and strategies have been adopted to support this transition; the following have a notable impact on the studied industry:

- European Climate Law: Legal framework with the aim of reducing greenhouse gas emissions. The law sets out intermediate targets, including a vast reduction in greenhouse gas emissions by 2030, and a process to legally raise the EU's emissions reduction goal every five years (European Commission, 2020).

- European Industrial Strategy: Policy framework that encourages the growth of important industrial ecosystems and value chains, including the automobile industry, and the creation of novel technologies to lower greenhouse gas emissions. The strategy encourages the adoption of eco-friendly transportation, including alternative fuels and the advancement of electric and hydrogen-powered vehicles (European Commission, 2020b).

- European Union strategies related to energy: The Energy System Integration strategy and the Hydrogen strategy. The Energy System Integration strategy focuses on creating links between different energy carriers, infrastructures, and consumption sectors to make the system more efficient and interconnected. On the other hand, the Hydrogen strategy aims to support the decarbonization of various sectors by gradually transitioning towards renewable hydrogen technologies. The European Clean Hydrogen Alliance has also been implemented to support the demand for clean hydrogen in the EU (European Commission, 2020c).

- European Battery Alliance: Focuses on enhancing the performance and safety of batteries, raising their level of energy efficiency, and lowering their price to establish a value chain for batteries that is both economically and environmentally sustainable. The Alliance is actively assisting in the growth of a competitive and sustainable battery industry in Europe (European Commission, 2020d).

- New European Bauhaus: Framework for linking the European Green Deal to living spaces and experiences. It encourages eco-friendly design principles in line with environmental sustainability and promotes innovation and creativity. Additionally, it provides a framework for integrating sustainability and inclusivity into vehicle design (European Commission, 2021a).

- New transport proposals: Proposals intended to encourage more effective and environmentally friendly travel throughout the European Union. These actions are meant to aid in the 90% reduction of emissions from the transportation sector. The proposals include boosting connectivity, supporting the development of charging stations and alternative refuelling infrastructure (European Commission, 2021c).

- Provisional political measures to reduce CO2 emissions from new cars: The measures, part of the ‘Fit for 55’ package, call for a 55% reduction in CO2 emissions from new cars by 2030 and a 100% reduction in CO2 emissions from cars by 2035. in the EU, new petrol, diesel & hybrid vehicle registration will be prohibited beginning in 2035 (European Council, 2022).

These policies and strategies aim to promote the use of more environmentally friendly components and methods, create durable goods that can be repaired, recycled, or reused, develop new technologies to lower greenhouse gas emissions and boost energy efficiency, and promote circular economy principles. As a result, the luxury automotive industry is significantly impacted by the European Green Deal. The sector will need to adapt to these new policies and strategies to remain competitive and contribute to the EU's climate objectives.

### 1.3.2 The 'Fit for 55' Package

Amongst all decisions enforced by the European Union to achieve the Green Deal, there is one that changes the future of the luxury automotive industry in an unprecedented way: The 'Fit for 55' package, a set of proposals to review EU legislation and to implement new initiatives with the aim of ensuring that EU policies are aligned with the climate goals agreed by the Council and the European Parliament (European Council, 2023a). It is important to add that the Council (representing the Member States) will still have to formally approve the text for it to enter into force.

As a part of the package, the EU lawmakers in the European Parliament approved to ban the sale of vehicles with combustion engines by 2035 on February 14, 2023, in Strasbourg. 340 members voted in favour of the rules, versus 279 against, and 21 abstained.

Notably, one paragraph from the text specifies: "*In view of the increased overall greenhouse gas emissions reduction objective and to avoid potential market distorting effects, the reduction requirements for all manufacturers present in the Union market should be aligned, except for those responsible for less than 1.000 new vehicles registered in a calendar year. Consequently, the possibility for manufacturers responsible for between 1.000 and 10.000 passenger cars or between 1.000 and 22.000 light commercial vehicles newly registered in a calendar year to apply for a derogation from their specific emissions targets should cease from 1 January 2036*" (European Parliament, 2023).

The derogation exclusively defers the prohibition on internal combustion engines by one year for manufacturers responsible for between 1.000 and 10.000 passenger cars, leaving the situation uncertain for manufacturers with limited production of alternative models. Consequently, it is imperative for them to devise a strategy to ensure their survival through the energy transition of society.

The exemption may provide an explanation as to why small luxury automotive manufacturers, such as Bugatti and Pagani, which produce fewer than 1.000 new vehicles annually, have yet to indicate any plans to transition towards electric or hybrid engines.

On March 25, 2023, an agreement was made between the European Commission and an alliance of countries comprising Germany, Italy, Poland, Bulgaria, and the Czech Republic, allowing the sale of combustion engine vehicles powered by e-fuels. E-fuels are considered "carbon neutral"

and are being advocated for by companies like Porsche to extend the lifespan of traditional auto manufacturing companies (Financial Times, 2023).

The luxury automotive industry is facing significant challenges due to the European Union's 'Fit for 55' package. To ensure its survival through the energy transition, the luxury automotive industry needs to embrace the energy transition as an opportunity for growth and transformation, rather than a threat to its traditional business model.

### 1.3.3 ESG principles in the context of luxury

Environmental, Social and Governance (ESG) is a structure that aids stakeholders in comprehending how an organization is addressing risks and opportunities associated with the three factors (Kyle & Miller, 2023). These factors have grown in significance for businesses as consumers demand more sustainable and responsible practices from the companies they buy from. Today, luxury businesses are approaching sustainability with a broader perspective. They recognize that business strategy and ESG strategy are now intertwined (KPMG, 2022).

ESG considerations are essential in the luxury automotive sector to guarantee that businesses uphold their reputation for providing high-quality goods and services while also satisfying stakeholder and customer demands.

1) The Environmental (E) Component: An organization's impact on the environment, through resource usage, waste management procedures, and emissions, is measured by the environmental (E) component of the ESG. Companies in the luxury automotive sector must reduce their carbon footprint.

2) The Social (S) component of ESG refers to a company's influence on society, including its interactions with its workers, clients, and nearby communities. Businesses in the luxury automotive sector must ensure that their goods and services satisfy the needs of their clients. The social impact of luxury car manufacturers' products on the communities they serve and the working conditions of employees must also be considered.

3) The Governance (G) component of ESG considers a company's internal management and decision-making processes, such as the policies and procedures, chief executive officer (CEO) compensation, and board diversity. Companies in the luxury automotive sector must have strong governance structures in place to guarantee that they are conducting business in an honest and open manner. Examples of this are strong ethical standards, open reporting, and efficient risk management procedures.

Ferrari serves as an example of a luxury automotive manufacturer that has adopted ESG principles in its procedures and policies. At Ferrari, The ESG Committee is responsible for providing the board with guidance and help on a range of issues, including the criterion for choosing and appointing directors, as well as their performance evaluation, their nomination

and re-nomination and the monitoring of the company's ESG strategy, goals, and accomplishments. The committee met once in 2022 to discuss assessments, objectives, and the sharing of in-depth information about sustainable development with the board of directors (Ferrari, 2023).

## Intermediary conclusion to Chapter 1

- Luxury goods are linked to emotions and they exceed what is strictly necessary.
- Luxury vehicles represent a niche within the automotive industry that goes beyond conventional mobility necessities, focusing on exceptional design, engineering, and branding to create an exclusive product.
- Luxury car companies hold significant influence and profitability within the industry, driving innovation and setting new standards in design and engineering.
- Sustainability is defined as meeting the requirements of the present generation without sacrificing the ability of future generations to satisfy their own needs (Brundtland Report, 1987).
- Sustainable development is relevant for the luxury sector, as luxury brands symbolize consumption driven by factors beyond functionality.
- Circular economy is based on eradicating waste and pollution, promoting the circulation of products and materials at their highest value, and restoring nature (Ellen Macarthur Foundation, 2023).
- The energy transition involves a shift in primary energy consumption. It is disruptive to the studied industry and signifies a paradigm shift impacting the entire value chain.
- The use of hydrogen in the luxury car industry has gained significant attention. E-fuels offer climate-neutral and low-emission alternatives for internal combustion engines.
- Incentivized by accessible and cost-effective production and distribution, automobile companies, including luxury car manufacturers, may invest in and develop more hydrogen-powered vehicles.
- Lithium-ion batteries have emerged as the preferred technology for electric vehicles and play a crucial role in integrating intermittent renewable energy sources into power systems.
- There is a growing trend of luxury companies offering green luxury products, which symbolizes a reconciliation between luxury and sustainability.
- The European Green Deal presents both challenges and opportunities for the luxury automotive industry. Embracing the energy transition and exploring alternative technologies will be crucial for the industry's survival in a changing landscape.

# Chapter 2: Luxury Car Consumers in the Energy Transition Era

In this second chapter, the focus shifts towards the luxury car consumers' attitudes and purchasing behaviours in response to the energetic transition of society. The chapter will first discuss the factors influencing the luxury consumption of consumers and will end with the emerging sustainable luxury market, exploring the values that are encouraged by sustainable development in the luxury industry. The way luxury automotive customers overcome the Luxury-Sustainability paradox is studied. This chapter aims to provide insights into how luxury automotive companies can navigate the energy transition while meeting the needs of their discerning customers and adhering to their core values.

At the end of this chapter, a qualitative study has been conducted with the aim of helping to bring an answer to the research question of this thesis. 14 respondents shared their perspective on five questions relating to the energy transition and luxury cars.

## 2.1 The Luxury Market

Luxury brands symbolize the prevailing consumer-driven society worldwide. How people perceive themselves, the need for conformity, and the desire for being distinct are believed to be influential factors in shaping people's attitudes towards luxury products (Zhechev & Stanimirov, 2016).

Vigneron and Johnson (2004) established two primary categories of luxury consumption reasons: non-personal perceptions and personal perceptions. Their proposed a model for luxury consumption reasons is presented in Figure 5.

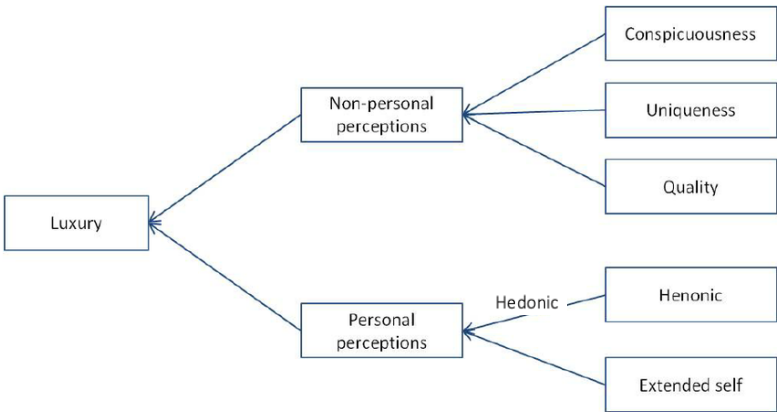



*Figure 5: Model for luxury consumption reasons (Vigneron and Johnson, 2004)*

According to a model proposed by Brun & Castelli (2013), customers can be identified by using the three fundamental factors that influence consumption behaviour: content, social, and form.

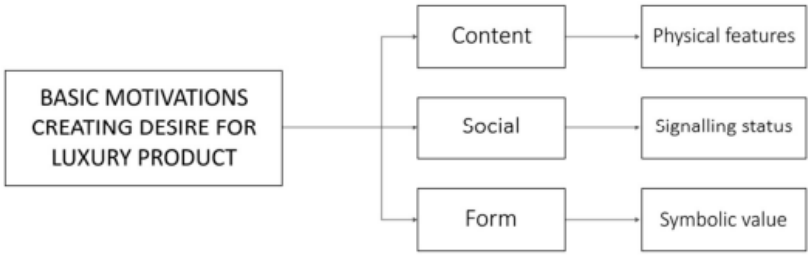



*Figure 6: Motivations underlying desire for luxury (Brun & Castelli, 2013)*

The first factor, content, refers to the physical features of the product or service being consumed. Among other factors, the quality, design, or utility of the product could motivate consumers. The second factor, social, is related to the product's social signalling value. Consumers may be persuaded to purchase a product to highlight their social status, group identity, or values to others. The third factor, form, refers to the symbolic value of the product (Brun & Castelli, 2013).

The luxury market is driven by both personal and non-personal factors. Consumers are motivated by their desire to signal their social status and demonstrate their wealth and by the pleasure and enjoyment they experience from owning luxury goods. These models offer valuable insights for luxury brand managers looking to appeal to consumers by addressing their motivations for luxury consumption. Understanding these factors is crucial for luxury brand managers seeking to adapt to the shifting attitudes of consumers in response to global trends, such as the energy transition.

## 2.2 The Luxury Automotive Market

Luxury cars have come a long way since they were first introduced as a mode of transportation for wealthy individuals. Today, luxury cars serve as status symbols for their owners. In addition to meeting functional needs, luxury cars also provide owners with a sense of self-esteem and indulgence. It is crucial for luxury car manufacturers to uphold their brand reputation to attract consumers (Manoukian, 2021).

A multitude of factors have been identified by scholars that play an essential role in consumers' decision-making process when purchasing luxury cars. These factors include the impact of brand image on product life cycle strategy and consumer behaviour (Park et al., 1986; Roth, 1995), as well as the quality and reliability of the car, the after-sales services provided, and the exclusivity of the brand (Balli et al., 2007; Kim et al., 2011; Manoukian, 2021). Apak et al. (2021) emphasized the significance of assessing consumer preferences in terms of attributes that facilitate decision-making. The authors suggested that when consumers make a buying decision, the main factors they consider are flexibility and brand image. Finally, a recent study conducted by McKinsey (2022) revealed that design and driving performance are primary purchasing factors for both EVs and ICEs (McKinsey, 2022).

