Università
Ca'Foscari
Venezia

Master's Degree

in Business Administration

Final Thesis

HOW GREEN ECONOMY IS GOING TO CHANGE CAR INDUSTRY

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Academic Year
2018 / 2019

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Sommario

INTRODUCTION

In recent years, there has been a widespread awareness of the fact that our prevailing pattern of development is unsustainable and inequitable. The global economic growth of the last decade has been characterized by a strong consumption of natural resources and an increase of pollution level that has never been seen before. This impact on the wellbeing of current generations presents tremendous risks and challenges for the future. For this reason, all the global institutions and governments have decided to adopt multiple policies in order to diminish the level of pollution and GHG emissions around the world before 2050 with the goal of building a sustainable industry.

Sustainable measures require investments in research and development of technical and managerial skills by all innovative companies and they also require a significant period of time until they can be adopted. Moreover, if we want those policies to have a strong impact, eco-innovative solutions will be needed. Several industries have already started adopting these policies. This is especially evident in the car industry, where companies are now focusing on hybrid and electric vehicles for the reduction of consumption of fossil fuels. It has been nearly 5 years since the signing of the Paris Agreement, and the transition to a climate-friendly transport system has emerged as an important priority. Carmakers must phase out diesel and petrol cars, with an end to new sales by 2030. This will also bring other benefits, such as less traffic congestion and improved air quality.

Anyway, the car industry's inaction is robbing us of that greener, cleaner and more survivable future. Ford, Volkswagen, Toyota and Tesla are changing the face of this industry, since they have decided to invest billions in their R&D department in order to improve their technologies in this new industry. Moreover, these new policies are getting so strong that they have started influencing customers' own choices and lifestyle, leading them to focus on a new market which anyway is still being developed.

This work will analyze the relationship between the way consumers' choices are and have been influenced by car industries' policies which, at the same time, have been changed by politics.

CHAPTER 1: GREEN ECONOMY AND SUSTAINABLE DEVELOPMENT

1.1 A COMPLEX RELATIONSHIP: MAN, AND THE ECOSYSTEM

Since the Ecosystem is defined as an[1]: “ecological unit controlled by the equilibrium condition of the relations between living beings and the chemical-physical in which it is found” and Man is defined as[2]: "mammal characterized by its erect position, the extraordinary development of the brain, the psychic faculties and intelligence, the exclusive use of articulated symbolic language and the consequent ability to establish, transmit and modify a culture", these elements should live in a balanced situation.

Like all living beings, man is in the circle of complex synergies that ensure the functioning of ecosystems. However, due to the innate propensity for innovation, typical of human beings, the balance between man and the environment has altered. Man has acquired, over time, the awareness of his own possibilities to intervene in natural mechanisms and has passed from an integration behaviour to one of domination, survive and fill the needs that characterize him.

The relationship between human beings and the ecosystem has gone through many stages[3]:

1. “Hunter-gatherers”: from the origin of the species until 12000 BP. In this stage human beings and the ecosystem coexisted in a perfect balance.
2. “Agriculture” until 200 BP. This is the phase when the previous balance ~~is~~ was upset since animal and plant species were chosen on specific criteria determined by the human being. Moreover, in some areas climatic conditions were favourable for the development of numerous settlements, which caused the first great human impact on the environment.
3. “The Agrarian and Industrial Revolutions”: since the second half of the 18th century. The use of new techniques that involved new energies rapidly changed the fertility cycles of the soil~~s~~ with consequent changes in the relationships between the

[1] Dizionario “il Sabatini Colletti”
[2] Dizionario “il Sabatini Colletti”
[3] Slide

parts of the biosphere. The development born out of the Industrial Revolution ~~has~~ led to an increasingly disproportionate use of natural resources for the creation of numerous assets. Hence the anthropization of the environment that brought the birth of metropolises and industrial districts. On the one hand this process ~~has~~ clearly improved human well-being, both economically and culturally, and in terms of health too, but, on the other hand, it radically modified the biosphere creating numerous ecological crisis.

All the pollutants released into the environment over the last two centuries have involved serious environmental problems that have been highlighted only in recent years. Global risks are intensifying, in particular there is an increase of economic vulnerabilities, geopolitical tensions, societal and political strains, environmental fragilities and technological instabilities. The accelerating pace of biodiversity loss is a concern. Species abundance has been down by 60% since 1970[4]. In the human food chain, biodiversity loss is affecting health and socioeconomic development, with implications for well-being, productivity, and even regional security.

1.2 SUSTAINABLE DEVELOPMENT AND GREEN ECONOMY

Sustainable Development is an intergenerational phenomenon and a process developed on several levels, ranging from the global to the regional and local dimensions. Sustainable development has been the goal of the international community since the UN Conference on Environment and Development (UNCED) in 1992[5] when governments were asked to develop national strategies for sustainability, incorporating numerous policy measures determined in the Rio Declaration and Agenda 21. [6]

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[4] World Economic Forum. Marsh & McLennan Companies., & Insurance, Z. (2019). *Global Risks Report 2019*.

[5] https://sustainabledevelopment.un.org/topics/greeneconomy

[6] Kolbasov, O. S. (1992). UN Conference on Environment and Development. *Izvestiya -Akademiya Nauk, Seriya Geograficheskaya*, *6*(June), 47–54.

"Rio Declaration"[7] defined all new global objectives for the sustainable development through 27 principles aiming at establishing a new and equitable partnership through the creation of new levels of co-operation among States, key sectors of societies and people.

Agenda 21 is a vast program for the 21st century, approved by consensus among the word leaders in Rio, representing over 98% of the world's population. It embraces all the area of sustainable development and it reconciles requirements of a high-quality environment and a healthy economy for all the people in the world It also identifies the key areas of responsibility, offering preliminary cost estimates for success. Agenda 30 essentially resumes all the principles determined in Agenda21.

Despite the numerous efforts from multiples governments around the world to implement these strategies, there are a lot of concerns over global economic and environmental developments in many countries. These have been intensified by recent, prolonged, global, energy, food and financial crises, and underscored by continued warnings from global scientists that our society is in danger of transgressing several planetary boundaries or ecological limits. Despite the growing of interest in green economy, negotiations among Member States are still difficult. This is caused by the difficulty to find agreements among the universal principles of green economy, the lack of clarity around what green economy policy measures encompass and the way these States can integrate these policies with national priorities and objectives related to economic growth and poverty eradication.

In order to promote sustainable development, it is important to encourage the use of technologies in the public domain and transfer these technologies to developing countries.

Industrial countries should influence the flow of such technologies either directly~~,~~ or through demanding the private sector and public institutes that receive R&D funding

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[7] Chemiluer-Gendreau, M. (2011). Rio political declaration on social determinants of health. *Mundo Da Saude*, *35*(4), 467–472. https://doi.org/10.1787/9789264095281-12-en

from government to be more active in transferring technologies to developing countries. The products and technologies emerging from such publicly funded programs should be placed in the public domain. A network of technology experts in various areas should be made available either to advise developing countries, or to design a model R&D cooperation agreement, global demonstration programs, knowledge-sharing platforms, and a global database on freely available technologies and best practices in licensing.

1.2.1 SUSTAINABLE DEVELOPMENT AS A DECISION-MAKING STRATEGY

In response to a growing environmental crisis and to vast social inequalities in global development, modern society adopted sustainable development as a leading development model with clear "action-guiding power". A strategy is a way forward to make a desired future happen, in this case the achievement of sustainable development and its objectives. If we conceptualize sustainable development as a decision-making strategy it allows to actually "use" it, so moving beyond the rhetoric, and turning sustainability and its "action-guiding" power into an "action-generating" concept. Anyway, the link between sustainability and decision-making involves some challenges: [8]

- interpretation (sustainability should be interpreted considering its organizing principles, applied in a given socio-environmental context);
- information-structuring (the inherent multi-dimensional complexity of sustainability should be structured into operational information units (for example indicators) and properly communicated in order to feed the decision-making process);
- influence (sustainability information should exert a real influence on decision-making and on the actual implementation of sustainable development).

[8] *Wass_2014_SustainabilityAssessmentandIndicators-ToolsinaDecision-Making*. (n.d.).

Sustainable Assessment (SA) is a process by which the implications of an initiative on sustainability are evaluated, where the initiative can be proposed or existing policy, plan, program, project, piece of legislation or a current practice or activity. SA generates information for decision makers, ensuring that decisions are taken with the best available knowledge of its full sustainability impacts. This should lead to the right decisions. SA is also a learning process that can lead to a shift in the involved stakeholders'/decision-makers' sustainability knowledge and it can structure complex information that allows decision-makers to deal with the complexity of sustainable development.

Sustainable indicators (SI) are an essential and powerful tool in decision-making for sustainability identified in Agenda 21. These indicators are variables related to a reference value that gives meaning to the variables. *SI* have several complementary purposes in a decision-making strategy for sustainable development and in *SA*, support the three challenges mentioned before. *SI* communicate information to inform decision-making for sustainable development, they facilitate continuous learning among involved stakeholders and their development and application could be considered as a way of social learning and they can be used to demonstrate accountability to societies and its stakeholders by communicating about systems sustainability performance.

Sustainable Assessment and Sustainable Indicators are tools to support decision-making for sustainable development that can be used in different fields and in social-environmental contexts. These tools address all the 3 challenges mentioned. As such, these challenges are not only opportunities to understand the linkages between sustainability and decision-making, but also opportunities to improve *SA* and *SI* theories and practices.

1.3 DEFINITION AND HISTORY OF GREEN ECONOMY

There is no unique definition of green economy, but the terms themselves underscore the economic dimension of sustainability and they respond to the growing "recognition that achieving sustainability rests almost entirely on getting the economy right"[9]. The terms also emphasize the crucial point according to economic growth and

environmental management can be complementary strategies in which synergies prevails over tradeoffs.