Rezzano et al. (2021) conducted a survey of 447 luxury car owners and utilized the gathered data to identify five macro-clusters of customers in the luxury car industry based on their values and purchasing behaviour.

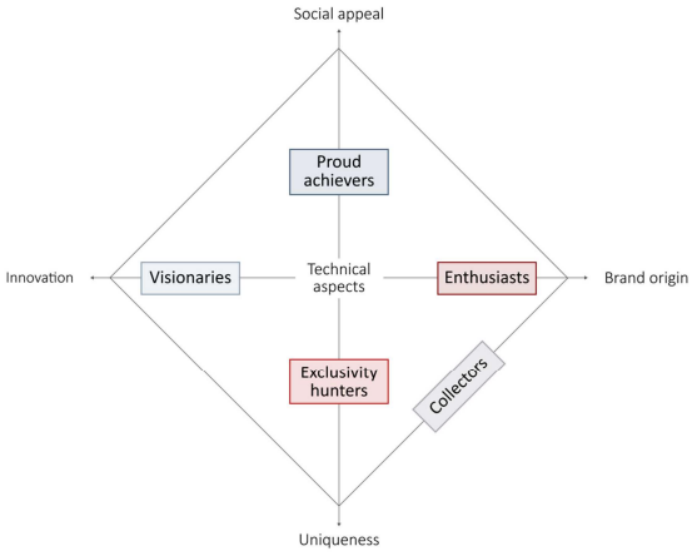



*Figure 7: Clusters of luxury car customers (Rezzano et al., 2021)*

The identified clusters of car consumers are categorized as:

- Proud Achievers cluster is characterized by a preference for social approval and conformity.
- Visionaries prioritize technical and innovative features.
- Enthusiasts are passionate about luxury cars and related services.
- Exclusivity Hunters desire exclusive cars customized to their personal preferences.
- Collectors value the origin and uniqueness of the brand, exhibiting a strong emotional attachment and alignment with their values.

Car enthusiasts, who are deeply connected to brands that provide exclusive experiences or exceptional performance, are another significant segment of the luxury car market. Luxury car brands need to provide a superior customer experience to meet or surpass the expectations that the buyer brings to the table (Manoukian, 2021). McLaren and Ferrari are two known brands that use funding from selling commercial cars to invest in R&D for racing cars (BBC, 2007). This means that buyers contribute to racing efforts, adding value for customers by raising the brand's prestige, inspiring pride, and strengthening the emotional bond between the customer and the brand.

Luxury car customers' expectations have evolved to include factors such as seamless customer experiences, customization, and experiential diversity across multiple channels (Guan et al., 2022). Ferrari has effectively implemented these evolving customer expectations in their offerings through the Ferrari Corse Clienti Programme. Participants are invited to exclusive events around the world where they can race vehicles that aren't permitted on public roads, such as Formula 1. Only strong brand power will enable this to occur (Oz, 2023). The F1 Clienti

and XX Programme offered by Corse Clienti provides coaching from former Formula 1 drivers, access to telemetry analysis, a physiotherapist, a masseuse, and technical and logistical support. Customers have the option to request private track days on Fiorano or another circuit with help from Ferrari mechanics and specialists. Customer satisfaction is given top priority in the program. By developing enduring relationships with their customers and by encouraging awareness and pleasure of their products among current and potential customers, Ferrari sold 66% of their new cars to customers who already owned one, and their active clientele increased by 25% between 2018 and 2022 (Ferrari, 2023). With the energy transition underway, it is essential for luxury automotive brands to develop and maintain strong relationships with their customers to adapt to changing market demands. Personalized relationships build trust between business and consumer and allows brands to better understand their customers' needs and preferences.

Zhechev & Stanimirov (2016) have developed a conceptual model that includes six generalizing variables that potentially affect customer attitudes.

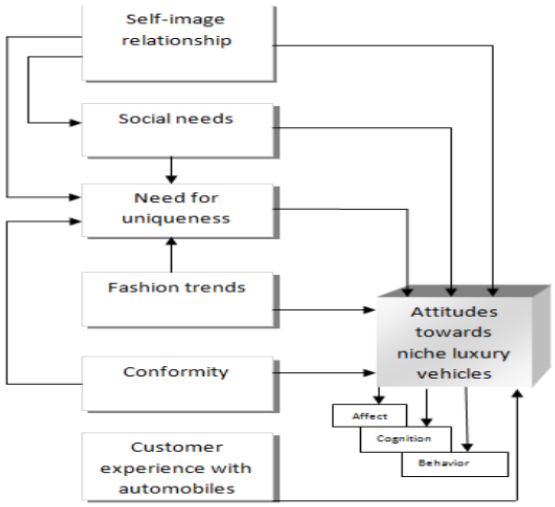



*Figure 8: Factors shaping attitudes towards luxury vehicles (Zhechev, V., & Stanimirov, E., 2016)*

Guan et al. (2022) have addressed the expansion of the luxury automobile market in China and its anticipated influence on the global market in the coming years. Chinese luxury car buyers are focusing more on technology features like powertrain functions, connectivity, and Advanced Driver Assistance Systems (ADAS) features. Furthermore, personalized services throughout the buying process are crucial to them. The growth of the luxury car market in China is driven by the increasing number of wealth individuals.

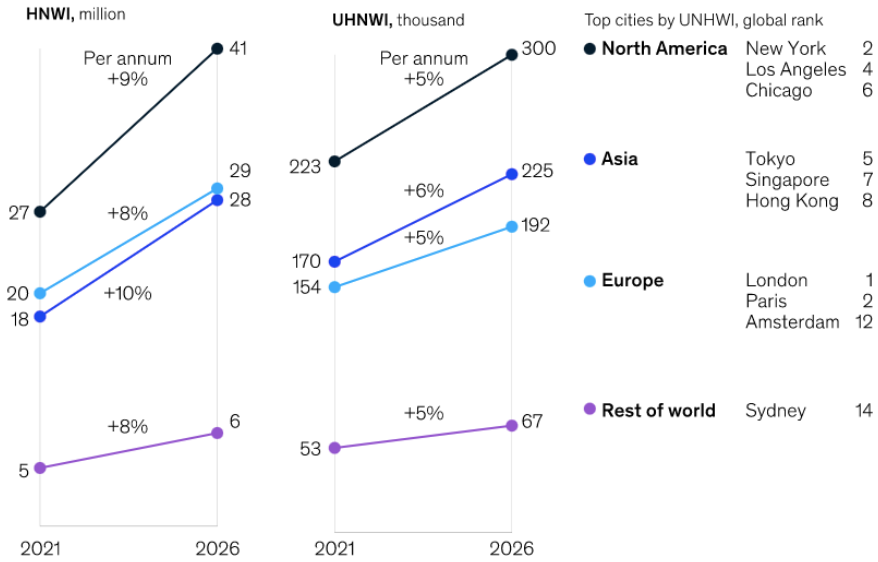



*Figure 9: High net-worth individuals and ultra-high-net-worth individuals by geography (Guan et al., 2022)*

The growth of these individuals is expected to increase the demand for luxury cars worldwide, underscoring the vast potential of the luxury car market (Guan et al.,2022).

## 2.3 The Sustainable Market

The consideration of studies on sustainable mobility represents a viable approach for the luxury automotive industry to address the challenges posed by the energy transition. Sustainable development promotes values of altruism that reflect sensitivity to social justice and the well-being of other humans (Stern, Dietz, and Kalof, 1993). While most people have a positive opinion towards sustainable mobility, only a few take actions to change their behaviour. To successfully shift mobility patterns towards sustainability, technologies must be designed to consider individual factors such as stage of change, opinion, and influencing factors. Technologies must be designed to inform individuals of available opportunities and the associated impacts of their mobility decisions. To encourage positive social norms surrounding sustainable mobility activities, this information must be delivered in a clear manner, within the appropriate social context, and with the goal of fostering connections with peers (Sadeghian et al., 2022).

The sustainability critiques directed towards the luxury industry commonly centre on aspects of the supply chain that are often overlooked, including the procurement of raw materials, the treatment of animals, labour practices, manufacturing processes, and environmental impact (Kapferer & Michaut-Denizeau, 2015). Customers are increasingly looking for products in today's market that are ethically and environmentally conscious. It is essential to be able to convey the history of the origin of the materials used in the products and the considerations that went into their selection, according to Maria Mulder, Head of Colour and Trim at Bentley Motors. Products that offer both high luxury and ethical and environmental responsibilities are becoming more and more popular with consumers (Wired, 2021).

Sustainable operations practices, which comprise seven main initiatives that address every aspect of the operations function, have been identified as crucial for organizations aiming to enhance their environmental performance (Nunes et al., 2016).

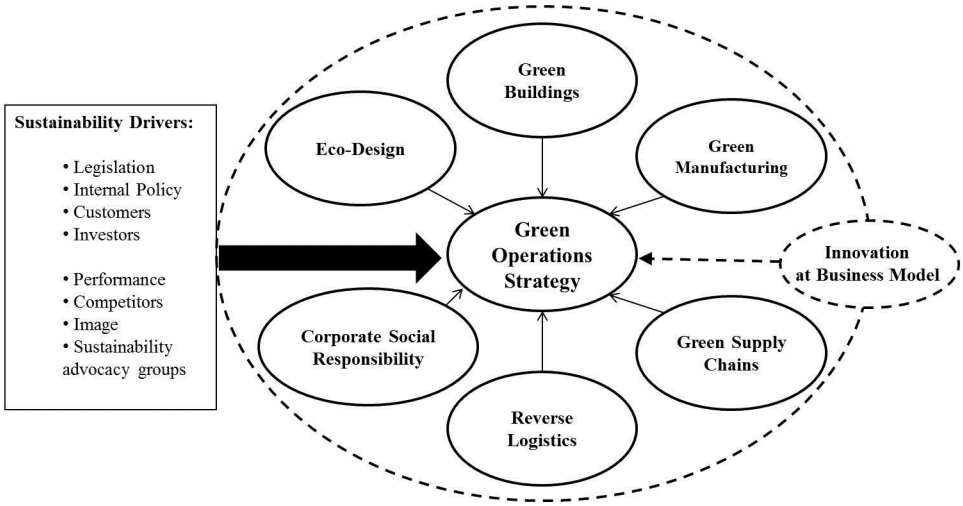



*Figure 10: Main sustainability (Nunes, B., Bennett, D. A., & Shaw, D, 2016)*

Recent research has investigated the drivers of purchase behaviour for green-luxury cars, highlighting the key role played by four aspects: materialism, vertical individualism, horizontal collectivism, and vertical collectivism (Ali et al., 2019).

In a study conducted by Aliyev, Wagner, and Seuring (2019), survey data from 1601 respondents of over 60 nationalities was analysed to examine the relationship between purchase intentions for green and luxury cars. The results indicated that while conspicuousness had a substantial positive effect on luxury car purchase intentions, it did not significantly influence green car purchase intentions. The study also identified the drivers of purchase intentions for both green and conventional luxury cars, highlighting that the 'extended self' and the sense of superior quality were common motivators, while unique value had no impact on purchase intentions for either type of car (Aliyev et al., 2019).

A more recent study by Hur et al. (2023) found that a hedonic motive had a positive impact on plans to purchase green vehicles, demonstrating that, in addition to functional characteristics, emotional values have an important impact on decision-making.

The results derived from the studies are consistent with the model proposed by Brun & Castelli (2013) in Figure 5.

## 2.4 Electric Vehicles Adoption

Consumer perceptions of EVs have undergone significant changes in recent years. The adoption of EVs has accelerated since 2020 (McKinsey, 2020), especially among luxury vehicle owners. In a study conducted by McKinsey (2022), 44% of ICE vehicle owners were interested in

transitioning to EVs. The growing preference for electric engines may be attributed to due to their technological advancements and the growing concern for environmental sustainability in society, as electric engines emit less pollutants and greenhouse gases than traditional ICEs (AFDC, 2021).

Potential customers highly prioritize environmental, financial, and technological attributes of EVs. The primary motivation for purchasing an EV in Kuwait is to have a vehicle with outstanding acceleration, rather than environmental concerns (Ottesen et al., 2023). This opportunity has been exploited by brands that will be studied in the third chapter of this paper.

The findings of Jansson et al. (2017) are notable as they highlight the significant role of personal norms, opinion leadership, and opinion seeking in electric vehicle (EV) adoption, surpassing the impact of environmental sustainability concerns and social norms associated with EV adoption. Individual attitudes and values, as well as social influence, may be more influential than environmental considerations in shaping consumer behaviour toward EVs.

Social influence plays a major role in shaping consumer attitudes. Notably, recommendations from family and friends play a significant role in shaping consumers' decisions when purchasing cars, particularly in the case of EVs. Research indicates that 64% of car owners become interested in or choose to buy EVs after being positively influenced by feedback from users within their social circles (Yang & Tan, 2019).

## 2.5 Overcoming the Sustainable-Luxury paradox

Luxury consumption and sustainability have been a subject of debate in recent years. The purpose of this section is to analyse the attitudes and perceptions of luxury buyers towards sustainability in the luxury sector, as well as the factors that may contribute to the perceived tension between luxury and sustainability from the consumers’ perspective.

Kapferer and Michaut (2015) suggest that although some luxury consumers consider sustainability when making purchases, sustainability is not a primary concern for most luxury buyers. However, luxury consumers have clear expectations regarding the sustainable orientation of luxury brands, implying that sustainability is now viewed as an element of quality.

Consumers' interpretations of luxury contribute to the perceived conflict between luxury and sustainability, with those who associate luxury with exceptional quality perceiving the conflict between luxury and sustainability as less significant. Furthermore, consumers expect luxury brands to adhere to their core values of craftsmanship and local production to maintain their ideal reputation. The scepticism of luxury buyers about the contradiction is largely driven by perceptions of luxury as superficial and the belief that luxury causes societal instability Kapferer and Michaut (2015).

A study conducted by the authors identifies human welfare and animal welfare as the two primary dimensions that consumers use to divide their perceptions of the tension between luxury and sustainability.

To overcome the consumers' perceived contradiction between luxury and sustainability, there is a need for luxury brands to communicate their sustainability efforts credibly to their consumers and move their attention towards programs that represent the real ideals of luxury.

## 2.6 Qualitative Study on Consumer Perceptions

As part of this research paper, a qualitative study was conducted to gain insight on consumer perceptions regarding the energy transition and luxury cars. The target of the survey is to bring an answer, from the consumer's perspective to the research question: "Is the energy transition within reach of the luxury automotive industry?"

This study can be classified as a qualitative research method. The aim was to gather descriptive information about interviewees' experiences, perceptions, beliefs and behaviours regarding the topic of this research paper. The aim of this method is to generate theories and insights based on discovered patterns that would emerge during the analysis of the results. The data collected from the method could be used to inform the luxury automotive industry of consumer preferences and guide future decisions regarding the luxury automotive industry's shift towards renewable energy sources.

The survey was conducted by sending a questionnaire to luxury car owners via e-mail. It was conducted in three languages (EN, FR, NL). 14 responses were gathered. The cited respondents were given fictive for names privacy reasons. All respondents are men and Belgian residents. The collected information offers indications that could be further confirmed by a more extensive study, in the hypothesis where a broader and more diverse sample of customers can be inquired.

### *Question 1: Which luxury car do you currently own?*

The respondents' luxury cars were diverse. The following brans were represented:

- Porsche: 5 respondents
- Aston Martin: 3 respondents
- Ferrari: 2 respondents
- Bentley: 1 respondent

Three respondents owned luxury car models that are not mentioned in this research paper; however, the models align with the proposed definition from the first chapter of this thesis.

- New Range Rover Defender: 2 respondents
- Audi R8 V10: 1 respondent

### *Question 2: Do you have preferences regarding the engine type of luxury cars? Could you elaborate on the reasons why?*

For the first open question, 9 out of the 14 respondents have a preference towards internal combustion engines compared to other engine types of luxury cars. The most notable aspect in favour of this argument is the pleasure and the sensations associated to ICEs. As advanced by Charles, owner of a Porsche: "*driving can be a passion or a way to enjoy freedom, just like sailing, flying, fishing, trucking, playing tennis or swimming*." The pleasure and sensations associated with ICEs emphasized by Charles and echoed by others, indicate that there is still a strong demand for the experience and sound provided by these engines.

On the other hand, the preferences towards hybrid engines expressed by three respondents indicate a growing interest in the benefits that hybrid technology offers. Yves thinks hybrid engines brings the "*Best of both worlds, quiet electric driving and sportier motorized driving.*" This perspective suggests that luxury car manufacturers may need to consider customers seeking a balance between efficiency and driving dynamics.

Two respondents had no preference regarding the engine type. Antoine highlighted the importance of context and purpose in determining the engine type by stating: "*I don't have a general ultimate preference, but rather specific preferences depending on the car's intended use. For pure driving pleasure and automotive passion, my preference would be for large naturally aspirated engines (V10 or V12). They provide a driving experience and a sound that enthusiasts particularly appreciate. For daily use, I have a preference for turbocharged engines. They are often more fuel-efficient and generally quieter in terms of noise. Luxury electric cars also do not bother me for daily use (e.g., Porsche Taycan Turbo S)*." Antoine's preferences suggest that luxury car manufacturers need to consider diversification and develop engines that satisfy the specific context and purpose of use of the vehicle.

According to Paolo, "*The luxury industry will have consumer desires as a driving force for its development. The big question is whether people who have access to luxury, especially cars, care enough about ecology. Are the world of luxury sufficiently aware of environmental issues?".* Recommendations for this issue will be developed in the conclusion of this qualitative research. Since it is a broad and intricate matter, the final chapter of this research paper will provide more detailed and specific recommendations.

### *Question 3: How do you think the luxury automotive industry should approach sustainability and more specifically the energy transition? What do you think luxury car manufacturers could do to adapt to the growing challenges of the energy transition?*

For the second open question, respondents' answers provided a range of perspectives on how the luxury automotive industry should approach sustainability and adapt to the energy transition.

Thomas believes the luxury automotive industry should lead this transition by example. Investment in R&D was brought up by Charles and Alexis as an important path. Eric Suggested that luxury car manufacturers develop their own charging stations. Alexis also suggested the integration of sustainable and environmentally friendly materials.

Two respondents suggested differentiation based on target audience. Antoine suggests that luxury car manufacturers should offer both fully electric vehicles and traditional combustion engines versions of their luxury cars.

Once again, sound loss was underlined as a concern by respondents regarding the transition to other engine types. According to Guillaume, compensating for loss of auditory pleasure is imperative: "*A luxury car provides a lot of pleasure to its driver. Since a part of this pleasure will be lost, it needs to be replaced by something else to continue pleasing the buyers. Powerful performance seems effortlessly achievable with electric motors. Now it is crucial to also provide a lot of driving pleasure through a well-engineered chassis and low weight.*"

Opinions regarding the role of the industry exhibited divergence. Although most respondents recognized the need for sustainability and a transition towards alternative energy sources, a minority of participants argued that luxury car brands should not exert further efforts towards more sustainable mobility. According to Alex: "*These cars are not the issue. They are often owned by enthusiasts who rarely drive them*." In contrast, Louis stated: "*I am well aware of the lack of sustainability in current luxury automobiles, and a transition must take place.*"

*Question 4: EU lawmakers in the European Parliament approved to ban the sale of vehicles with combustion engines by 2035 in Europe. On March 25, 2023, an agreement was made between the European Commission and an alliance of countries allowing the sale of combustion engine vehicles powered by e-fuels. E-fuels are synthetic fuels made using renewable hydrogen and other gases that can power conventional combustion engines. What are your thoughts on the recent agreement allowing the sale of combustion engine vehicles powered by e-fuels? Specifically, would you be more interested in exploring the use of e-fuels in internal combustion engines, or in the development of hybrid/electric engines? Why?*

Since multiple respondents recommended the pursuit of alternative and sustainable fuel sources in the previous question, the relevancy of this fourth question is emphasized.

Most respondents expressed with enthusiasm their support towards the recent agreement allowing the sale of combustion engine vehicles powered by e-fuels, showing once again that luxury car owners are very attached to ICEs. 10 respondents were more interested in exploring the use of e-fuels in internal combustion engines than the development of hybrid and electric engines. The most important factor influencing participants' decision is their belief that e-fuels will ensure the continuation of the sensations associated to ICEs in their luxury cars.

Participants see opportunities for innovation and growth in developing and utilizing e-fuels. They see these fuels as an opportunity to make technological advancements and find viable solutions for the industry's adaptation to more sustainable energy sources. E-fuels are perceived as a potential solution to achieve a balance between maintaining the driving sensation of luxury cars and attaining sustainability goals.

### *Question 5: Do you think the energy transition is within reach of the luxury automotive industry?*

Respondents were presented with the Research Question of this academic paper as their last question. When asked whether they think the energy transition is within reach of the luxury automotive industry, all of them, said yes.

However, some respondents advanced concerns about the electrification of luxury cars. According to Antoine, "*the risk would be that future and the history of luxury automobiles could be damaged due to the energy transition*". This concern brings up one of the main challenges luxury car manufacturers are facing. Indeed, innovations, no matter how effective they are, will only be accepted by consumers if they are prepared for them.

### *Summarized*

Many respondents express sentimentality and attachment towards the sound traditional engines produce. This could be a reason why the majority of respondent were in favour of e-fuels, as they offer a future where internal combustion engines can still be manufactured. luxury car manufacturers should consider finding a balance between sustainability and preserving the characteristics that enthusiasts value.

The diverse preferences expressed by the participants in the question regarding their preferred engine type highlights the importance of providing a wide range (ICE, Hybrid and Electric) of engine option to meet the customers' preferences. Since ICE are still so popular, advancements in sustainable fuels are necessary. This is intended to prevent luxury car owners who have placed high hopes in sustainable fuels from being disappointed and turning away from the industry.

Respondents expressed scepticism and concerns regarding electric vehicles, encompassing doubts about the feasibility of electrification, the environmental impact of batteries, and the loss of sensations experienced in ICEs (APPENDIX 1). Several measures can be taken to address these concerns. First, a strong emphasis should be placed on communication, education, and raising awareness among consumers. Providing the consumers with accurate, accessible and transparent information can help alleviate scepticism. Then, investment in R&D is crucial to drive advancements in battery technology, charging infrastructure and the range of EVs. Continued innovation and improvement in these areas will contribute to the broader acceptance and adoption of EVs.

According to Paolo, "*the energy problem stems from a lack of awareness in society regarding the issue. The energy problem is highly complex, and few people fully understand it. Each person has their own truth, which generally serves their own interests best*." Therefore, effective communication about the necessity of a transition is key. This can be implemented through education and awareness campaigns, transparent and accessible information, stakeholders' engagement and policy support.

Some respondents express frustration towards political decisions regarding environmental policies for cars. They perceive inconsistencies and general lack of foresight in these decisions (APPENDIX 1). The impact of such policies, such as changes in tax deductibility, is questioned in terms of actual climate benefits. Addressing this critical perspective requires policymakers to engage in transparent and evidence-based decision-making processes.

The recommendations presented in this section aim to specifically address the issues identified through the analysis of the qualitative study results. However, this thesis includes a dedicated chapter focusing on recommendations for the luxury automotive industry to thrive in the energy transition. The recommendations in the last chapter of this research paper are discussed in greater detail, providing a comprehensive and in-depth exploration of proposed strategies.

## Intermediary conclusion to Chapter 2

- The luxury market is influenced by personal and non-personal factors. Consumers are motivated by social status, exclusivity and pleasure derived from owning luxury goods.

- Luxury car consumers value brand image, design, performance, quality, reliability, after-sales services, and exclusivity when making purchasing decisions.

- Sustainability is not a primary concern; it is now viewed as an element of quality by most luxury buyers. However, attitudes and perceptions evolving, with an increasing demand for ethically and environmentally conscious products.

- The qualitative study aimed to gain consumer insights on the research topic was sent to luxury car owners via email. 14 responses were collected from Belgian residents. The collected information offers indications that could be further confirmed by a more extensive study.

- Preferences regarding engine types varied among respondents, with a majority expressing a preference for ICEs due to the sensations associated with them.

- Respondents provided suggestions on how the luxury automotive industry should approach sustainability, including leading by example, investing in R&D, developing charging stations and integrating sustainable materials.

- The recent agreement allowing the sale of combustion engine vehicles powered by e-fuels was met with enthusiasm by most respondents, as they believed it would preserve the sensations associated with ICEs.

- All respondents believed that the energy transition is within reach of the luxury automotive industry, although some expressed concerns about potential damage to luxury automotive brands' reputation.

- The study highlights the importance of finding a balance between sustainability and preserving the characteristics valued by enthusiasts, as well as providing a wide range of engine options to meet customer preferences.

- Skepticism and concerns about electric vehicles were expressed, emphasizing the need for effective communication, education and the pursuit of continuous improvement.

- Recommendations are presented, focusing on communication, education, raising awareness, investment in R&D, transparent decision-making processes, and policy support to address the identified issues.

# Chapter 3: The Transformation of Luxury Car Manufacturing

This chapter aims to examine luxury car manufacturers' efforts to produce environmentally friendly vehicles and the strategies they have employed to adapt to the energy transition. One question that arises is whether these efforts are only peripheral, involving only superficial compensation measures, or whether they involve a profound transformation of supply chains, incorporating new materials and processes, and completely overhauled production activities. To avoid accusations of greenwashing, this chapter will investigate the sustainability claims made by luxury car manufacturers. The analysis of luxury car manufacturers' efforts to produce environmentally friendly vehicles and their strategies to reduce their environmental impact will provide insight into the industry's progress towards the energy transition as well as the challenges it still faces.

## 3.1 Navigating Sustainability in The Luxury Automotive Industry

### 3.1.1 The Value of Sustainability

Sustainability has become a priority for companies, with many adopting sustainable practices for various reasons. Some do it for the potential positive benefits, risk management, and wealth generation, as suggested by Esty and Winston (2007). Others do it to avoid the consequences of noncompliance, as noted by Kapferer and Michaut-Denizeau (2015). Additionally, companies can create value by adopting a responsible approach, as pointed out by Wheeler et al. (2003). Therefore, businesses are increasingly driven to embrace sustainable practices due to various factors, including legislation, consumers, internal policies, rivals, performance gains, and corporate image, as suggested by Hoffman (2000). By doing so, companies can not only mitigate risks but also create value and enhance their reputation.