The expression "Green Economy"[10] was first defined in a report for the Government of the United Kingdom in 1989 by a group of environmental economists, entitled "Blueprint for a Green Economy". The terms in the document means "an economy that generates growth, creates jobs and eradicates poverty by investing and safeguarding the resources of natural capital on which the survival of our planet depends".

OCSE uses the term "green growth" to indicate an economic growth that can reduce pollution, greenhouse gas emissions and waste, preserving the natural heritage and its resources. In 2008, the expression was considered in a context of multiple discussions on the policy response to multiple global crises. In the context of financial crisis and global recession, UNEP suggested the idea of "green stimulus packages" and identified specific areas where a large-scale public investment could start a "green economy"[11]. This inspired multiple governments to implement "green packages" in their economic recovery efforts. UNEP considers the green economy as an economy with low carbon dioxide emissions, efficient in the use of resources and socially inclusive, which produces human well-being and social equity, while reducing environmental risks. The meeting point of all these definitions is the criticism on the vision of traditional economy which doesn't consider all the damages linked to the environmental impacts caused by economic systems, considering especially the primary sector.

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[10] Allen, C., & Clouth, S. (2012). Green economy, Green growth, and Low-carbon development–history, definitions, and a guide to recent publications. *Division for Sustainable Development, Department of Economic and Social Affairs, United Nations, New York, August.*, (1), 1–63. Retrieved from https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=634&menu=1516

[11] Owen, A. D., & Hanley, N. (2004). The economics of climate change. *The Economics of Climate Change*, *98*(2), 1–297. https://doi.org/10.4324/9780203495780

"Green economy"[12] does not substitute "sustainable development", but the former is necessary to reach the latter in the long term. This kind of economy invests on the natural capital, considering biodiversity as a thing that contributes to the human well-being providing free services like the public goods.

While definitions are useful for the interpretation of the green economy concept, there has been an attempt to move beyond these simple definitions in order to define a set of guiding principles. All of them were published by a variety of organizations in the lead up to *Rio20*. An analysis of eight sets of principles was conducted by the United Nations Division for Sustainable Development that year (UNDESA, 2014). It found out a considerable diversity ~~of~~ among the principles proposed to enhance interpretation and application of the green economy. However, there is also considerable synergy amongst the different sets of principles. Here is the list of the most common green economy principles as identified in the review[13]:

1. The green economy is a means for achieving sustainable development.
2. The green economy should create decent work and green jobs.
3. The green economy is resource and energy efficient.
4. The green economy respects planetary boundaries or ecological limits or scarcity.
5. The green economy uses integrated decision making.
6. The green economy measures progress beyond GDP using appropriate indicators/metrics.
7. The green economy is equitable, fair and just – between and within countries and between generations.
8. The green economy protects biodiversity and ecosystems.
9. The green economy delivers poverty reduction, well-being, livelihoods, social protection and access to essential services.

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[12] Frey, M. (2013). La green economy come nuovo modello di sviluppo. *ImpresaProgetto - Electronic Journal of Management*, *3*, 1–18.

[13] *Module 1 Introduction to the Workshop*. (n.d.). 8–26.

10. The green economy improves governance and the rule of law. It is inclusive; democratic; participatory; accountable; transparent; and stable.
11. The green economy internalizes externalities.

1.4 CORPORATE SOCIAL RESPONSIBILITY AND THE GREEN PAPER

Before focusing on the actual data regarding the current situation, we should focus on corporate social responsibility, by briefly analyzing both the pyramid scheme created by Carrol and "The Green Paper" in order to identify the relationship between the company and the external environment that surrounds it. At the beginning of the 50s the firm was a strong entity with ~~a~~ strong responsibility towards the society. At the time the responsibility of a firm was strictly connected to the increase of its economic growth, differentiation of products, attention for employers and improvement of the social environment. This approach was criticized since those "improvements" were thought to be abstract only and they didn't mirror reality.

During the 70s an integration of policies was improved in order to protect both the social community and the environment. The key vision that drastically changed the vision of business objectives, came with the development of Carrol's theory in 1991[14].

Carrol defined four levels of responsibility: economic (profitability: the foundation upon which all others rest), legal (citizens have to abide by the law: Law is society's codification of right and wrong – "play by the rules of the game"), ethical (people must do what is right, just, and fair and avoid harm), philanthropic (the good corporate citizen must contribute resources to the community and improve life quality).[15]

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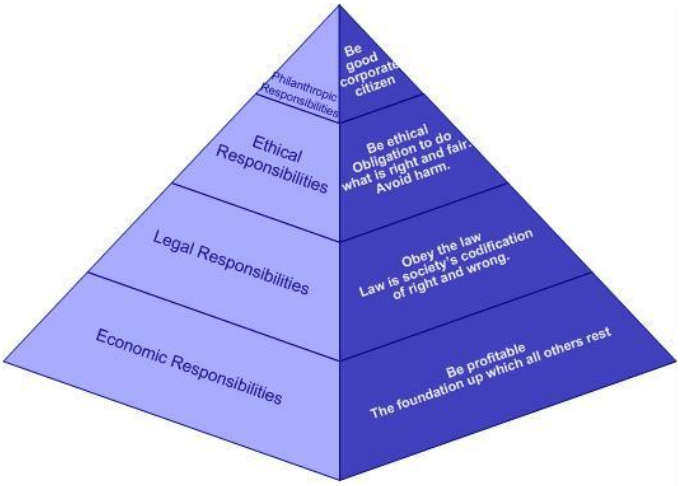
[14] Archie, C. B. (1991). The Pyramid of Corporate Social Responsibility: Toward the Moral Management of Organizational Stakeholders. *Business Horizons*, (August), 153–170.

[15] Carroll, A. B. (1991). The pyramid of corporate social responsibility: Toward the moral management of organizational stakeholders. *Business Horizons*, *34*(4), 39–48. https://doi.org/10.1016/0007-6813(91)90005-G

Figure 1: Carroll's CSR Pyramid



Carroll's CSR Pyramid

For *CSR* to be accepted by a conscientious business person, it should be framed in such a way that the entire range of business responsibilities are embraced. *CSR* consists of those four levels of responsibility. The next post-Carrol step was in 1992 when the ONU organized the Earth Summit took place in Rio. It was the first time that a deep analysis about the conditions of the planet had taken place and it defined a plan (*Agenda 21*) to deal with the main environmental problems. After this meeting many commercial agreements were born to protect human rights and respect the environment. This commitment is called *Corporate Social Responsibility*.

"The Green Paper"[16] realized by the European Commission held that: "affirming their social responsibility and assuming on their own initiative commitments that go beyond the regulatory and conventional requirements to which they must nonetheless comply". So, firms should strive to "raise the norms related to social development, environmental protection and respect for fundamental rights, by adopting an open government system, able to reconcile the interests of the various stakeholders in a global approach quality and sustainable development". So, the firm itself changes its vision trying to make it more ethical and therefore socially responsible. A firm is socially responsible if it invests in the recruitment, in the formation and management of human resources if the firm itself limits the impact of its activities on the environment, investing in technologies and eco-sustainable production processes and if it guarantees the

[16] *Green Paper. Commissione delle Comunità Europee. Bruxelles, 18.7.2001*. (n.d.).

integration and respect of social and environmental problems also in the choice of partners and suppliers and if it invests its resources for the improvement and safeguarding of the community in which it operates. So, we can observe that the *CSR* brings the attention from a governance oriented to the needs of the entrepreneur and shareholders, to a governance oriented to the environment and the sustainable development.

1.5 THE UN AND EUROPEAN UNION: POLICIES AND THE CURRENT SITUATION

The OECD[17], the organization for cooperation and economic development, defines and expresses its point of view regarding the green economy in an exhaustive way. The OECD was established with the Convention on the Organization for Economic Cooperation and Development, signed on December 14, 1960, and replaced the OECD, created in 1948 to manage the "Marshall Plan" for the post-war reconstruction of the European economy. Today, 34 countries are part of it, recognizing themselves in democracy and in the market economy. L'OECD[18] aims to promote policies for:

- Achieve higher levels of sustainable economic growth and employment in member countries, encouraging investment and competitiveness and maintaining financial stability
- Contribute to the development of non-member countries
- Contribute to the expansion of world trade on a non-discriminatory basis in line with international obligations

The concept of green growth, for the OECD, is the potential to face economic and environmental challenges and to open new paths of growth through productivity, innovation, the creation of new markets totally dedicated to the green economy and the more balanced macroeconomic stability which reduces the volatility of resource prices.

[17] https://italiarapparigi.esteri.it/rapp_ocse/it

[18] http://www.oecd.org/

In order to understand better the idea of green growth related to the OCSE we should focus on Rintaro Tamaki's theory. He was the deputy Secretary-General of the OECD[19] in charge of the strategic direction on Environment, Green Growth, Taxation, Investment, Financial and Enterprise Affairs & Anti-Corruption, Competition and Corporate Governance. It's significantly important his preface in the document called "Green Growth Indicators" (2017)[20]: "Green growth is about fostering growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. Governments that pursue policies designed to promote green growth need to catalyze investment and innovation that underpin growth and give rise to new economic opportunities. They also need indicators that can help raise awareness, measure progress and identify opportunities and risks."

This document is useful to analyze either the green growth itself or the emission of CO2: despite the fact that we can observe a slowdown in OECD countries, globally CO2 emissions grow up to 58% from 1990. Most of the countries reduced the level of emissions, but only the ones linked to GDP growth and the carbon productivity has improved in the last decade. According to the figure below [21], the Production-based productivity considers only the Co2 generated in the national territory without taking trade flows into account. Anyway, we all use products that are produced in other countries partially and this is why the second column is called "Demand-Based" that determines a value in $, generated per unit of Co2 which satisfies the domestic final demand, without considering if the part of the product was realized in a foreign country. So in the OECD countries, the total amount of emissions that satisfies the domestic final

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[19] Ocampo, J. A. (2013). The macro-and mesoeconomics of the green economy. *Getting Development Right: Structural Transformation, Inclusion, and Sustainability in the Post-Crisis Era*, 153–172. https://doi.org/10.1057/9781137333117_8

[20] http://www.oecd.org/greengrowth/green-growth-indicators/

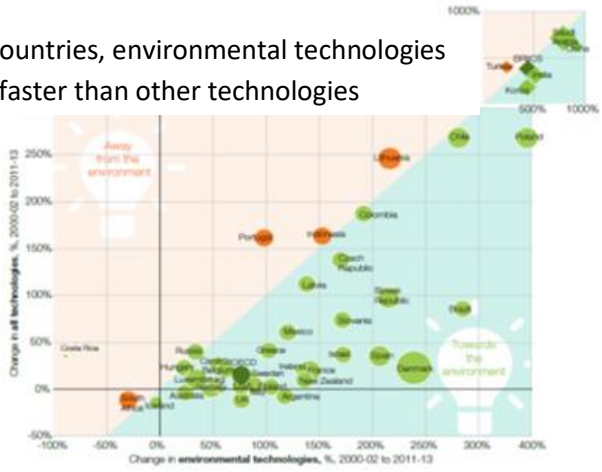
[21] http://www.oecd.org/greengrowth/green-growth-indicators/

demand has increased faster than the total from domestic production, so we can identify OECD countries as “net importers” of Co2.

Figure 2: GDP for each kg of CO2

What about the innovation front? Governments are spending more on R&D but the amount of money related to environment has not changed that much in last years. Governments should set long-term incentives to protect environment and to push innovation to achieve results determined by global policies[22]:

In Figure: In most countries, environmental technologies progressed faster than other technologies



[22] http://www.oecd.org/greengrowth/green-growth-indicators/

The previous figure the change in patent applications, for all technologies on the vertical axis, for environmental technologies on the horizontal axis. Green countries are those in which environmental technologies are the most important focus right now meanwhile the orange countries are those that progress of these technologies is still slow. The size of the bubble represents the share of environmental technologies among all innovations: Denmark is the leading innovator.

1.5.1 UNEP

UNEP was Established at the conclusion of the United Nations Conference on the Human Environment in Stockholm in 1972, the mission of UNEP is to coordinate and facilitate the creation of partnerships in the realization of projects for environmental protection. UNEP carries out its mission by encouraging, informing and enabling nations and their people to improve the quality of their lives without compromising that of future generations. UNEP is the first of the United Nations agencies whose headquarters has been established in a developing country. It has headquarters in Nairobi, Kenya and other administrative offices and representative offices in Bangkok, Bonn, Geneva, Manama (Bahrain), Mexico City, New York, Osaka, Paris, Montreal and Vienna. Starting in 1999, the Council meets every year as a global forum of environment ministers to discuss the most relevant environmental issues Vienna. During the UN Sustainable Development Conference held in June 2012 in Rio de Janeiro (Rio + 20) it was decided to strengthen UNEP by introducing universal membership and the development of environmental strategies in the system UN sector. From 2014, every two years a General Assembly is held called "United Nations Environment Assembly of UNEP". As the supreme organ of the UNEP, it adopts substantial political and administrative decisions, establishes the work program and the budget and monitors the activity of the secretariat. It also offers the international community the opportunity to take stock of the environmental situation, discuss international strategies for the protection and sustainable use of natural resources and establish environmental policy measures. Finally, the General Assembly allows ministers to make important strategic decisions globally. If we consider the field of transportation, UNEP pays attention to the fuel efficiency/fuel economy/fuel consumption which is a ratio calculated using the distance travelled by a vehicle per unit of fuel consumed (like km/l) or rate of carbon dioxide

(CO2). UNEP[23] is promoting the Global Fuel Initiatives aims to cut global average fuel consumption from the current global average of 8L/100 km to 4L/100 km which means going from 12,5km/l to 25km/l within 2050. In the European Union, a mandatory auto fuel economy standard was in place to reduce emissions to 130 g CO2/km by 2015 and 95g CO2/km by 2020. In US, the federal Environmental Protection Agency has proposed a standard of 250 grams per kilometre for light-duty cars and trucks and medium-duty passenger vehicles, beginning with new vehicle models for 2012, going down to 102g CO2/km in 2025.

There are several aspects that affect the amount of fuel used and the greenhouse gas emission of any given vehicle. These includes[24]:

- The efficiency of its engine, which varies with engine type (e.g. diesel vs. petrol, or spark-ignition vs. compression), the mass of the car and its load, and the engine speed (usually noted in RPM)
- The quality and type of the fuel used – for example high sulphur diesel lowers vehicle efficiency as it taxes emission controls
- Driver behaviour, which can be addressed through eco-driving
- Driving conditions (including idling and stop-and-go traffic) and road infrastructure
- Aerodynamic drag, which is related to the design of the vehicle
- Rolling friction or resistance, which is related to the tires used
- Braking frequency and technology, which can be addressed through regenerative braking technology now being used in hybrid vehicles;
- Transmission type – manual versus automatic
- Air conditioning
- Power steering
- Engine cooling

[23] https://www.unenvironment.org/

[24] Altenburg, T., & Assmann, C. (2014). Green industrial policy: concept, policies, country experiences. In *Oxford Review of Economic Policy* (Vol. 30). https://doi.org/10.1093/oxrep/gru025

- Electrical systems, including headlights, battery charging, active suspension, circulating fans, defrosters, media systems, speakers, and other electronics.

The green economy replaces fossil fuels with renewable energy and low carbon utilization. The current energy system is responsible for two thirds of greenhouse gas emissions and generates very high costs to be incurred in terms of adaptation. the best alternative is the use of energy from renewable sources which reduces the risks of rising prices and the volatility of fossil fuels, in addition to the benefits of climate change mitigation. The green economy determined by UNEP designs sustainable urban areas through low-carbon mobility (green cities). Urban areas now absorb 60-80% of energy consumption, with 75% of carbon emissions. In order to increase the energy efficiency, it's necessary to reduce emissions and, at the same time, promote access to basic services through innovative low-carbon transport modes. So, UNEP shows that the most efficient politics are the ones that promote economic and fiscal incentives, especially in the private sector.[25]

1.5.2 EMAS

The Community Eco-Management and Audit Scheme[26] (EMAS = Eco-Management and Audit Scheme) is a system to which companies and organizations, both public and private, that are based in or outside the European Community can voluntarily join who wish to engage in evaluating and improving their environmental efficiency. The first EMAS Regulation n. 1836 was issued in 1993 and in 2001 it was replaced by Regulation No. 761 which, in turn subjected to revision, was replaced in 2009 by the new Regulation n.1221. EMAS is mainly intended to improve the environment and to provide organizations, supervisory authorities and citizens (to the general public) with an instrument through which information on the environmental performance of organizations can be obtained. EMAS is especially linked with European company since the states in which is possible to be registered are Finland, Germany, Spain, Italy; Denmark, Austria, Belgium and Portugal (in fact only Volkswagen is registered in the EMAS.

[25] https://www.enea.it/it
[26] http://www.isprambiente.gov.it/it/certificazioni/emas

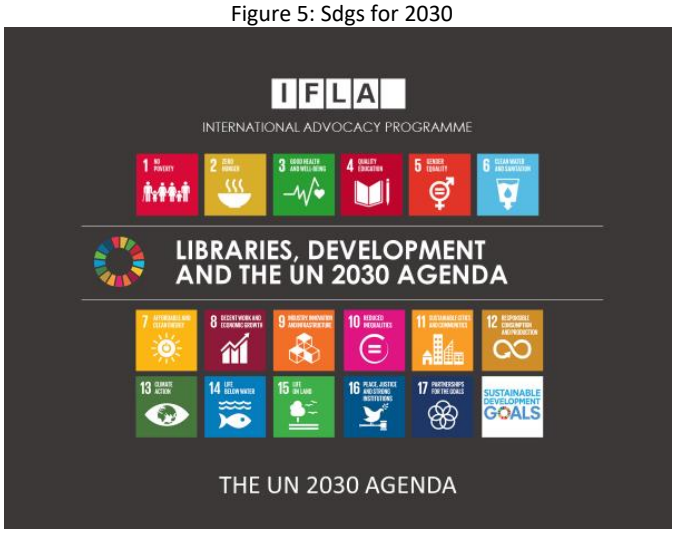
EMAS identifies some steps that are necessary to become an environmental leader and achieving continuous improvement as we can see in the following scheme:

Figure 4: how Emas works

The role of the European Commission is to facilitate the implementation of the EMAS and to promote this scheme at a European level. Every Member State has designated a Competent Body who is the first point of contact for any organisation interested in registering with EMAS. The Competent Body can provide organisation with useful information on the steps to implement EMAS and the administrative procedures and fees involved.

1.5.3. SUSTAINABLE DEVELOPMENT GOALS (SDGs)

Figure 5: Sdgs for 2030



The 2030 Agenda for Sustainable Development[27], adopted by all United Nations States in 2015, provides a shared project for the preservation of the planet. It's important to focus on the 13th principle: climate changed is caused by emissions of CO2 and other greenhouse gasses. Companies, especially those that operate in the car industry, can contribute to this SDG by decarbonizing their operations and supply chains through continuously improving energy efficiency, reducing the impact of emission of their products, services and processes and setting objectives to reduce those emissions in line with climate science and increase all investments in the development of innovative low-carbon products and services. So, we have 4 key business elements:

1. Energy efficiency
2. Environmental investments
3. GHG emissions
4. Risks and opportunities due to climate change

All these elements are considered by all the companies that we are going to analyse in the next chapters due to the necessity to develop new technologies to preserve the equilibrium of the planet.