The sustainability of car manufacturers has been a topic of continuous debate due to factors such as pollution in urban areas (Nunes, Bennett, & Shaw, 2016). To address these concerns, luxury companies must avoid greenwashing and go beyond the substitutive effect of carbon offsetting. One approach to achieve this is by implementing sustainable supply chains, which can help mitigate the risk of the boomerang effect (Karaosman et al., 2018).

### 3.1.2 Adoption of Sustainable Practices

The business case for sustainability has been emphasized by Kotler, Kartajaya, and Setiawan (2010), who argue that organizations that embrace sustainable practices and innovative business models can enjoy greater long-term profits. In the automotive industry, sustainability decisions are shaped by the allocation of resources and the adoption of sustainable practices, which range from reactive responses to legislative pressures to proactive behaviours and eco-design interventions (Orsato and Wells, 2007).

In this context, green technologies have been deployed across different domains of sustainable operations practices, including eco-design, which aims to enhance fuel efficiency and reduce emissions, despite potential business risks (Nunes and Bennett, 2010; Martinuzzi et al., 2011). Consequently, green operations strategies can drive the adoption of sustainable improvements in a variety of operational domains, informed by specific practices (Nunes et al., 2016).

### 3.1.3 Previsions for The Luxury Automotive Segment

Although the luxury automotive industry is facing pressures related to the energy transition, the following brands achieved record deliveries in 2022. Figure 11 is based on results published by the manufacturers in 2023.

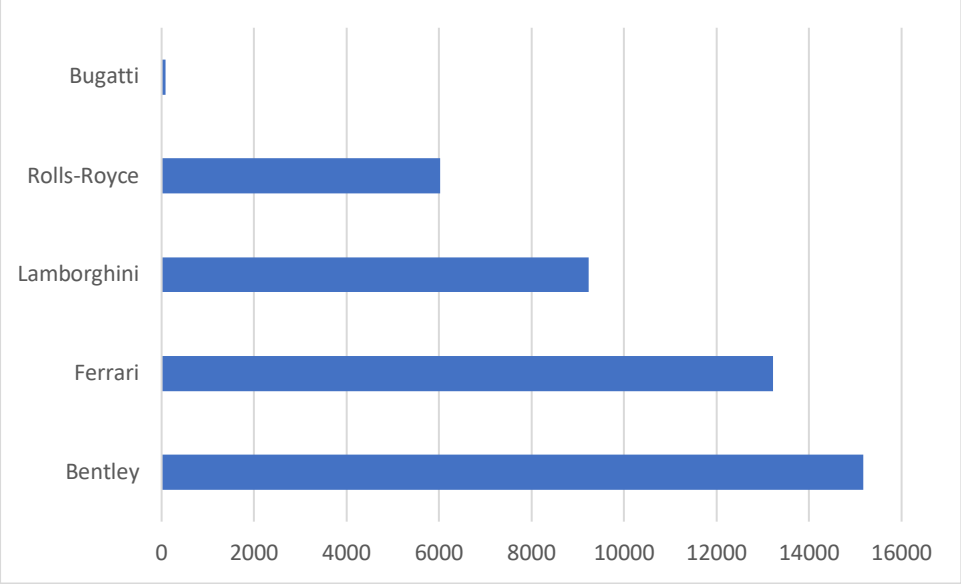



*Figure 11: Number of cars delivered by manufacturer in 2022*

The luxury car market is expected to keep growing due to the rise of wealthy individuals in the world. The luxury automotive sector is projected to experience the fastest growth in the car industry, while also achieving the highest expected profit margins. According to a report by the Data Bridge Market Research team (2022), the global luxury car market is projected to grow rapidly.

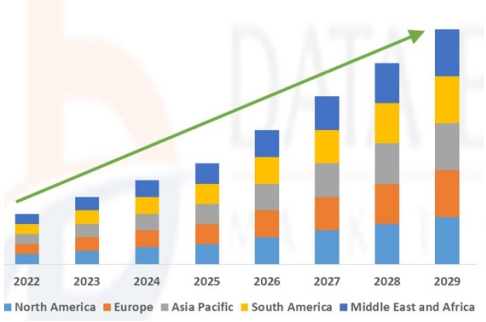



*Figure 12: Global Luxury Car Market, By Regions, 2022 to 2029 (Data Bridge Market, 2021)*

The market value of the global luxury car market has been estimated to grow by 12.75% over the period of 2022 to 2029 (Data Bridge Market, 2021).

In another report, conducted by McKinsey (2022), the luxury-car industry is segmented in four. The luxury segments are projected to grow at a rate of 8 to 14 percent through 2031.

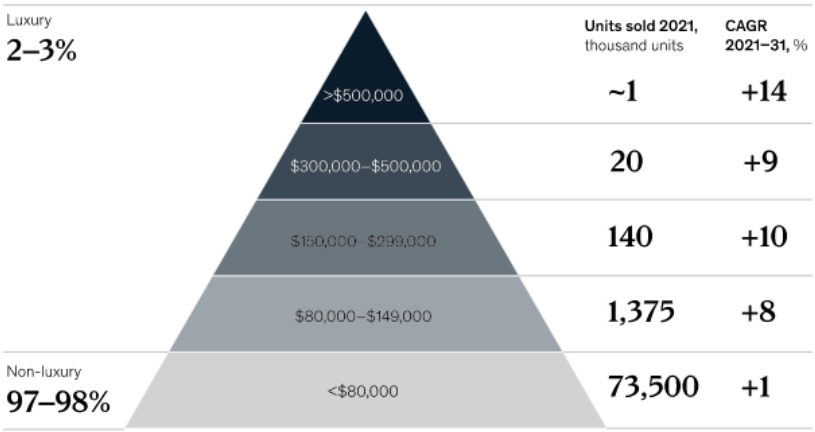



*Figure 13: Segmentation of car market by vehicle cost range (McKinsey, 2022)*

The growth in the luxury-car industry has shifted from North America and Europe to Asia and the Middle East due to the increase of wealthy people in these regions. This shift has attracted new entrants to the market. It also resulted in more new-product launches, particularly in China (McKinsey, 2022).

### 3.1.4 Implications of A Net Zero Transition

Actors of the automotive industry are pressured to make investment decisions despite the uncertain developments in the sector (Deloitte, 2019). The International Energy Agency predicts that low-emission cars will grow to 125 million in 2030, compared to 3 million in 2018 (IEA, 2018). The growing interest in electric and hybrid engines could be attributed to the implementation of government incentives and policies aimed at promoting their usage (Diamond, 2009).

The transition to net-zero mobility will require a major shift in the engine types of vehicles being manufactured (McKinsey Global Institute, 2022). This opens an opportunity for companies to adapt their business models and capitalize on the growing demand for low-emission vehicles. Three major concerns, including the need to reduce carbon emissions, sustainability along the value chain, and digital responsibility, are involved in the automotive industry's transformation (PWC, 2023).

The Alternative Fuels Data Centre (2021) provides valuable insights into the annual emissions of vehicles by engine type.

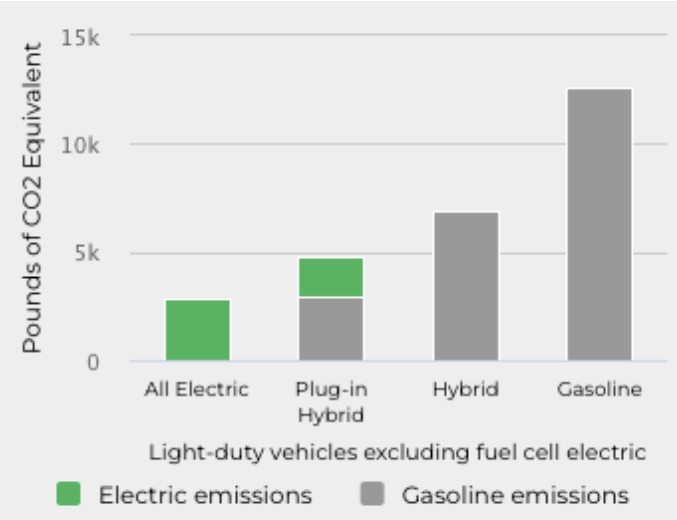



*Figure 14: Annual Emissions per Vehicle (Alternative Fuels Data Centre, 2021)*

As indicated in Figure 13, electric engines produce significantly less emissions than other engine types, emitting only 1278 kilograms (kg) of CO2 Equivalent per year. Plug-in hybrid engines emit more than electric engines but still produce significantly fewer emissions than hybrid and gasoline engines, emitting 2188 kg of CO2 Equivalent per year. Hybrid engines produce 3128 kg of CO2 Equivalent per year and gasoline engines emit 5713 kg of CO2 Equivalent per year.

### 3.1.5 Importance of The Luxury Automotive Niche

Luxury car manufacturers are crucial in the development of advanced technologies due to their investments in research and development, resulting in the provision of high-skilled jobs and engineering expertise. They can also serve as a strategic platform for introducing green technologies into the industry (Nunes and Bennett, 2010; Martinuzzi et al, 2011). Even though luxury cars have a significant impact on the environment as individual vehicles due to their high value and limited production numbers, they can still be considered favourable when assessing the ratio of emissions per unit of economic value they contribute (Nunes et al., 2016). Prior to moving into mass production, luxury automobile brands play a crucial role in advancing and improving technologies for both drivers and passengers, such as airbags, anti-lock braking system (ABS), and telematics. Consequently, they can introduce green technologies into the industry, contributing to business sustainability, socio-economic performance, and sustainable personal mobility (Schot and Geels, 2008; Smith, 2007).

Geels (2005) also highlighted that the luxury market niche played a significant role in the evolution from horse-drawn coaches to motorized vehicles by driving the adoption and development of engine technologies, implying that luxury car manufacturers play a vital role in the adaptation of the automotive field to the ongoing energy transition.

## 3.2 Performance is no longer Monopolized by Internal Combustion Engines

The performance sector is no exception to the trend towards electric vehicles, as EVs are now being recognized for their impressive performance capabilities. Not only do EVs comply with stringent European regulations, they also bring new value to the industry with their unprecedented power. The electric engines provide instant torque, which results in swift and smooth acceleration, enhancing the driving experience. In addition, the lower centre of gravity of EVs increases their stability and ease of handling on the road. Several Luxury car manufacturers have been quick to recognize the potential of EVs and are developing ground-breaking models that combine high performance with sustainable mobility (Swallow, 2022). These brands, studied in the following section, are proving that the industry is adapting to the times and that EVs have a promising future in the performance sector.

### 3.2.1 Rimac Automobili

Rimac Group designs and produces electric high-performance cars and technology solutions for top automakers worldwide. Rimac Group has been able to accelerate the transition to electrification by producing high-performance parts and technology solutions for electric vehicles. The company is dedicated to ESG issues and operates in a critical industry. The brand plans to expand its family of high-performance models and introduce important original equipment manufacturer (OEM) electrification projects into mass production (Rimac Automobili, 2022).

The Rimac Nevera is the flagship model of the Croatian Rimac Group. This high-performance electric vehicle develops 1408 kilowatt (kW) (1914 horsepower) and 2360 Newton meters (Nm) of engine torque. The Nevera has a maximum speed of 412 km/h and a 0-100 km/h acceleration time of 1.82 seconds. The EV has a powertrain that includes four separate electric motors, which are attached to the car's surface using carbon sleeves. The car also has four independent inverters and four separate gearboxes. Based on preliminary tests and simulations, the car has a range of 550 kilometres (km). The vehicle's sophisticated driver aid systems include 13 cameras, 6 radars, and 12 ultrasonic sensors (Rimac Automobili, 2023a).

The weight of the vehicle, which amounts to 2150 kg (Rimac Automobili, 2023a), represents a notable trade-off for the Nevera’s performances. However, the focus is primarily on delivering unmatched performance rather than prioritizing weight reduction in this context.

In April 2023, the Nevera set 23 performance records in a single day (Rimac Automobili, 2023b). These records include various acceleration and braking records (APPENDIX 2).

### 3.2.2 Automobili Pininfarina

The Battista is Pininfarina’s strategic move to take advantage of the opportunity presented by the energy transition. Handcrafted in Italy, with a total of 128 million possible interior

combinations, the electric high-performance vehicle delivers 1900 horsepower (hp) and 2300 Nm of torque generated by its powerful 120 Kilowatt hour (KWh) battery and four motors. The car can travel up to 476 kilometres on a single charge (Automobili Pininfarina, 2023) and weighs about 2063 kg (Blain, 2022).

The Battista is also designed with sustainability in mind, featuring eco-friendly materials and ethical sourcing and production of semi-aniline leather and recycled ocean plastics (Automobili Pininfarina, 2023).

### 3.2.3 Lotus Cars

The Lotus Evija is a limited-edition electric vehicle that marks a new era for the British brand. The Evija is the lightest production EV high-performance vehicle and it features a one-piece carbon fibre monocoque. The vehicle has a 2000 kW lithium-ion battery and a range of 400 km. The car's four electric motors produce 500 horsepower each. The Evija's aerodynamics and cooling package ensure optimal battery performance, enabling the car to be driven without derate for up to seven minutes in track mode. With the ability to accept an 800-kW charge, the battery can be fully recharged in just nine minutes. The car's weight is 1680 kg, with a driving range target of 402 km. The Evija has a strategic role, as it serves a symbol for Lotus. As the first all-electric vehicle produced by Lotus, the Evija inspires and challenges the development of future models, while reinforcing the brand’s reputation (Lotus Cars, 2019).