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[27] Johnston, R. B. (2016). Arsenic and the 2030 Agenda for sustainable development. *Arsenic Research and Global Sustainability - Proceedings of the 6th International Congress on Arsenic in the Environment, AS 2016*, 12–14. https://doi.org/10.1201/b20466-7

1.5.4 PARIS AGREEMENT[28]

At the COP21 (Conference of the Paris) to the United Nations Framework Convention on Climate Change, 195 states and the European Union adopted the Paris Agreement, a treaty which represent an agreement between states governed by international law. This multilateral treaty, countries agree to act in their national context to hold the temperature "well below" 2°C while also pursuing effort to stay below 1.5°C. The agreement doesn't prescribe specific mitigation actions or which emission levels should be achieved by when. Instead, it focuses on individual climate mitigation plans and transparency. In 5 year cycles, all parties have to prepare "nationally determined contributions", report report on implementation, account for their contributions and regularly enhance the plans in the light of a global stock take. The approach taken by the Paris Agreement is an experiment that relies on the national determination of efforts combined with the persuasive impact of the transparency framework and the regular taking stock progress. It remains to be seen whether these elements and the cycles will trigger sufficiently ambitious contributions once details to these elements are agreed.[29]

1.6 THE CURRENT SITUATION

The annual carbon footprint of a carmaker is the sum of the lifecycle GHC emissions of the cars it sells in a given year. These emissions are made up of:

- GHG emissions caused through the production of the car
- Emissions caused through supplying this fuel
- Emissions caused through recycling at the end of its life

[28] Wewerinke-Singh, Margaretha; Doebbler, C. (2016). The Paris Agreement: Some Critical Reflections on Process and Substance. *University of New South Wales Law Journal*, *39*(4), 37–53. https://doi.org/10.1016/0008-6223(96)89488-7

[29] Bodle, R., Donat, L., & Duwe, M. (2016). The Paris Agreement: Analysis, Assessment and Outlook. *Climate and Carbon Law Review*, *10*(1), 5–22. https://doi.org/10.2307/43860128

The following shows an average amount of GHG emissions over the lifetime of a Volkswagen group car[30]:

Table 1: Car companies 2018 carbon footprints

TABLE 4: CAR COMPANIES 2018 CARBON FOOTPRINTS

CAR MANUFACTURER	EMISSIONS IN MILLION TONS OF CO_2E	VEHICLES SOLD	AVERAGE LIFETIME EMISSIONS PER VEHICLE IN TONS OF CO_2E	AVERAGE FLEET EMISSIONS CO2 IN G/KM
VW Group	582	10.8	53.8	192.7
Renault-Nissan Alliance	577	10.3	55.7	196.6
Toyota	562	10.4	53.8	180.8
General Motors	530	8.6	61.3	217.9
Hyundai-Kia	401	7.4	54.0	186.3
Ford Motor Corp	346	5.6	61.4	210.6
F.C.A	305	4.8	63.1	220.5
Honda	283	5.2	54.1	185.0
PSA Group (incl Opel)	201	4.1	49.2	176.3
Suzuki	164	3.3	49.6	168.8
Daimler AG	161	2.7	58.7	212.0
BMW AG	136	2.5	54.4	192.3
Top 12 car manufacturers	4246	76.0	55.9	195.0
Car industry	4807	86	Share of global GHG emissions	9%

TABLE 5: CAR COMPANIES 2017 CARBON FOOTPRINTS

CAR MANUFACTURER	EMISSIONS IN MILLION TONS OF CO_2E	VEHICLES SOLD	AVERAGE LIFETIME EMISSIONS PER VEHICLE IN TONS OF CO_2E	AVERAGE FLEET EMISSIONS CO2 IN G/KM
VW Group	575	10.6	54.3	191.6
Renault-Nissan Alliance	571	10.3	55.7	196.9
Toyota	569	10.3	55.2	185.9
General Motors (incl Opel)	540	9.0	60.0	203.8
Hyundai-Kia	399	7.3	54.6	188.6
Ford Motor Corp	385	6.3	61.3	211.4
F.C.A	308	4.8	63.7	223.1
Honda	289	5.3	54.8	187.4
PSA Group	210	4.2	49.5	176.5
Suzuki	159	3.2	50.0	170.5
Daimler AG	158	2.7	58.3	212.4
BMW AG	133	2.5	54.1	193.7
Top 12 car manufacturers	4296	76.5	56.2	195.1
Car industry	4857	86.4	Share of global GHG emissions	9.1%

In 2018 Volkswagen group was the biggest climate company in terms of emissions with a carbon footprint of 582m tons of CO2 resulting from the cars it produced in 2018 and the emissions caused by them over their lifetime. Toyota produced 562m tons of CO2, Ford produced 346m tons of CO2 and General Motors 530m tons of CO2. In practical terms the total amount of emissions of Volkswagen group is higher than the ones

[30] Stephan, B., Lee, I., & Kim, J. (2019). *Crashing the Climate - How the Car Industry Is Driving The Climate Crisis.*

produced by Australia (535m tons of CO2). What is surprising is that these numbers are higher than the previous year even if all these companies are now focus and involved in the production of many hybrid vehicles. We know also that the priority is to phase-out diesel and petrol gas and a greater uptake of greener modes of transportation. The real problem is that all these moves will not transform the industry within the required timescale considering that for the 2040 the temperature will be higher by 1.5 degrees and almost all the companies that belong to the car industry won't be ready for that expiration date. For example, Volkswagen announced that it will produce the last petrol gas model in 2026 and it will carbon neutral by 2039 which means that, by the 2050, there will still be petrol gas cars.

The problem related to carmakers is that the model offered on the market is not that high since in the last 5-6 years company have release almost 30 electric vehicles that represent less than the 8% of total models released in the car market globally (considering fuel and hybrid vehicles). But according to forecasts, the global electric car market is expected to have incredible growth in the new decade (2020-2030): almost 1/3 of the cars that will be sold will be electrics.[31] This is the prevision for this market, but past experience suggests is necessary a stronger regulation to achieve this result. It is also true that in order to have this improvement in this industry, it's necessary to build a consistent charging infrastructure to give customers the possibility to charge their cars wherever they need it[32]. According to data in the following picture, most of the companies have not set yet their long term strategies

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31

4https://www.transportenvironment.org/sites/te/files/2018_06_EV_announcements_r5eport.pdf

[32]6 Stephan, B., Lee, I., & Kim, J. (2019). *Crashing the Climate - How the Car Industry 7Is Driving The Climate Crisis*.

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Table 2: Top 12 car companies'ICE

2019 Sales Rank	Name	Public commitment to a global phase out of the ICE	Note
1	VW Group	Will stop selling fossil fuel cars by 2040.	Start of production of last ICE-platform in 2026.Carbon neutral by 2050, including vehicle and manufacturing supply chain
2	Toyota Grop	2050 Strategy based only on Electric cars	Diesel phase-out only in Europe by 2019. Plan to have zero CO2 emissions in vehicle lifecycle by 2050
3	Reanult-Nissan Alliance	/	Nissan: plans to stop diesel for passenger cars ateach model's renewal in Europe. Limit diesel salesto commercial vehicles in Japan and US74Renault: reduce by 50% its diesel offer by 2022.
4	General Motors	/	Committed to "all electric future" without a datefor ICE phase-out
5	Hyundai-Kia	/	/
6	Ford Group	/	/
7	Honda Motor	/	/

8	FCA	/	Diesel phase-out in its passenger cars sold only in the EMEA (Europe, Middle East, Africa) market by2021 (light commercials will remain diesel)
9	PSA Group	/	No new diesel engine to be developed.
10	Daimler AG	/	Carbon neutral by 2039, in vehicles and factories
11	BMW AG	/	/
12	Suzuki	/	/

In the next chapters the situation regarding the above-mentioned companies will be analyzed, in order to verify how these are modifying consumer choices and the benefits that hybrid models will bring to the environment in terms of emissions.

CHAPTER 2: THE GREEN ECONOMY IN THE CAR INDUSTRY

2.1 HISTORY OF HYBRID VEHICLES

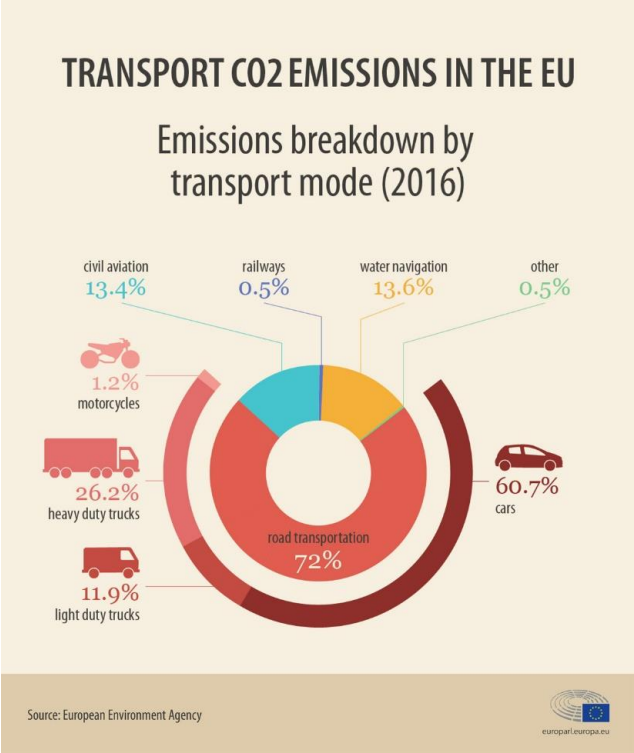
According to the following data, the most important source of carbon emissions is related to transports: 27% of the total Co2 emissions in Europe comes from vehicles. The category of transport is the only major sector in which emissions have grown since 1990, leading to an increase in the EU's emissions in 2017. Paris Agreement has the goal to limit the rise of temperatures to below 2°C: if the EU want to reach this objective, emissions must be reduced almost to 0°C in the transport industry. In order to do that, the European Commission has suggested a "net zero" 2050 scenario, estimating that all new car sales will have to be zero emissions by the mid-2030s. Clearly, it's necessary a completely change in car industry, moving from fuel engines to the electric and hybrid ones. Although it seems a recent invention, the first hybrid car dates back to more than a century ago: indeed, the first model, called Hybrid Lohner-Porsche Mixte, was produced by Porsche in 1899.[33] The peculiarities of this model concerned electric motors on wheel hubs and the combustion engine on board to recharge the batteries. The only possibility to recharge those batteries was using that engine, without using any electrical plugs with a related autonomy of 60 kilometres. But for these reasons and the fact that gasoline was a low-cost solution, this model (and hybrid models in general) were not successful. During World War II, electric vehicles were employed for the delivery in countries where there were fuel-leakages, like, in England, the Wilson Electric model LW milk delivery van. In 1942 Peugeot developed an electric microcar called VLV, powered by four 12V acid batteries and made of aluminium for a total weight of about 350kg. The batteries accounted for about half the total weight.[34] The vehicle maximum speed was 36 km/h while the range about 75 km. These two are the reasons why the company