### 3.2.4 Gumpert

Roland Gumpert, a German car brand, has unveiled the world's first series production model of its Nathalie car featuring a hydrogen-electric hybrid powertrain with a reformed methanol fuel cell system supplied by Blue World Technologies, a Danish company (Fuel Cells Bulletin, 2020). The Nathalie's energy concept includes a 15-kW methanol-driven fuel cell, which continuously generates hydrogen from methanol to produce electricity. The fuel cell can be refuelled with commercially available methanol, enabling the car to operate in areas without a developed charging infrastructure. The Nathalie has a roll cage and carbon exterior-chassis for safety and performance and can accelerate from 0-100 km/h in under 2.5 seconds. The Nathalie "First Edition" is limited to 500 vehicles, including a special edition for the product launch (Roland Gumpert, 2020).

### 3.2.5 Aspark

The Japanese brand Aspark has recently introduced the Owl, an EV with a maximum speed of 413 km/h and an output of 1980 horsepower. The Owl's battery system is bespoke and capable of delivering a capacity of 69 kWh. The vehicle features a Lithium-ion battery that can be charged onboard, taking approximately 2 hours and 40 minutes to fully charge. Fast charging station takes about 40 minutes. The vehicle's power comes from four electric motors and a dual-speed transmission that reduces motor load. The Owl's interior is crafted with state-of-the-art instrumentation (Aspark Company, 2023).

### 3.2.6 Automobili Estrema

Automobili Estrema is planning to set a new electric vehicle lap record on the Nordschleife circuit at the Nürburgring track with their upcoming model, the Estrema Fulminea. The company has launched a campaign to fund the costs of the record attempt and a documentary series covering the development of the vehicle (McDee, 2023).

The Estrema Fulminea's first production model is set to arrive in June 2023. It will include a hybrid battery pack that combines both ultra-capacitors and solid-state Li-Ion cells. The battery pack will be housed in two separate carbon fibre cases (Automobili Estrema, 2022). The electric powertrain of the Fulminea will have 2040 horsepower, enabling the EV to accelerate from 0 to 320 km/h in less than 10 seconds (McDee, 2023).

### 3.2.7 Hyperion Motors

Hyperion, a technology start-up, has developed the XP-1, an electric car powered by a fuel cell engine module that uses hydrogen to generate electricity. The XP-1 has a range of 1600 Km on a single charge and a maximum speed of 350 km/h (Fuel Cells Bulletin, 2020).

The Californian company aims to bring all the benefits of electric power without the limitations of batteries. Hyperion also plans to mass-produce high-performance fuel cells for commercial vehicle, stationary power, and spaceflight applications (Hyperion, 2023).

### 3.2.8 Tesla

The Tesla Roadster is a high-performance EV of the American company Tesla that was presented in November 2017 but has not yet been commercialized. The car accelerates from 0-100 km/h in 1.9 seconds. The car's aerodynamic design and all-wheel drive enable it to optimize performance while still accommodating seating for four (Tesla, 2023).

### 3.2.9 Drako Motors

The Drako GTE is an electric vehicle from the brand Drako Motors. The car is equipped with four motors that provide 1200 horsepower when combined. This allows the GTE to have high-speed acceleration and a top speed of 332 km/h. The quad motors provide precise control over each wheel's traction and the lithium-ion battery pack is assembled with a cooling architecture. The GTE also features fluid surfaces that provide performance gains and a luxurious, hand-crafted interior (Drako Motors, 2022).

### 3.2.10 Maserati

After Maserati's Grecale, the brand's first 100% electric vehicle (Maserati, 2022), the GranTurismo Folgore was introduced drawing inspiration from Formula E technology. The Folgore's advanced 800-volt battery powers three permanent magnet motors for a total output of 761 horsepower and 1350 Nm of torque. The car has a top speed of 320 km/h and a range of up to 450 km (Maserati, 2023).

### 3.2.11 Summarized

The emergence of high-performance electric vehicles has disrupted the world of high-performance cars. With their impressive power output, instant torque, and reduced carbon-emissions, EVs are the new face of performance vehicles. The emergence of EVs has not only challenged but also expanded the customer base within the automotive industry, thereby disrupting the traditional dominance of ICE vehicles in the performance segment. In the undergoing energy transition, it is evident that the performance sector is ready to adapt to the times, and electric vehicles have a promising future in this industry.

## 3.3 Exploring Luxury Car Manufacturers' Initiatives

The focus of this section is to study whether the efforts made by luxury car manufacturers are just peripheral and based around compensation or if there is a profound transformation of the supply chains, the incorporation of new materials, sustainable processes, and entirely reworked production activities.

### 3.3.1 Aston Martin

Aston Martin, the British luxury car manufacturer, has announced plans to combat climate change by transforming its products and production processes. This section examines the various initiatives that Aston Martin is taking to reduce its carbon footprint, mainly by studying Aston Martin's most recent sustainability report from 2022.

#### *Electrification of Products*

Aston Martin is planning to electrify its entire vehicle line-up by 2030. The brand will launch its first plug-in hybrid car in 2024, followed by its first battery electric car in 2025. By 2035, all Aston Martin models bought within the UK, the EU, and California will have zero tailpipe emissions. To achieve this, Aston Martin has established an EV Champion network and an Electrification Centre of Excellence for training. The company has also conducted initial instructor-led training for EV in association with the University of Warwick, with 130 workers already completing the training (Aston Martin, 2023).

#### *Manufacturing Facilities*

The company is committed to reducing CO2 emissions from its manufacturing processes by 2.5% annually and CO2 emissions intensity and energy consumption per vehicle, both by 2.5% annually. Aston Martin aims to have net-zero manufacturing facilities by 2030 and extend it to its entire supply chain by 2039. The company reduced its CO2 emissions per vehicle manufactured by 3.9% in 2022 compared to 2021 (Aston Martin, 2023).

#### *Sustainable Materials*

Aston Martin is working with supply chain partners towards more environmentally friendly materials in the manufacturing process. The brand has already brought innovations in the use of sustainable materials, including recycled and FSC-certified materials. FSC certification allows businesses and consumers to choose forest products made with materials from well-managed forests and/or recycled sources (Forest Stewardship Council UK, 2023). Aston Martin is investigating novel approaches like the use of thermoplastic composites made of natural fibres to maximize the use of sustainable materials in all its models (Aston Martin, 2023).

### 3.3.2 Porsche

Porsche AG Group has made significant efforts in recent years towards reducing the environmental impact of its vehicle production. The company's aim is to integrate sustainability into every aspect of its operations, with a particular emphasis on the value chain (Porsche AG, 2023).

#### *Electrification of products*

By 2025, 50% of Porsche's new cars will have electric engines. By 2030, more than 80% of the brand’s line-up will be fully electric. Over the next five years, the German company intends to invest more than € 20 billion on electrification and digitalization. The company is also investing in infrastructure and technologies to support the advancements of mobility, including a plan to build up to 80 fast-charging stations beside major European roads (Porsche AG, 2023).

Porsche's first electric car, the Taycan, was launched in 2019 and confirmed that it’s working on a new, electric luxury car. Porsche also invested heavily in Croatian EV high performance electric car maker Rimac in 2021, showing the brand’s interest in high-performance electric vehicles. Next to electric engines, the manufacturer also offers Hybrid models (Porsche AG, 2023).

#### *E-Fuels*

Porsche is focusing on e-mobility for future vehicles to meet ambitious decarbonization goals, but also recognizes the importance of operating existing combustion engine vehicles as close to net carbon neutral as feasible. To achieve this, Porsche has developed synthetic fuels employing renewable energy sources for combustion engines. Porsche was one of the first companies to research synthetic fuels. In 2021, Porsche built a pilot plant in Punta Arenas, Chile, to produce

e-Fuels using local wind energy. Porsche anticipates that e-fuels will not only be used in road transport but also in other sectors: in the aviation, shipping, and chemical industries. In the future, Porsche wants all current and new vehicles to run on e-fuels (Drums, 2023).

#### *Zero-Impact Factory*

Porsche AG's objective is to reduce its environmental impact by 95% by 2030 compared to 2018, which is consistent with its vision of a zero-impact factory. The Stuttgart-Zuffenhausen and Leipzig production facilities are close to achieving this goal. Porsche Leipzig has already started to practice resource and energy conservation, with the facility running solely on electricity generated by renewable sources. The factory has been successful in implementing policies that lower the consumption of waste, energy, solvents, water, and CO2. The Leipzig plant has net carbon-neutral operations since 2017, green energy supply since 2017, and platinum certification from the German Sustainable Building Council in 2019 (Porsche AG, 2023).

#### *Decarbonization & Circular Economy*

As part of its contribution to the UN's climate targets, Porsche AG Group has an extensive decarbonization program, which aims to achieve net carbon neutrality by 2030 across its entire value chain. The company is avoiding or reducing CO2 emissions, switching to less CO2-intensive energy sources, and offsetting unavoidable CO2 emissions through carbon offset projects. Since 2014, Porsche AG's internal production activities have already reduced CO2 emissions per vehicle produced by more than 98%. By 2025 compared to 2014, the company wants to cut five specific types of environmental pollution produced by the production of each vehicle by 45%. Porsche is also investing in the circular economy by developing repair and reconditioning policies and using circular materials in its vehicles (Porsche AG, 2023).

### 3.3.3 Ferrari

Ferrari has recently committed to becoming carbon neutral by 2030 through a focus on energy and materials, electrification and efficient risk management. The Italian luxury car manufacturer plans to reduce CO2 emissions by at least 90% by 2030 compared to 2021 and achieve carbon neutrality in all operations (Ferrari, 2023).

#### *Electrification of products*

The company's currently offers four hybrid vehicles: the SF90 Stradale, the SF90 Spider, the 296 GTB & the 296 GTS. The models have been successful, with 2859 units sold in 2022 (Ferrari, 2023).

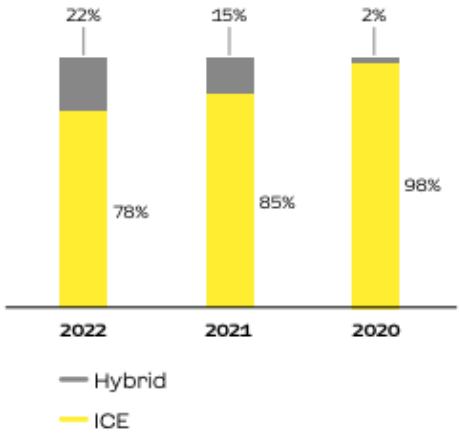



*Figure 15: Percentage of Ferrari vehicle deliveries by engine type (Ferrari, 2023)*

Aiming to release 15 new models between 2023 and 2026, Ferrari has stated that their first electric vehicle will make its appearance in 2025. Ferrari aims to establish a vehicle line-up by 2026 that consists of 40% ICE models, 5% EVs, and 55% hybrid models.

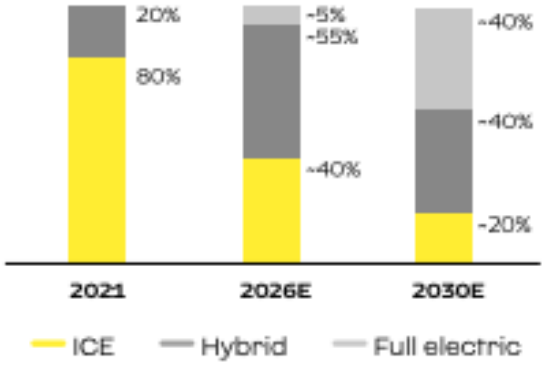



*Figure 16: Ferrari's projected vehicle line-up by engine type (Ferrari, 2023)*

By 2030, the Italian manufacturer's portfolio should consist of 20% ICE, 40% hybrid, and 40% fully electric vehicles (Ferrari, 2023).

### *Research and Development*

Ferrari places a strong focus on the development of fuel alternatives for internal combustion engines, energy efficiency solutions, and using technology to comply with regulations without sacrificing performance. The company is working to improve ICEs while also preparing for the shift towards electric technology, with its expertise in ICEs being utilized to provide effective solutions for its upcoming electric engines. To reduce emissions of raw materials used in battery packs, Ferrari is exploring the use of recycled aluminium and green steel. Ferrari places a strong emphasis on innovation. The company encourages employee contributions, resulting in technological, design and craftmanship advancements. The proposals have been concentrated on the two pillars of Ferrari's sustainability strategy, process efficiency and carbon neutrality (Ferrari, 2023).

### *Sustainable Value Chain*

Ferrari has imposed strict standards for its partners and suppliers in order to guarantee that its supply chain is maintained efficiently and responsibly. The company encourages sustainable practices among its suppliers, dealers, and business partners. Ferrari has conducted a risk analysis to determine which suppliers are essential, and starting in 2020, it strengthened the qualification and selection procedures for suppliers to confirm their technical aptitude, financial stability, and dependability using a compliance evaluation screening methodology (Ferrari, 2023).

To reduce greenhouse gas emissions along the whole value chain, Ferrari measures its CO2 emissions and has started a structured interaction with its supplier base to find practical ways to cut greenhouse gas emissions and advance the low-carbon transition. For instance, the company plans to erect a new "e-building" in Maranello where electric engines, inverters, battery modules, and magnets will be handcrafted and assembled. In 2019, Ferrari developed the Gasoline Particulate Filter to reduce particulate emissions from its vehicles (Ferrari, 2023).

### *Environmental Sustainability*

Ferrari reduces its energy consumption and emissions using renewable energy sources (such as solar panels and fuel cells) and by improving the efficiency of facilities. The Group's overall energy consumption fell by 9% in 2022. In addition, new photovoltaic panels were installed to their buildings (Ferrari, 2023).