[33] https://www.energysage.com/electric-vehicles/buyers-guide/top-hybrid-companies/

[34] https://www.automobilemag.com/news/hybrid-history/

produced only 377 units. The automotive market lost interest in hybrid models until the Clean Air Act in 1970 when four TRW engineers, working under the Department of Health, Education and Welfare (called EPA) invented a clever electromechanical transmission for hybrid vehicles. In 1976 General Electric was tapped to construct a parallel-hybrid sedan which was capable of doubling the efficiency of the engine. In 1995 Toyota produced the "Toyota Hybrid System" (THS) that was combined with an internal combustion engine.[35] This technology was used to create the first Toyota Prius in 1997 that was basically the first modern hybrid model. According to European Parliament cars are now responsible for the 60.7% emissions of Co2 (road transportation for 72% considering all types of transports in Europe. Even if these data are referred to the European continent, the same numbers can be observed all over the world. This is the main reason why numerous automotive companies are now focused on producing hybrid models.[36]

Figure 6: Transport co2 emissions in the EU



[35] ICE: engine in which combustion is intermittent, such as the more familiar four-stroke and two-stroke piston engines

[36] https://www.europarl.europa.eu/news/en/headlines/society/20190313STO31218/co2-emissions-from-cars-facts-and-figures-infographics

As we saw in the first chapter, these companies are considering 4 key business elements in the business of hybrid models:

- Energy efficiency
- Environmental investments
- GHG emissions
- Risks and opportunities due to climate change

According to these elements and forecasts, more than half of the new cars that will be sold in the future will be electric even if actually the technology is not that desirable: first of all electric cars will need to go farther on a single charge and they will need to charge faster than now (actually the average km on a charge is around 320, but in 10 years it will be almost 480). Another element is the average cost for a battery that now is around 160€ kilowatt/hour but it will drop around 80€ in by 2025 according to analysts at Bloomberg New Energy Finance. Also, electric cars are going farther thanks to numerous improvements in the energy efficiency of the cars themselves. The last element that we must take into consideration is psychological: when people are facing a decision to buy a hybrid or electric car they must answer different questions like "where am I going to fill the tank?". Gas stations are almost everywhere and to fill up a tank takes just a couple of minutes, while it's different for electric cars since charging the battery is not something that you usually do. Also, it's not that common finding places where people can recharge their tanks, and this is the reasons why many companies are now focused on building networks of fast chargers.[37]

As we can see there are some problems that have not been solved yet, but apart from these things the hybrid and electric market is strong, and all automotive companies are involved in it. Someone that wants to buy a new hybrid car has multiple choices (SUV, sedan and small cars) since there are so many models that fit with their preferences. As Thomas Ingenlath (CEO of Volvo's sport division) said "Innovating in the electric vehicle space will require shorter-term product planning and the ability to pivot when it comes to product design and manufacturing, despite the industrial complications of doing so.

[37] https://edition.cnn.com/2019/09/02/perspectives/electric-vehicle-design/index.html

China's auto companies have done a great job here — they work fast with short-term planning. Long-established car companies will need to learn to adapt and develop products faster than they currently are in order to keep up" and this is the goal of all automotive companies in the industry.[38]

Nowadays there is a large offer of electric and hybrid vehicles and the production is increasing more and more. As we have seen one of the main reasons is linked to the more stringent legislation to reduce pollutant and carbon-dioxide emissions established by the European Commission and all the Institutions around World. But what is a Hybrid Vehicle? We can define it as a vehicle that uses more distinct power sources to be moved, a primary source (fuel) and a second one (electric). The most popular one in the past was the (BEV), a battery electric vehicle which uses a storage system based on chemical energy stored in rechargeable battery packs. As a matter of fact, all hybrid vehicles are distinguished by their degree of electrification, according to batteries capacity circuit of voltage and electric power. We can basically distinguish between 6 different types:

- µHEV micro-hybrid electric vehicles
- MHEV mild-hybrid electric vehicles
- HEV (FCVs) hybrid electric vehicles
- PHEV plug-in electric vehicles
- REEV range extender electric vehicles
- BEV (EVs) battery electric vehicles

Due to their technologies, platform uses by MHEV and HEV can be exploited to develop pure internal combustion engine or electrified vehicles that have small batteries, thus having a very small impact on the platform.

PHEV started from a conventional platform designed for an internal combustion engine but was then modified in order to suit electrified vehicles. BEV uses this technology but it's less expensive and it can be modified easier than the PHEV technology.

[38] https://edition.cnn.com/2019/07/18/cars/electric-car-market-sales/index.html

2.2 TOYOTA

The company was founded in 1933 by Kiichiro Toyoda that was the first in Japan to produce cars. Toyoda travelled to Europe and the United States in 1929 to analyse the automobile production and he began researching gasoline-powered engines in 1930. In 1934 the company produced its first Type A Engine which was used in the first model car (Toyota Model AA). This model was exported in the United States in 1957, in Brazil in 1962 and in Thailand in 1964. Toyota's first U.S. car assembly plant, a joint venture with General Motors Corp, opens in California. Five years later the company launched the luxury Lexus brand in North America and in 1992 the company created the first Toyota European car plant in Great Britain - in 1999 the company produced the 1.000.000th vehicle. The real change in Toyota happened in 2004 when the company introduced Lexus, the first real alternative to traditional fuels in the premium segment which brought Toyota to be one of best car companies regarding electric and hybrid vehicles.

Toyota Motor Europe has become the first manufacturer to join the UN Environment Programmes Climate Neutral Network: this initiative aims to bring together public and private entities to reduce gas emissions. The UNEP Deputy Executive Director said about this decision that: "The participation of a major company like Toyota is a sign that private companies are increasingly playing their part on the road to a low carbon society." On May 20th Toyota and Tesla announced a partnership to develop electric vehicles, including investments for Toyota around 50 million in Tesla equity and 42 by Tesla in Toyota's equity to buy part of the NUMMI which was an automotive manufacturing company in Fremont which was jointly owned by Toyota and General Motors
The company counts more than 300.000 employees and at the end of 2018 it was the sixth largest company in the world by revenues.

2.2.1 TOYOTA's INITIATIVES FOR SUSTAINABLE GROWTH

Toyota is implementing a positive cycle of making even-better cars that can exceed customer expectations, with the goal to improve customers' lives and reinforce its stable base of business. Based on this, this company is building its strategy around concepts of

safety, peace of mind, environmental sustainability and Waku-Doki (a Japanese philosophy built around the feelings of excitement and exhilaration). In 2015 Toyota defined the Six Toyota Environmental Action Plan to meet Toyota Environmental Challenge in 2050 and to formulate it, some environmental activities were categorized according to 3 issues:

1) Contribution to a low-carbon society
2) Contribution to a recycling-based society
3) Environmental protection and contribution to a society in harmony with nature

Toyota is using its strengths to solve global social problems following United Nations Sustainable Development Goals (SDGs) determined in 2016, reducing the numbers of traffic accident injuries and deaths and, at the same time, promoting sustainable community building and improving mobility. The company considers the environment as a key management issue and it has declared that it is supporting reduction of greenhouse gas emissions, considering factors such as technology capability, infrastructure development, consumer preferences, fuel prices and many other variables. As for the European market, Toyota has decided for technology neutrality: the company believes that a setting of specific sales quotas for certain types of zero-emission vehicles is the best mechanism to achieve the desired Co2 reduction targets. The company thinks that a massive electrification of fleets using a variety of technologies adapted to a variety of consumer needs will be more successful.

As we know, the company's specific philosophy is contributing to society through production of cars and leading the market through innovation related to technology and creativity. Takeshi Uchiyamada, Chairman of the Board of Directors, declared:" I believe that the keys to success are to reverse ways of thinking, "to make the impossible possible" and "breakthrough technology." We will never change this basic stance, "Do what should be done instead of doing what is possible." This spirit of innovation challenge is the Toyota's DNA. We wish to continue to be a company that creates a desirable future with our stakeholders and brings smiles to our customers and society.

2.2.2 TOYOTA ENVIRONMENTAL CHALLENGE 2050[39]

Toyota is promoting a wide range of environmental initiatives to face environmental issues. Company is focus on reducing the environmental impact of cars close to zero emissions, producing new initiatives towards a sustainable society to make an impact on it. But what kind of issues is the company trying to face?