In December 2022, a proximity analysis was conducted by the company to assess the impact of their factories and racetracks on protected areas located within a 10-kilometre radius. The results of the analysis revealed that the company's sites had minimal to no environmental impact in these areas. To further prevent pollutants and bacteria from affecting the natural landscape, the company employed eco-active materials in the construction of the main tribune at the Mugello racing circuit (Ferrari, 2023).

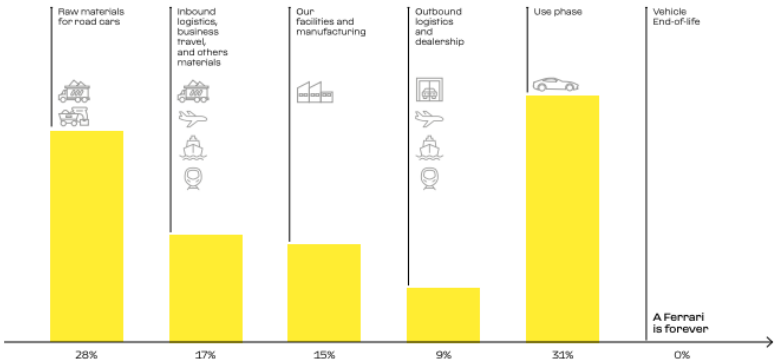



*Figure 17: 2021 Ferrari Group average carbon footprint distribution (Ferrari, 2023)*

### 3.3.4 Bentley

Bentley aims to become the world's most sustainable luxury car brand. This section discusses Bentley's efforts to achieve this goal, including the electrification of vehicles, carbon-neutral manufacturing and responsible practices in the use of leather.

#### *Electrification of products*

Bentley has already made progress towards the electrification of their vehicle line-up with the release of the Bentayga Hybrid and the Flying Spur Hybrid (Bentley Motors, 2021a). Bentley plans to introduce five EVs, one per year, beginning in 2025 as the company aims to fully embrace electrification by 2026. By 2030, the company aims to have all electric vehicles (Bentley Motors, 2021b).

In 2019, Bentley introduced the EXP 100 GT concept car as part of its efforts to explore the future of luxury cars. The car is fully electric, offering the option for fully autonomous driving, and uses artificial intelligence to personalize the passenger's experience. The EXP 100 GT also utilizes air curation to reduce the impact of city pollution (Bentley Motors, 2019).

#### *Manufacturing*

Bentley's factory has been certified as fulfilling the PAS 2060 carbon neutral standard by the Carbon Trust, an internationally recognized specification for carbon neutrality. The company has implemented various strategies, including the use of solar panels, efficient manufacturing principles and employee engagement, to increase production while reducing energy use and CO2 emissions. By 2025, Bentley aims to reduce the environmental impact of its entire production by 75% compared to 2010. The company also aspires to become plastic neutral by the end of 2025. The site's long-term goal is to transform into a climate-positive factory (Bentley Motors, 2021c). In order to transform its entire product portfolio and manufacturing facilities, Bentley commits to invest € 2.8 billion in sustainable initiatives (Bentley Motors, 2021a).

#### *Environmental Sustainability*

Bentley uses hydrotreated vegetable oil fuel (instead of conventional fuel) to reduce emissions. Additionally, the company has implemented several recycling programs and cut their water usage by 55.9% and increased biodiversity on the factory site by building green walls, growing wildflowers, and maintaining beehives (Bentley Motors, 2023). By 2025, the brand has committed to achieving carbon neutrality for their entire network of retailers globally (Bentley Motors, 2021b).

Bentley is the first automobile manufacturer to become a member of the Leather Working Group, a global community dedicated to forming a sustainable future with responsible leather (Leather Working Group, 2023), with the aim of establishing responsible practices in the use of leather (Vollmer, 2023; Wired, 2021).

### 3.3.5 Lamborghini

Automobili Lamboghini has developed a 2030 strategy that aims to define its vision and interpret the new trends of the automotive industry. This strategy places a strong emphasis on sustainability, digitalization, and urbanization. A sustainability project team has been established to integrate existing initiatives and introduce new ideas and innovations (Automobili Lamborghini, 2022). Lamborghini places a strong emphasis on sustainability and uses the idea of ESG as the foundation of its business strategy. By acting ethically towards the environment and society, the corporation hopes to create value (Automobili Lamborghini, 2023a).

In 2021, Automobili Lamborghini published its Environmental Mission Statement, which outlines the brand's environmental targets in four categories: climate change, resources, compliance, and biodiversity. These goals include becoming a carbon neutral company by 2050, transitioning to a complete range of hybrid products by 2024, reducing product CO2 emissions by 50% by 2025, achieving a 35% reduction in the production site's environmental impact by 2025, promoting a circular economy model, ensuring full compliance with environmental regulations, monitoring environmental impacts associated with the brand's operations, and contributing to safeguarding biodiversity through community engagement and environmental education (Automobili Lamborghini, 2022).

#### *Electrification of Products*

The company announced its "Direzione Cor Tauri" electrification strategy that aims to significantly reduce the carbon footprint of its future models in accordance with the company's environmental sustainability strategy. By the end of 2024, all engines will have hybrid transmissions. The first electric Lamborghini will be presented in the second half of the decade. Lamborghini is investing over € 1.5 billion in the hybrid transition. It is the brand's biggest investment to date. The plan aims to cut CO2 emissions by half by 2025 (Automobili Lamborghini, 2021).

The Sián, presented in 2019, is the first Lamborghini powered by a hybrid V12 engine based on supercapacitors. It has been limited to 63 models produced (Automobili Lamborghini, 2019). On March 29, 2023, just before the 60$^{th}$ anniversary of the company, Lamborghini unveiled the Revuelto. The combination of the hybrid system with the internal combustion engine (ICE) of the Revuelto produces a combined maximum power of 1015 horsepower (Automobili Lamborghini, 2023b).

#### *Sustainable Value Chain*

As part of Lamborghini's "Direzione Cor Tauri" sustainability plan, the company has set a target to reduce the carbon footprint of its production site in addition to its upcoming models. The company aims to achieve a reduction of 35% reduction in the production site's environmental impact by 2025. Lamborghini has established strict criteria for energy-efficient construction of

new buildings. The manufacturer also installed a photovoltaic system to provide electricity (Automobili Lamborghini, 2022).

In order to evaluate suppliers' sustainability practices in terms of human rights, environmental protection and corruption, Lamborghini also created a global sustainability rating system. When contracts are awarded to suppliers, the sustainability rating is now a legally binding factor (Automobili Lamborghini, 2022).

#### *Environmental Sustainability*

Lamborghini has partnered with the Experis Academy technical institute in Italy to repurpose carbon fibre scraps generated in their manufacturing process to train technical experts. The remainders are transformed into valuable raw materials used for teaching students. Similarly, Lamborghini also partners with the Cartiera Cooperative to repurpose leather offcuts from their Upholstery Department into high-quality leather goods, using materials that would otherwise be disposed of as waste. This circular model not only reduces environmental impact but also creates jobs and encourages social inclusion (Automobili Lamborghini, 2022). The Italian car manufacturer has been recognized two years in a row as one of the most sustainable Italian companies by receiving the Green Star Award. The award evaluates the sustainability practices of Italian businesses, including innovation and technology. The company's commitment to sustainability started in 2009, leading to certification as a CO2-neutral production site in 2015 (Automobili Lamborghini, 2023).

The Lamborghini Park project, developed in conjunction with universities, involves planting oak trees to understand the relationship between tree density, forestry productivity, and CO2 absorption and biodiversity maintenance. Soil analysis over time will assess the increase in soil carbon content based on planting density, providing valuable information for reforestation efforts (Automobili Lamborghini, 2022).

### 3.3.6 Bugatti

While Bugatti has not yet announced plans to develop electric or hybrid engines, the company is taking steps towards achieving net-zero carbon emissions in its production processes. In addition to using 100% green biogas and electricity in its production facilities and recycling 98% of its waste products, Bugatti has implemented several environmental protection efforts. These efforts, based on the principle of carbon offsetting, include reforestation projects in Alsace and the preservation of the Amazon rainforest in Brazil (Bugatti, 2021).

### 3.3.7 Closing example: De Tomaso

The unveiling of De Tomaso's P900 marks is another demonstration of how the luxury automotive industry has been adapting to the energy transition. By developing a carbon neutral V12 engine that runs on synthetic fuels, De Tomaso is proving to luxury car enthusiasts that the

ICE still has its place, next to powerful electric engines, in sustainable luxury. The P900 is designed for track use and boasts advanced aerodynamics and a carbon fibre chassis. Early adopters will have the opportunity to acquire a V10 version until the V12's development is finished, which is anticipated to happen in 2024 (Carmone, 2022).

## Intermediary conclusion to Chapter 3

- Sustainability has become a priority for luxury car brands, driven by potential benefits, risk management, wealth generation, and value creation.
- Historically, luxury car manufacturers have played a significant role in adopting new technologies, highlighting their importance in the ongoing energy transition in the automotive industry.
- Sustainable supply chains can help luxury companies address concerns, mitigate risks, and avoid greenwashing.
- Embracing sustainable practices in the automotive industry can lead to long-term profits and innovative business models.
- The luxury car market is expected to grow rapidly, attracting new entrants and resulting in increased product launches.
- Electric vehicles are projected to dominate the luxury segment in the future
- Luxury car manufacturers play a crucial role in developing advanced technologies, providing high-skilled jobs, and introducing green technologies into the industry.
- Luxury vehicle brands, such as Rimac, Pininfarina, Lotus, Gumpert, Aspark, Automobili Estrema, Hyperion Motors, Tesla, Drako, and Maserati, have demonstrated the potential of electric vehicle technology in performance cars.
- Electric vehicles are recognized for their impressive performance capabilities and comply with stringent government regulations, offering unrivaled power output and acceleration due to instant torque.
- The studied luxury car brands have made significant commitments to the electrification of their vehicle lineup.
- The studied manufacturers have set ambitious goals to achieve carbon neutrality across their entire value chain.
- Investment in research and development, electrification of products and the exploration of e-fuels are part of the industry's efforts to address sustainability challenges.
- Carbon offsetting is still a popular initiative by luxury car manufacturers to balance their emissions by supporting initiatives that reduce carbon emissions.
- De Tomaso's P900 showcases the industry's adaptation to the energy transition with its carbon-neutral internal combustion engine that runs on synthetic fuels, challenging the dominance of the electrification strategy.

# Chapter 4: Author's Internship Company in the Energy Transition

This chapter aims to unveil the efforts produced by the author's internship company in face of the energy transition. The main challenge encountered was the restricted availability of information. Under these circumstances, the information provided is relies on publicly available sources.

## 4.1 Louyet Sports Cars

The author's internship company is Louyet Sports Cars, the official retailer of McLaren Automotive in Belgium and Luxemburg. The company is part of a larger automotive group called Louyet Group, official retailer of Rolls-Royce Motor Cars in Belgium along with various other brands. Louyet Group, one of the major players in the Belgian automotive landscape, has 22 sales points in Belgium and over 550 employees. Together, they represent the annual sale of 8500 new cars, 1600 used cars, and 600 motorcycles (Louyet Group, 2023).

In order for this case study to be relevant, it is important to analyse McLaren Automotive & Rolls-Royce Motor Cars' efforts to adapt to the greening of society. The two UK brands have made significant efforts in transitioning to cleaner energy and reducing their carbon footprint in the last few years. These efforts have a direct impact on their retailers in Belgium.

## 4.2 McLaren Automotive Group

McLaren Automotive Group declares being dedicated to sustainability, incorporating environmental concerns, social equality, community collaborations, and technical innovation into its business strategy. The company is switching from fossil fuels to electrified powertrains and researching alternate fuel sources for their cars (McLaren Automotive, 2023).

The McLaren Technology Centre, built in 2004, was planned with sustainability in mind. As part of its cooling system, the structure has a 30000 m3 decorative lake. It has a combined heat and power system to control temperature. Rainwater is also collected by the flat, self-cleaning roof and used to rehydrate the nearby lake (McLaren Automotive Group Limited, 2021).

### *Sustainable Value Chain*

McLaren Automotive aims to decarbonize its value chain by 2030, by identifying and lowering emissions sources, involving partners in best practices, benchmarking and evaluating operations, and promoting sustainability improvements throughout the supply chain. With almost no waste going to landfills and a thorough recycling program that turns waste into energy, McLaren demonstrates commitment towards a circular economy. Along with minimizing trash to landfill from on-site operations, they are supporting product end-of-life innovation lake (McLaren Automotive Group Limited, 2021).

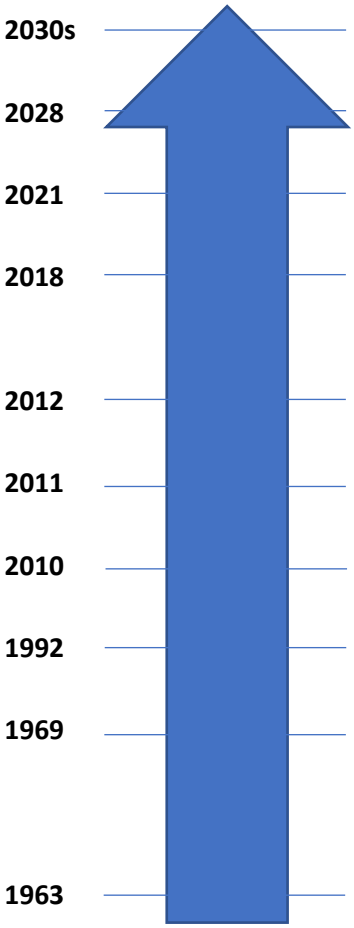
### *Weight Reduction*

In order to sustain the car's performance as the industry transitions to electrification, McLaren Automotive Group is working towards weight reduction. To reduce weight and increase energy efficiency, McLaren seeks out novel materials and seamlessly combines components. The company's journey toward sustainability began more than 40 years ago when they introduced the first carbon fibre Formula 1 chassis (McLaren Automotive Group Limited, 2021).