The impacts on the global environment are becoming more serious and social demands have also become stringent due to concerns related to the environment. Consequently Toyota is facing the following, fundamental, challenges:

- Extreme weather phenomena attributed to GHG emissions
- Aggravated air pollution in cities
- Resources depletion such as metals
- Degradation of biodiversity due to ecosystem changes and climate changes and climate change

In order to do that Toyota has realized a plan called “Six challenges for 2050” which describes its plan to face those issues, targets and actions to do that:

1) New Vehicle Zero Co2 emissions challenge: Toyota wants to reduce the global average new vehicle Co2 emissions by 90% from 2010 level
2) Life Cycle Zero Co2 emissions challenge: the company wants to eliminate all Co2 emissions, including materials, parts and manufacturing from the vehicle lifecycle through the development and adoption of low Co2 emission materials and reducing environmental impact adopting more recycled biomaterials
3) Plant Zero Co2 emissions challenge: the goal is to introduce and develop low Co2 technologies, to promote the use of renewable energy and hydrogen. This could be possible by reducing energy used by simplifying processes and innovative energy saving and by using wind power in Plants wherever possible like the Tahara Plants in the South of Japan.
4) Challenge of Minimizing and Optimizing water usage: Toyota wants to minimize water consumption based on individual local situations which means introducing

[39] Toyota Annual Report 2016-2017-2018

technologies that reduce industrial water consumption through rainwater use and improving water recycling rates.

5) Challenge of Establishing a recycling-based society and systems: to do it the company has to promote a global rollout of end-of-life vehicle treatment and recycling technologies developed in Japan. in order to that Toyota has to establish a recycling-based society, using eco-friendly materials, developing recycling technologies and manufacturing vehicles from end-of-life cars
6) Challenges of Establishing a future society in harmony with nature. The goal is to expand Toyota's long-standing nature conservation activities in the areas of forestry, environmental grants and environmental education.

The company has promoted a wide range of environmental initiatives to face those issues since they may involve some risks. So, Toyota has collected information and has analysed those challenges to grasp potential risks and business opportunities to formulate an Environmental Action Plan. When a company collects and analyse information, it will graps' the trends of macro economy and the key points to address global framework, policy trends, movements of emerging countries, major index of credit rating agencies and many other things.

2.2.3 THE ECO-CAR STRATEGY: ELECTRIFICATION

As seen, the company started in 2015 the Toyota Environmental Challenge 2050, working on 6 challenges with the goal to eliminate not only the emission of Co2 but making a positive impact on the planet and society. As regards the first challenge (New Vehicle Zero Co2 Emissions Challenge), the company started to develop and to promote the use of different eco-cars to achieve the "Paris Agreement[40]" whose goal is to keep the global warming below 2°C. Toyota thinks that is important to give the next generation the same mobility we have today, at the same time addressing climate change and the uncertain future petroleum resources. This is also one of the reasons why the company is focusing to develop an eco-car that can save energy and can use different kind of fuels. But what kind of fuels?

[40] This agreement sets a long-term goal of limiting global warming to be below 2 Celsius degrees compared with pre-industrial levels and calls for net zero greenhouse gas emissions to be reached during the second half of the 21st century

Toyota is developing electric and hydrogen power, which it views as especially promising approaches to fuel diversification. Currently electric cars are facing problems with the battery limitations even if these problems will be probably partially solved in 10 or 20 years and the company at the beginning of 2016 set up an EV (electric vehicles) Business Planning Department as an internet start-up with the goal of creating and realizing products based on the market characteristics of individual countries and regions. This new department is collecting different technological know-how and resources from Toyota Group to find new solutions. Toyota is also developing an efficient FCVs (fuel cell vehicles) car that uses fuel cell instead of battery to power its on-board electric motor. These fuel cells generate electricity to power the motor, using oxygen from the air and compressed hydrogen[41]. These models offer The same convenience as the one of conventional gasoline vehicles in terms of cruising range and refuelling time. Also, hydrogen can be produced from a variety of materials and used for multiple applications.

Since it is not possible to improve these technologies without improving infrastructures, the company is working with multiple stakeholders, including policy makers, infrastructure and energy-related industry bodies, international organizations, and citizen groups to reach the gaol to build a low-carbon society. In Japan Toyota has begun studies with Seven-Eleven Japan Co. on reducing Co2 emissions and energy use related to distribution and store operations, meanwhile in the United States the company has begun pilot tests using commercial heavy-duty trucks equipped with fuel cell systems in California. Cooperating with Shell Oil Company.

In order to expand zero-emission vehicles, it is necessary to change some elements in productions structures and therefore the company has internally developed fuel cell stacks and high-pressure hydrogen tanks that form the heart of the FCV and has achieved world class performance in both. Toyota is acquiring technologies through in-house development while advancing business innovation to prepare for the anticipated pressure on production site management resources arising from electrification.

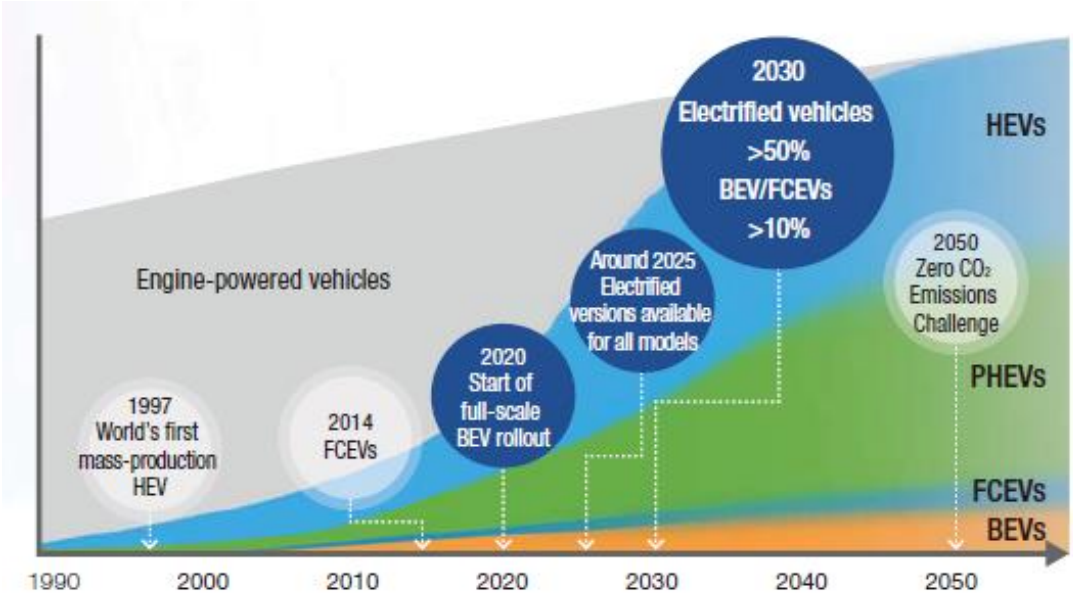
In 2017 the company announced its plan to sell more than 5.5 million electrified vehicles per year by 2030 since Toyota believes that eco-friendly vehicles can help to protect the

[41] https://en.wikipedia.org/wiki/Fuel_cell_vehicle

environment. In order to meet customer expectations and needs, the company is producing a different line-up of electrified vehicles, through the introduction of new technologies and developing infrastructures necessary to achieve those challenges mentioned before. In Toyota's opinion electrification will be indispensable to reduce vehicles' Co2 emissions, which is why the company is pushing so hard to popularize electrified vehicles. It is particularly aiming for at least 50% of all vehicles it will sell globally in 2030 to be electrified, and, of those, for more than 10% to be batter electric vehicles (EVs) or fuel cell electric vehicles (FCVs).

In the following chart there is a representation of the vehicle electrification milestones mentioned before:

Figure 7: Electrification milestones



Almost 20 years ago Toyota launched Prius, which was the first mass produced hybrid vehicle. Since then, the company has tried to improve electrification technology, creating different engines like FCV and PHV. Toyota will provide a wide range of options in its development and will offer different models, with different characteristics based on national and region conditions, customer preferences and other factors. As mentioned before, another goal is to achieve the zero-emission from new vehicles and for that Toyota will diversify its powertrains and strive to make each type best-in-class.

In the last 10 years the company has launched multiple partnerships with different companies, but without creating any strong "relationship" that can last for many years since the development of technology is really quick and things change even faster.

In 2011 Toyota and Ford decided to team up to develop a new hybrid powertrain for SUVs, allowing drivers who want the capabilities to get gas mileage of a smaller car. This thing offered fuel efficiency and at the same time a great efficiency like the ones offered by the regular gas-powered truck. This partnership was made to overcome the increasingly stringent regulation about gas emissions.[42]

In 2017, Toyota formed a joint venture with Mazda, along with Japanese parts supplier Denso, to develop components and a specific platform for electric cars. This partnership is about realizing new hybrid vehicles for Mazda within 2020. The new platform will support new mid-size electric SUV models from both automakers. The platform should be flexible enough to build future models including mid-size SUVs and sedans, but since things change fast and the automotive industry is in a period of profound transformation, companies do not exactly know if this will be possible. Also, regulations change fast since all the limits determined in the Paris Agreement seems like they will not be respected due to the increase in the pollution rate.

In 2019, Toyota teamed up with Suzuki for a new hybrid vehicle in UK. The engine is basically like the one used by Toyota's Corolla and Rav4 models. Based on this partnership Suzuki will be able to use the technology used by Toyota while the Japanese car manufacturer will be able to have a faster growth in Indian market where Suzuki has already a strong position. This will give Toyota the opportunity to expand its market share since India is the world's fifth-largest passenger car market, but it has struggled to increase sales due to poor demand for its lower-cost models. The companies have been pooling their strengths. Toyota is the leader in the hybrid technology and is investing in automated driving while Suzuki specialises in affordable compact cars.[43]

In the same year Toyota and Subaru announced that they would expand their partnership into connected-car programs and a co-developed electric vehicle platform. The partnership was about to build the second-generation sports coupe currently sold

[42] https://www.forbes.com/sites/altheachang/2011/08/31/ford-toyota-hybrid-partnership/#588e37eb4fed

[43] https://www.theguardian.com/business/2019/mar/20/toyota-team-up-with-suzuki-to-build-hybrid-cars-in-uk

as the Toyota 86 and Subaru BRZ. Both companies believe in the CASE (connected, autonomous/automated, shared and electric) demands as the core need for cooperation and cost-sharing. The partnership is not only about these models, but it has also been realized to develop three programs called out for future development: a new jointly engineered battery electric vehicle platform, a co-development of a new all-wheel drive models and an implementation of Toyota's hybrid powertrains in Subaru nameplates

2.3 FORD MOTOR COMPANY

Ford Motor Company is the most important car manufacturer in the United States. The company was founded by Henry Ford in Michigan in 1903 and it is known for having used the assembly line, later adopted by numerous companies in different industries. This phenomenon was named Fordism. The company's first international sales branch opened in Paris in 1909 and in 1913 they introduced the integrated moving assembly line to auto production. For the entire century the company grew up to become one of the most important automotive company. In the 2013 the company introduced the Ford Fusion Energi, a plug-in hybrid model that reached the record sales in the same year in August. In just 6 months the Fusion Hybrid sales increased by 164,3% and it ended the year as the fourth top selling hybrid in the U.S. after 3 models released by Toyota. After a couple of years (2014-2015) in which the company observed a decreasing sales trend due to a decrease in sales in US hybrid market, Ford reached its best result in terms of sales that amounted to 60.000 vehicles.[44] The company is facing the climate crisis: Ford has reached an agreement with California on higher gas-mileage standards to reduce emissions. The company doesn't support a rollback of federal emissions standards and it supports Co2 reductions consistent with the Paris climate accord.[45]

Like Toyota, Ford is also paying attention to the hybrid market and it has planned a long-term strategy around the concept of sustainability, recognising shifts in lifestyles,

[44] https://www.greenstyle.it/green-economy-ford-pubblica-rapporto-2017-sulla-sostenibilita-231859.htm

[45] https://www.theguardian.com/environment/2019/oct/10/climate-crisis-what-carmakers-say

aspiration and consumer trends. Also, this strategy is built around multiple realities like the rapid growth of the cities, air quality concerns and climate change. For the following years the company will improve fuel economy across global products, through specific Co2 reductions in specific regions, offering competitive fuel economy for new vehicles and pursuing electrification strategy. Before analysing the strategies adopted by Ford it is important to consider some factors that are affecting company:

- Government policies: a lot of governments have introduced climate change regulations and fuel economy standards, and, at the same time, they are encouraging innovation in electric vehicles and many other alternatives like hydrogen engine.
- Physical risks: weather can affect automakers' energy supply and production.
- Market trends: even if costumers demand for specific engine tends to reflect fuel price movements, Ford continues to pursue its vision of affordable fuel economy in a low carbon future and zero emissions.
- Investors' concern over climate change.

Ford is a top leader in the US for electric cars, since the amount of GHG emissions is going down so quickly. The company is using a life-cycle assessment to understand and reduce impact of its vehicles, developing technologies to improve fuel economy and exploring multiple alternative fuel and powertrain options. By 2020-2025 Ford will launch more than 13 new electric vehicles and it will cut more than 20 million pounds of Co2 following its science-based global strategy built around the idea to develop an intelligent energy management technology (e.g. waste heat recovery.

Ford has developed a Life Cycle Approach (LCA) which is an analytical tool that helps the company to identify and measure the potential environmental impacts of products and services. It is especially used to quantify the amount of GHG emissions of vehicles, and to help company to assess the environmental and cost impact of different materials

2.3.1 ELECTRIFICATION PLAN BY THE END OF 2025

Leading the US market in electrification is a critical point in Ford's strategy. At the end of 2016 the company was the top seller of plug-in hybrid vehicles and second largest

seller of electric vehicles in US (more than 560.000 vehicles). It invested more than 4.5$ billion in electrification to support those 13 vehicles that it will produce by the end of 2021 and more than $11 billion will be invested by the end of 2025. Ford is also testing hybrid taxis and vans in numerous US cities and is expanding battery development program in Europe and Asia. We can distinguish between three types of electric vehicles:

1) Hybrid Electric Vehicles (HEVs): they are powered by an internal combustion engine (ICE) and an electric motor with a battery system. They have a specific regenerative system that can capture energy to increase consumptions and efficiency. They have a regenerative braking system that captures energy, otherwise lost to braking, to recharge the battery.
2) Plug-in Hybrid Electric Vehicles (PHEVs): they have ICE and a high voltage battery that can be charged at home or in a public electric outlet. When the battery is low, it works like the HEV models
3) Battery Electric Vehicles (BEVs): they use a high voltage electric motor empowered by a battery pack. The advantage of this technology is the lack of tailpipe Co2 and other emissions during use.

The company is also developing Hydrogen Fuel Cell Vehicles (FCVs) that are zero-emission electric-drive cars. The fuel cell system converts stored hydrogen to electricity, leaving only water and low-temperature heat as by-products. Even if the company is reducing tailpipe emissions, there are other emissions that are assuming a greater importance: Ford has prohibited GHGs such as perfluorocarbons and sulfurhexafluoride and it has replaced chlorofluorocarbon refrigerants with hydrofluorocarbons which does not contribute to ozone depletion and it has lower global warming impacts.

In 2022 the company will invest more than $11 billions to produce more than 40 hybrid and fully electric vehicles. By doing this, Ford is planning to increase its offers around the world, focusing on the Chinese and European markets. The company wants to build a profitable electric vehicle portfolio by leveraging brand. At the beginning of 2019 they announced the creation of “team Edison” which is a dedicated global electric vehicle organization that focuses on the design and implementation of a customer approach, including those electric vehicles and services. The most important service is related to charging since it is a key customer experience, creating new possibilities for customers

to charge their cars at home and new possibilities on the road. In Europe the company is already part of the IONITY which is a joint venture for high-powered public charging meanwhile in the U.S. this kind of service is still under development since fuel vehicles are still preferred. Ford is implementing internal controls including centralized tracking of emissions data globally, collecting data and realizing report related to GHG emissions: all this information is collected in the Ford Global Emissions Manager database realized for this plan. Other information is related to reduction of waste of water and increased recycling. This plan does not involve only hybrid models, but it's focused around sustainability: renewability and recycling are key words here. The company has over 300 parts from renewable materials such as soy, wheat, rice, castor, tree cellulose, jute and coconut. All these things are from non-food, which are sometimes burned in the field, has also provided farmers with a new source of revenue: Ford achieved a 228-million-pound reduction in Co2 by using less energy, producing less waste and moving away from fuels.

An important part of the plan for 2025 is to create some partnerships with companies to improve sustainability: at the end of 2019 the company subscribed a partnership with McDonald's to offer a new life to a residue from the coffee roasting process that would otherwise be destined to end up as waste material. Companies have discovered that the material that covers the coffee beans can be used as a material to reinforce some vehicle's parts, like the headlight housings and other internal components, which are, among other things, about 20% lighter and with a saving of up to 25% of energy during the manufacturing process. In addition, according to Ford technicians, the thermal properties of the component obtained from the casing are significantly better than the material currently used. Through this initiative, Ford continues to pursue the objective of using recycled and renewable plastics on board its vehicles globally, thanks to the adoption of an ever-increasing quantity of sustainable materials. From its side McDonald's plans to use 100% of materials from renewable sources, recycled or certified

to produce its packaging by 2025 and, through the NextGen Cup Consortium and Challenge, is supporting the development of a recyclable and compostable cup.[46]

Another important partnership is the one with Pirelli: this company was recognised as the best supplier, receiving the Sustainability World Excellence Award by Ford. The partnership is about the sustainable supply of natural rubber, reduction of coal and innovation of materials

In 2018 Ford Motor Company, BMW, Daimler Group and Volkswagen Group, with Audi and Porsche, have created IONITY, a joint venture created for the implementation of a network of high-power charging points for cars with power supply, in order to ensure coverage of large distances on European roads. Through IONITY, the creation of over 400 rapid charging stations is expected and distributed throughout Europe by 2020. The ultra-fast, high-power charging network will reach 350 kW, therefore much faster than the charging technologies available at moment. The installation of the first 20 stations began in 2017, with a first station built in Germany, which was active in 2018. This is an important step towards the diffusion on the European electric car market, an approach that will help to tackle climate change.

The end of 2019 signed a specific agreement with Volkswagen to share investments to reduce costs and accelerate the development of new technologies. Thus, Ford will be able to access the Wolfsburg group's technologies to produce new "high volume" hybrid cars: 600 thousand units in 6 years. Company will have the access to MEB, which is a modular electrification platform whose goal is to consolidate electronic controls and reduce the number of microprocessors, advance the application of new driver assistance technology and somehow alter the way cars are built by the companies that use it. At the end of 2019 the company decided to support the New Deal for Europe to promote more cooperation and innovation for a sustainable future. This programme is promoted by United Nation and it basically identical to the Paris Agreement.

46 https://www.repubblica.it/motori/sezioni/attualita/2019/12/06/news/ford_e_mcdonald_s_una_partnership_all_insegna_della_sostenibilita_-242709145/?refresh_ce

Through all these initiatives the company has already reached great results: in the decade between 2010 and 2019 they reduced the total amount of emissions about over 3,4 tons which is the equivalent amount of emission made by 728.000 vehicles in a year. So basically, like Toyota, Ford is moving its business from the fuel market to the electric and hybrid ones, improving his technologies and creating new ones to improve performances of these vehicles.