While McLaren Automotive has incorporated sustainable practices into its business strategy, the company's primary focus is on technical innovation and performance. The emphasis on lightweight materials and aerodynamics, although beneficial for improving fuel efficiency and lowering emissions, is ultimately driven by the goal of enhancing the car's performance rather than solely prioritizing environmental concerns. It is essential to approach this initiative with a critical perspective and question whether the company's commitment to sustainability is genuine or if it is primarily driven by market demand and regulatory requirements.

### *Timeline*

The following timeline represents key moments in the history of McLaren Automotive, including more recently, the introduction of hybrid models:



**2030s** Arrival of fully electric McLaren's

**2028** McLaren plans to have over 90% of its cars electrified.

**2021** Artura, the company's first production hybrid car.

**2018** Speedtail, McLaren's second hybrid model limited to 106 models. It is the brand's fastest car.

**2012** P1, the company's first hybrid model limited to 375 units.

**2011** MP4-12C Coupe, McLaren Automotive's first production car.

**2010** McLaren Automotive is founded.

**1992** F1 road car, breaking numerous world records during the '90s.

**1969** M6GT prototype, McLaren's first road-legal car, the project to build 250 production cars is aborted when Bruce McLaren dies in a crash on June 2, 1970.

**1963** Bruce McLaren Motor Racing Limited is founded.

The head of vehicle development at McLaren, Geoff Grose, predicts that fully electric McLaren's will not arrive until the 2030s due to the weight of batteries. McLaren sees hybrid as the dominant powertrain until the end of the decade (Corby, 2023). According to Chief Executive Officer Michael Leiters, McLaren plans to have over 90% of its cars electrified within five years. Leiters, emphasized the importance of power-dense, high-performance battery technology to secure the UK's position as a global home for electrified luxury car manufacturing and suggested that McLaren's expertise in lightweight carbon fibre and aerodynamics can be utilized in other sectors, including the aerospace industry (McLaren, 2023).

## 4.3 McLaren Brussels

At the author's internship company, McLaren Brussels, official retailer of McLaren Automotive in Belgium & Luxemburg, there were several steps taken towards sustainability. However, the extent to which McLaren Brussels can affect McLaren Automotive Group's goal of transitioning towards more renewable resources is limited, as it is primarily a retailer and does not directly impact the manufacturing and development of vehicles. Nevertheless, McLaren Brussels' most notable commitment to sustainability is the decision to bring together its showroom (currently in Uccle, Brussels) and its workshop, (currently in Overijse, Flemish Brabant) by the end of 2023.

The integration of the two facilities into one location creates a more efficient and eco-friendly space, reducing the environmental impact of the business operations. By combining the workshop and showroom, McLaren Brussels can reduce the transportation of cars between locations, which in turn decreases their carbon footprint. This decision increases the efficiency of McLaren Brussels' operations, reducing costs and saving time. By having the two facilities in one location, employees and customers no longer lost time by travelling between locations.

## 4.4 Rolls-Royce Motor Cars

Modern production plant and corporate offices for Rolls-Royce Motor Cars were inaugurated in 2003 in Goodwood, England. The site was developed with the intention of having the least possible impact on the environment. The building is covered in a combination of limestone and cedar wood, and timber louvre panels regulate the amount of light that enters the structure, lowering the need for electricity. In just five years, the building's architecture and environmental goals have led to a 29% decrease in the energy footprint per car, which is manufactured at the facility by hand (Rolls-Royce Motor Cars, 2023).

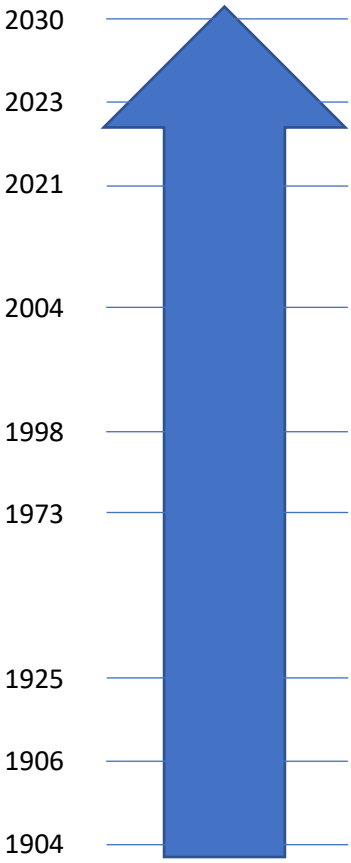
### *Electrification of products*

Rolls-Royce Motor Cars intends to gradually retire all models with internal combustion engines over the next seven years. The introduction of Spectre is a step in the company's strategy to switch to EVs by 2030 (Edie Newsroom, 2021). The Spectre, a new EV from Rolls-Royce will be on sale by the end 2023. Fulfilling the company's sustainability commitment and founders'

vision, the luxury car offers a maximum range of 520 kilometres per charge, with 585 horsepower (Swallow, 2022b).

### *Timeline*

The following timeline represents key moments in the history of Roll-Royce Motor Cars, including more recently, the introduction of the brand's first electric vehicle model:



| | |
|---|---|
| 2030 | Rolls-Royce plans to produce only electric cars. |
| 2023 | Spectre, the company's first electric car. |
| 2021 | Boat Tail is introduced, the world's most expensive street legal new car. |
| 2004 | The new Phantom, the first Rolls-Royce car to be produced under the ownership of the BMW Group, is introduced. |
| 1998 | Rolls-Royce Motor Cars Limited is founded. |
| 1973 | Rolls-Royce Motors is created as a separate entity from Rolls-Royce Limited, focusing solely on producing luxury cars under the Rolls-Royce brand. |
| 1925 | 40/50 Phantom, introduced as the New Phantom. |
| 1906 | Rolls-Royce Limited is founded, the Silver Ghost is introduced. |
| 1904 | 10 H.P. is launched by Charles Rolls and Henry Royce. |

The Rolls-Royce concept Vision Next 100, known as 103EX, manifesting the future direction of Rolls-Royce Motor Cars. The concept represents a personalized and unique approach to luxury mobility, allowing customers to customize their vehicles completely. Rolls-Royce aims to emphasize individuality and craftsmanship in the future. The integration of artificial intelligence within the vehicle establishes an interactive companion that aligns with the owner's persona and elevates the overall travel experience.

## 4.5 Summarized

To conclude, the efforts of McLaren Automotive Group and Rolls-Royce Motor Cars toward sustainability have a direct impact on Louyet Sports Cars, their official retailer in Belgium. These two UK brands have made efforts in transitioning to cleaner energy and reducing their carbon footprint in recent years. Although most engines of these brands are still designed using internal combustion, both brands have implemented strategies to transition towards the electrification of the proposed vehicle line-up. These efforts show that the two luxury car brands are aware of

their responsibility toward sustainability and are taking the necessary steps to achieve it. Nevertheless, it is crucial to critically evaluate the ongoing and future efforts of the brands to assess the extent to which both brands' actions align with the goals presented in this chapter to achieve sustainability.

## Intermediary conclusion to Chapter 4

- The efforts of McLaren Automotive Group and Rolls-Royce Motor Cars towards sustainability have a direct impact on Louyet Group, acting as their official retailer.

- While retailers can contribute to promoting sustainable practices through effective communication, the ultimate responsibility for vehicle design, production, and energy sources lies with the manufacturer. The author's access to information is limited to publicly available data published by McLaren Automotive and Rolls-Royce Motor Cars.

- It is important to critically assess the ongoing and future efforts of the brands to determine the extent to which their actions align with sustainability goals.

- In 2023, McLaren Automotive and Rolls-Royce Motor Cars predominantly employ internal combustion engines in their vehicle production.

- McLaren aims to decarbonize its value chain by 2030 through emissions reduction, sustainability improvements in the supply chain, waste management, and recycling programs.

- McLaren Automotive has introduced hybrid models and plans to have over 90% of its models electrified within five years, with a focus on power-dense, high-performance battery technology.

- Fully electric McLarens are expected to arrive in the 2030s, as the company addresses the weight limitations of batteries.

- Rolls-Royce Motor Cars plans to produce only electric cars by 2030. The electrification of the cars has started in 2023 with the launch of the Spectre, the brand’s first electric car.

- Rolls-Royce envisions a future of luxury mobility that combines personalized and unique customization with the integration of artificial intelligence.

- Despite the expressed commitment to sustainability by both brands, providing specific figures representing the actual investment made would enhance their credibility. Transparency would facilitate the alignment of their communication with the observable and quantifiable reality related to the implementation of new sustainable practices.

# Chapter 5: Operational Recommendations

Luxury car brands face challenges as they strive to adapt to the energy transition without compromising customer experience. The luxury car market has is expected to grow and has an immense potential. Accordingly, the most successful player in the market will be the one capable of satisfying the greatest number of individuals to the highest degree (Guan et al., 2022). The existence of this market thus depends on the continued prosperity of wealthy individuals (Oz et al., 2023).

To thrive in the evolving competitive landscape, manufacturers of luxury cars must embrace environmental initiatives and associate an environmental-friendliness image with their brands (Nunes and Bennett, 2010). In the pursuit of sustainability, identifying and effectively addressing emerging trends becomes a crucial step for businesses (Vecchiato and Roveda, 2010).

Luxury brands have an opportunity to lead sustainable mobility by incorporating green technologies into their strategic plans, just as they have done for safety issues in the past. By doing so, luxury automotive manufacturers can position themselves as innovators and redefine industry standards. This would ensure the survival of the luxury automotive industry considering the challenges posed by the energy transition and the inherent paradox between luxury and sustainability.

## 5.1 Electric Powertrains

To accelerate the energy transition within the luxury car industry, manufacturers need to take proactive measures to shape the electric vehicle market and demonstrate a genuine commitment to sustainability (Jansson et al., 2017). Despite the uncertainties surrounding the feasibility of a complete transition, this involves focusing on several key aspects.

- Luxury car manufacturers should focus on the establishment of charging infrastructure, customization of marketing campaigns, and the development of long-lasting batteries (Ottesen et al., 2023). It is essential to ensure the development of infrastructure for charging EVs, which should encompass high-quality facilities, comprehensive functionalities, and wide coverage across different regions (Brown et al., 2021). This will help alleviate concerns about the range and enhance the convenience and accessibility of EVs, thereby promoting their adoption. The EV transition must be backed by a renewable charging infrastructure ecosystem and circular economy principles (Capgemini Research Institute, 2020). By developing and installing their own charging stations in strategic locations, luxury car brands could incentivise consumers further to switch to EVs.

- Vehicle manufacturers should prioritize improving the technologies of EVs and controlling vehicle costs, enabling a gradual replacement of existing conventional vehicles with EVs (Yang & Tan, 2019). This approach contributes to energy conservation and emissions reduction, aligning with sustainability objectives.

- Manufacturers should prioritize post-sales service quality, battery recycling, and related concerns, while simultaneously focusing the improvement of overall vehicle quality and customer satisfaction (Yang & Tan, 2019).

- Coordination with the mining and metals industry is vital to secure the supply of strategic materials required for the production of EV components (Bonnie et al., 2020). Supply chain resilience should be prioritized to guarantee the availability and sustainability of these critical raw materials (Brown et al., 2021).

- Luxury car brands and dealerships could invite customers to events in specific locations that combines luxury and sustainability to promote their electric models. By accompanying customers during the test drives, the brands can demonstrate the benefits that electric vehicles bring to the industry in terms of performance and comfort.

Transitioning to an all-electric luxury vehicle fleet may face realistic considerations and challenges. However, in the short term, such a transition serves as a tangible manifestation of a luxury car brand's commitment to environmental sustainability. By embracing electric vehicle technology, luxury car manufacturers affirm their dedication to reducing greenhouse gas emissions, minimizing environmental impact, and aligning with global sustainability goals. Moreover, the transition to electric luxury vehicles presents numerous R&D benefits. The shift necessitates advancements in battery technology, charging infrastructure, and energy management systems, stimulating innovation and fostering collaboration among various stakeholders. These R&D efforts not only drive progress within the luxury car industry but also contribute to the broader field of electric mobility, leading to advancements in battery efficiency, range, and performance that can benefit the entire automotive sector.

## 5.2 Sustainable Fuel Technologies

In addition to the transition towards EVs, luxury car manufacturers should invest in and develop sustainable fuel technologies for their ICE vehicles to remain competitive. The recent exemption obtained by a coalition of European countries allowing for the sale of combustion engine vehicles using e-fuels in Europe presents an opportunity for manufacturers exploring this path. By investing in sustainable fuel options, luxury car brands can contribute to emissions reduction and appeal to customers who may prefer traditional combustion engine vehicles.

Furthermore, the development of a green hydrogen corridor through projects like H2MED could indirectly impact the adoption of hydrogen fuel cell vehicles, including luxury vehicles, in the future. As the production and distribution of green hydrogen become more accessible and affordable, luxury car manufacturers may be incentivized to invest in and develop hydrogen-powered vehicles, contributing to a more sustainable mobility scenario.

To drive progress and promote collaboration, industrial alliances have proven effective in increasing investments in battery technology and hydrogen (Brown et al., 2021).

For luxury car brands that choose to pursue the utilization of e-fuels as an alternative to the electrification of their vehicle models, several operational recommendations can be considered to effectively navigate this path:

- Invest in R&D of sustainable fuels and build partnerships with energy companies and research institutions to create a strong supply chain. The collaborations will help ensure the availability and accessibility of these alternative fuels, facilitating their adoption by luxury car owners.

- Implement targeted marketing campaigns to educate customers and create awareness about the benefits of e-fuels and sustainable fuels. These campaigns should highlight the positive environmental impact, reduced carbon emissions, and compatibility with existing luxury vehicles. Emphasizing the high-end nature of these fuels to align with the luxury brand image and the compatibility with existing internal combustion engines is crucial.

- Engage in policy advocacy to encourage governments and regulatory bodies to support the development and adoption of e-fuels and sustainable fuels. This involves advocating for favourable regulations, incentives, and funding to incentivize the use of these alternative fuels and create a supportive regulatory environment for luxury car manufacturers.

- Prioritize customer engagement: by actively engaging with luxury car owners and potential buyers through exclusive events, demonstrations, and test drives to showcase the performance and benefits of vehicles running on e-fuels and sustainable fuels. Collect feedback from customers and integrate their preferences and expectations into future product development and marketing strategies. This engagement will not only drive customer interest but also foster brand loyalty and advocacy.

## 5.3 Strategy

To ensure long-term sustainability, the luxury automotive industry should adopt a systematic and comprehensive approach, making sustainability an integral part of its organizational mission (Capgemini Research Institute, 2020). To ensure a successful energy transition, luxury automotive brands should prioritize green sourcing and sustainability practices while considering the needs and requirements of customers (Brown et al., 2021; Yang & Tan, 2019). This will enable them to meet environmental goals, maintain industry competitiveness, and satisfy the preferences of the sector's target market. The following strategic recommendations are proposed to guide luxury car brands towards the energy transition:

- Enhance governance, measurement, and monitoring practices to effectively track sustainability initiatives (Capgemini Research Institute, 2020). The Environmental component of ESG has received significant attention in recent years. However, it is

equally important to emphasize the significance of the remaining two components: Social and Governance (B. Piraux, personal communication, May 16, 2023).

- Differentiation through technology. By embracing and effectively implementing emerging technologies, luxury car brands can enhance the overall customer experience, increase brand appeal, and position themselves as leaders in the industry. Brands can create a virtuous cycle that enhances sales and strengthens customer loyalty (Guan et al., 2022).

- Maintaining brand power and heritage. By creating a locked system and engaging customers through gamification strategies, exclusive events, and strong supplier chains, brands can enhance their reputation and maintain a loyal customer base (Oz et al., 2023).

- The transition from traditional wholesale dealership channels to Direct-to-consumer (DTC). DTC models provide a personalized and exclusive sales or service experience, meeting the expectations of affluent customers. By adopting an omnichannel approach and leveraging data analysis, brands can fully personalize the customer relationship, control pricing, and maintain exclusivity (Guan et al., 2022).

- Strategic partnerships and collaborations to drive innovation and enhance market positioning. By forming alliances with technology leaders, other OEMs, or information technology (IT) giants, luxury car brands can leverage expertise, access new markets, and generate revenue growth (Deloitte, 2019). Exploring partnerships with industries such as fashion, jewellery, and luxury goods can provide opportunities for cross-sales and brand synergies (Berk, 2014).

- Proactively prepare for the advent of autonomous vehicles and support Connected Autonomous Vehicle technology (Brown et al., 2021). As market opportunity estimates for autonomous vehicles indicate vast potential, luxury car brands must recognize the significance of this next transition (Bonnie M. et al., 2020).

- Substantial investments in sustainability should extend beyond the progress made in R&D and the manufacturing of EVs. Marketing, sales and aftersales must receive greater attention by luxury car manufacturers (Capgemini Research Institute, 2020).

## 5.4 Communication

Luxury firms should communicate their genuine beliefs to consumers in a credible manner to avoid perceptions of superficiality and societal unrest. Instead of simply emphasizing materials used, luxury firms should focus on programs that align with the authentic ideals of luxury (Kapferer & Michaut, 2015). This approach can establish positive brand associations, leading to favourable customer attitudes (Ottesen et al., 2023). In their communication efforts, luxury automobile brand managers can employ more hedonic appeals, highlighting the pleasure of sustainable luxury products (Aliyev et al., 2019).

To address the reputational risks associated with modern communication tools, luxury brands should be mindful of maintaining their exceptional quality while integrating sustainable attributes (Kapferer, 1990; Dekhili & Achabou, 2016). Managers should also consider the influence of societal norms and values on sustainable consumption, leveraging influential reference persons and opinion leadership communication strategies (Lang, 2007). Lastly, by presenting green luxury items as extensions of consumers' identities, values, aspirations, the perception that sustainability sacrifices indulgence can be mitigated (Kapferer et Bastien, 2012; Aliyev et al., 2019).

Luxury car manufacturers should prioritize effective communication about their sustainability efforts that goes beyond mere discourse and include specific figures that demonstrate the actual investment made towards sustainability goals. By providing transparent information on the financial commitment to sustainable practices, luxury car manufacturers can enhance their credibility and build long-term trust with stakeholders.

Reliance on carbon offsetting as the primary message should be avoided. While carbon offsetting can be a valuable component of sustainability strategies, it should not overshadow other concrete actions and investments made towards sustainable practices.

Luxury car brands should prioritize transparency in their efforts towards ESG principles. Disclosing specific figures that represent the actual investment made in sustainable practices, demonstrating a genuine commitment to ESG principles, will enhance reputation and contribute to long-term sustainability of the industry.

## 5.5 Environmental Sustainability

To facilitate the energy transition within the luxury automotive industry, the adoption of strategic niche management is essential, considering its relatively small fraction within the broader automotive sector. Strategic niches have been acknowledged as effective platforms for the promotion and market penetration of green technologies, thus facilitating the transition to a more sustainable future (Schot and Geels, 2008).

Innovation, particularly in the area of electrification has changed the automotive industry in an unprecedented way (Bonnie et al., 2020). By prioritizing innovation and responsible design, luxury car brands can develop product variants that reduce negative environmental effects, consequently aligning with sustainability goals (Chen, 2008).

Recognizing the complexity of sustainable design, the development of partnerships across disciplines and involving various stakeholders is imperative (Piancastelli & Frizziero, 2014). Collaborative efforts can encourage the integration of sustainable practices and expertise from diverse fields, improving the overall effectiveness and environmental impact of luxury automotive operations.

Luxury automotive companies can gain knowledge from brands in other sectors by studying from their commitment to social responsibility and sustainability (Guan et al., 2022). By adopting similar approaches and practices, luxury car brands can effectively align their business strategies with sustainable development goals.

The convergence of luxury and sustainability often presents conflicting values, especially when it comes to exclusivity versus sharing. To overcome this dissonance, luxury brands can promote the value of sharing and emphasize the importance of intergenerational transmission (Dekhili & Achabou, 2016). By highlighting the significance of preserving natural resources for future generations, luxury car brands can resolve the luxury-ecology paradox and win support for sustainable practices among their customers.

## 5.6 Manufacturing

Manufacturing facilities within the luxury car industry should proactively prepare to transition into an efficient mode of energy consumption (Ottesen et al., 2023). This requires adopting energy-efficient technologies, optimizing production processes, and implementing sustainable practices to minimize resource consumption and environmental impact.

The manufacturing process will be significantly impacted by the transition to electric vehicles, necessitating a shift in workforce composition. Rather than reducing the workforce through automation, the industry will require more workers skilled in engineering and technology to support the development and production of EVs (Bonnie et al., 2020). Upskilling and reskilling programs should be implemented to ensure that the workforce possesses the necessary knowledge and expertise to meet the evolving demands of the industry.

## 5.7 Government Involvement

Global EV adoption has been stimulated by regulatory support. China has taken significant initiatives in this regard, achieving the highest EV adoption rate of 7% worldwide (Bonnie M. et al., 2020). This example highlights the significant impact government involvement can have on the luxury automotive industry's adaptation to the energy transition. To encourage this transition, the following recommendations are proposed for governments:

- Offer financial support and establish regulations to promote R&D and investment in the luxury car industry. This support can facilitate the necessary developments in EV technology and alternative fuel sources for ICE (Hannon et al., 2022). To support EV adoption, it is crucial for governments to invest in charging infrastructure, including residential areas, public parking lots, and major public buildings (Bonnie M. et al., 2020).

- Provide assistance to workers, such as relocation and retraining programs, to help them transition their skills from IC vehicles to EVs (Hannon et al., 2022) or provide assistance to workers pursuing sustainable fuel sources for ICE.

- Promote the development of abilities in electrical engineering and EV-expertise (Brown et al., 2021).

- Collaborate with other industry stakeholders such as energy companies and research institutions to drive innovation.

## Intermediary conclusion to Chapter 5

The following recommendations are intended to advise luxury car brands on how to adapt to the energy transition, providing a comprehensive guide for stakeholders in the industry:

- Make sustainability an integral part of the organizational mission.
- Enhance governance, measurement, and monitoring practices.
- Foster collaboration between governments, luxury car manufacturers, energy companies, and research institutions to drive innovation and knowledge sharing.
- Prioritize effective communication about sustainability efforts, including specific investment figures illustrating the financial commitment undertaken.
- Promote transparency and accountability in efforts towards environmental, social, and governance (ESG) principles, emphasizing the significance of all three components.
- Invest in charging infrastructure, marketing customization, and long-lasting batteries to accelerate the energy transition.
- Improve EV technologies, control costs, and prioritize post-sales service quality to contribute to energy conservation and emissions reduction.
- Promote the development of abilities in electrical engineering and EV-expertise
- Coordinate with the mining and metals industry to secure the supply of strategic materials for EV production.
- Invest in sustainable fuel technologies for internal combustion engine vehicles. Allocate resources to research and development, targeted marketing campaigns, policy advocacy, and customer engagement.
- Differentiate through technology to enhance the overall customer experience.
- Leverage societal norms and values for sustainable consumption through opinion leadership strategies.
- Present green luxury items as extensions of consumers' identities, values, and aspirations to mitigate the perception that sustainability sacrifices indulgence.
- Maintain brand power and heritage through exclusive events and strong supply chains.
- Transition to direct-to-consumer models for personalized and exclusive sales or service experiences.
- Prepare for the advent of autonomous vehicles.

# Conclusion

Our planet has progressively been showing symptoms that something is wrong. Changes in rainfall patterns, extreme droughts and increased frequency of natural disasters across the globe reveal imbalance (World Meteorological Organization, 2021). These events have induced a disruption; the way in which humankind operates must be reconsidered. The Earth's signals can be seen as a compelling incentive to rethink the entirety of our economy.

The call for profound transformation is reflected in initiatives such as the European Green Deal. The stringent climate-related governmental regulations have compelled luxury automotive industry players to reconsider the Environmental component of ESG principles. However, to ensure a stable long-term transition, the other two components, Social and Governance, must also be spotlighted.

While the energy transition presents challenges for the luxury automotive industry, it also brings opportunities. Through their leadership and pursuit of new technologies, luxury automotive brands assume a pivotal role in driving this ongoing transition, contributing to its success and shaping the future of sustainable mobility.

In light of this transition, significant advancements have been achieved. Most importantly, in terms of engine technology. The era of performance vehicles is being redefined by the advent of high-performance EVs. As the competition for the fastest luxury EV intensifies, Rimac Automobili recently set 23 new performance records. Simultaneously, sustainable alternative fuel sources offer hope to enthusiasts who wish to preserve ICEs. While Porsche started producing synthetic e-fuels at the pilot facility in Chile, using renewable wind power (Drums, 2023), Koenigsegg, on the other hand, is exploring Icelandic technology to convert carbon emissions from volcanoes into methanol as a zero-carbon energy source for its vehicles (Swallow, 2021).

The future of the luxury automotive industry is captivating. Charles, one of the participants in the qualitative study, judiciously proposed that "*Finding the appropriate balance between various improved sources of energy adequately tailored to each type of use seems the key to succeed the energy transition.*"

Amongst all the recommendations presented in the last chapter of this thesis, the one regarding transparency and accountability regarding Environmental, Social, and Governance principles can be considered as the foundation upon which the industry must rely on to flourish.

By embracing the energy transition, the luxury automotive industry can shine in a changing landscape and contribute to a sustainable future. After conducting this research, it has been concluded that the energy transition is indeed within reach of the luxury automotive industry, affirming a positive response to the research question posed in the introduction.

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# Glossary

ABS: Anti-lock braking system

ADAS: Advanced Driver Assistance Systems

ADEME: French Environment and Energy Management Agency

AFVs: Alternative fuel vehicles

CO2: Carbon dioxide

DTC: Direct-to-consumer

CSF: Critical successful factor

ESG: Environmental, Social and Governance

EV: Electric Vehicle

EVs: Electric Vehicles

FSC: Forest Stewardship Council

HP: Horsepower

ICE: Internal Combustion Engine

ICEs: Internal Combustion Engines

IT: Information technology

KG: Kilogram

KM: Kilometre

KM/H: Kilometres per hour

KW: Kilowatt

KWh: Kilowatt hour

NM: Newton meters

OEM: Original Equipment Manufacturer

R&D: Research and Development

# Appendices

*The Appendices are not included in this version of the thesis.*