2.4 VOLKSWAGEN

The Volkswagen Group, also called Volkswagen AG, is the major German automobile producer and was founded in 1937 with the goal of producing a mass low-priced car. Originally, the company was directed by the German Labour Front whose chief engineer was Ferdinand Porsche who was also responsible for the design of the mass production, but the outbreak of World War II the factory was re-purposed to produce military equipment and vehicles. When the war ended, the control of the company was transferred to the West German government in 1949. During 1970s Volkswagen began phasing out its rear-engine cars, replacing them with front-engine front-wheel-drive designs: the company created Golf and Beetle that were both a success and determined the overall success of the company. In 2011 the company unveiled the its first hybrid model: Tuareg Hybrid. Between 2012 and 2013 they realized the hybrid version of Golf and Passat. In 2015 Volkswagen became the world's largest car manufacturer by volume. This year is also known as the year of the Diesel gate: in that year Volkswagen became the world's largest car manufacturer by volume, but this leadership didn't last that much. The U.S. Environmental Protection Agency (EPA) determined that the manufacture's diesel-powered cars contained software[47] that altered the vehicle's emissions to pass tests. Company admitted installing those "defeat devices" violating the Clean Air Act, to avoid environmental regulations of NOx and it recalled more than 11 million automobiles. In Europe irregularities were found in more than 800.00 cars after the carbon dioxide emissions tests. The company was fined for $4 billion in the U.S. market.[48]

[47] https://www.greencarcongress.com/2015/09/20150918-epaarb.html
[48] https://en.wikipedia.org/wiki/Volkswagen#Hybrid_vehicles

Environmental Research Letters is a quarterly peer-reviewed open-access scientific journal covering research on all aspects of environmental science and it published a study about Diesel gate.[49] It found out that almost 59 premature deaths will be caused by the excess pollution produced by these "defeat devices" in United States. Thanks to this scandal, there are signs that diesel penetration in Europe is now going down, partly as a result of the Diesel gate scandal[50] and it looks like it may also have the effect of expediting the transition to electric and hybrid vehicles. Many economic studies like Bloomberg (2016) and the Fitch report[51], predict a strong growth in the electrification of the car industry in the next 20 years that will inevitably reduce all types of direct traffic emissions.

On December 12, 2015, the Paris Climate Agreement was approved, and 196 countries undertook to keep global warming to below two degrees. Volkswagen group shares this vision since climate and environment protection have become guiding principles for all the car manufacturers. This has brought the company to face challenges: Volkswagen has not yet overcome the diesel crisis for which it's responsible and all the consequences will continue in the following years. For this reason, the company has already improved his internal processes and control mechanisms, reviewing his Code of Conduct. Like Ford and Toyota, Volkswagen has determined a 2025 Strategy: this plan is built around innovative strength, technical expertise, enormous commitment for its employees. On the other hand the company has set new priorities based on electrification strategy since by the end of 2025 it will have made more than 80 new electric models available for customers, reducing negative environmental impacts in production plants by 20%, which means 45% less energy, Co2 water, solvents and waste per vehicle compared to 2010 stats, and, by the end of 2030, the company will have electrified the entire model portfolio.

[49] https://www.bbc.com/news/business-34324772

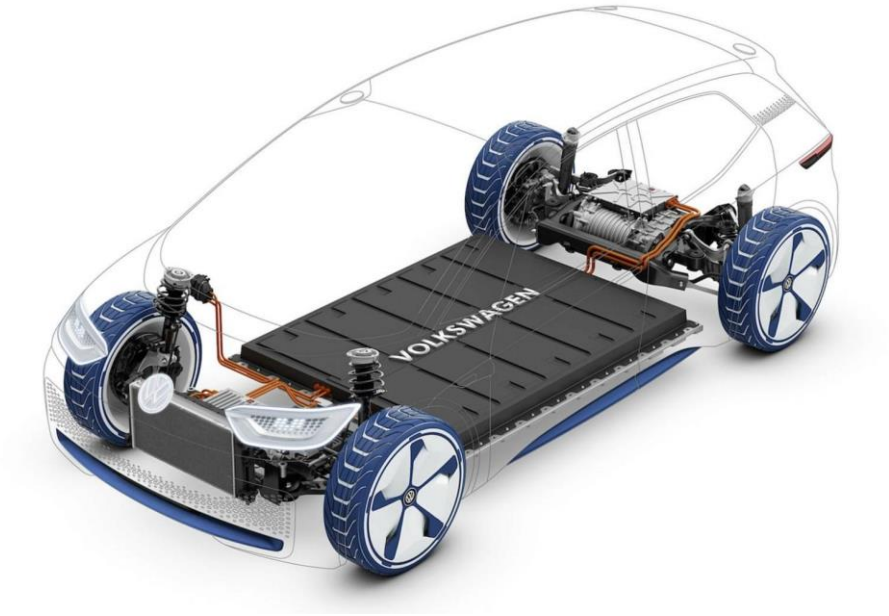
[50] https://iopscience.iop.org/article/10.1088/1748-9326/aa8850

[51] https://www.fitchratings.com/site/pr/1013282

One of the most important elements is the MEB (Modular Electric Drive Matrix) that was implemented at the beginning of 2019 and will be fundamental for the 2025 Strategy: this invention is a platform for electric cars developed by Volkswagen Group and its subsidiaries. The architecture is aimed to consolidate electronic controls and reduce the number of microprocessors, advance the application of a new driver-assistance technology and somewhat alter the way cars are built by the VW Group. The first MEB-based volume model will be introduced by the Volkswagen brand: the exterior dimensions of the new I.D. are based on the best-selling Golf compact. But with the help of the new MEB architecture and new components, the vehicle will have a different interior concept that you would expect to find in different models. The key element in this module is the new chassis used in the new structure. To create it, engineers were able to toss out the combustion engine and transmission. They then placed the electric motor in the rear of the vehicle and moved the front seats forward, a decision that created more room for passengers and their luggage. Drivers have a better overview of the road as well because developers raised the floor space to make room for the battery package. A positive effect of this adjustment: The raised sitting position gives the driver a better all-round view of traffic. Another benefit is created by the mid-vehicle positioning of the energy storage unit between the axles. This decision optimally distributes the vehicle's weight on the front and back axles – and creates positive road handling in the process.[52] The company has developed lithium-ion cells that are integrated in the battery system to give longevity to the engine. The development of the battery management system is being done solely by the company itself. The battery is based on a scalable module that can take on a different number of cells depending on the power level desired. The base version will have a 45 kW hours capacity and it will have a WLTP-range of up to 330 kilometers. If a customer needs a higher range, ha can order one that extends up to 550 kilometers that has an increased energy density so it can deliver more power thanks to its reduced weight. Regarding the supply chain it is characterized by a 100% of green power for cell manufacturing in the most important plant in Zwickau.The following picture represent the MEB and its structure:

[52] https://www.volkswagenag.com/en/group/fleet-customer/e-mobility/MEB.html#

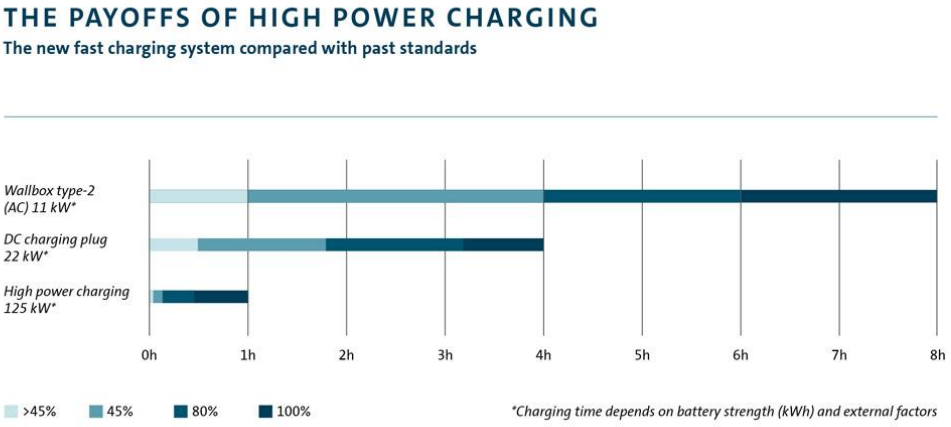
Figure 8: MEB toolkit



One of the most important challenges that the company will face in the 2025 Strategy is the charging infrastructure[53]: the network of electric filling station is expanding in Germany since it has more than 16.000 public (and semi-public) charging points at the beginning of last year and every ten points there is a fast charging station. The company is implementing infrastructure around the world but it is not that easy since it must face different legislations around the different countries where Volkswagen operates. An important operator in terms of charging is IONITY[54], which is an initiative which includes not only Volkswagen but also FORD, BMW and Daimler. The goal is to build stations throughout the European freeway network, in filling and rest areas. The maximum distance between recharging points should not be higher than 120 km and the time spent to recharge vehicles should not be higher than 30 minutes to charge their vehicles to reach at least 80% of the total capacity. The following picture represent how the new MEB platform and new batteries have improved the efficiency of hybrid and electric vehicles.

[53] https://www.volkswagenag.com/en/group/fleet-customer/facts_and_figures/MEB.html
[54] https://www.volkswagenag.com/en/group/fleet-customer/e-mobility/MEB.html

Table 3: Payoffs of high-power charging



As mentioned before, IONITY has developed an ultra-quick charging technology but it's only available for the sport cars produced by subsidiaries like Porsche, but part of the 2025 Strategy is to allow all vehicles to use this technology. IONITY has already developed multiple stations that offers a potential charge of 350 kW, but it has already developed a prototype of a charging station with a charging capacity of up to 450 kW. IONITY is pretty popular in Europe since the Combined Charging System (CCS) is the most adopted EV charging standard in Europe and is compatible with IONITY network.

2.4.1 STRATEGY 2025

This strategy was launched by Volkswagen in 2016, which is considered as the largest change process in the history of the company. This strategy has 4 building blocks:

1) Transformation of core automotive business
2) Establishing a new mobility solution
3) Boosting the Group's traditional innovative strengths

4) Becoming one of the world's leading providers of sustainable mobility calls for substantial capital expenditure[55]

Figure 9: 2025 Strategy

This strategy is built around sustainability and mobility since the goal is to operate responsibly along the entire value chain, realizing the Model of Sustainable Development that provides a benchmark for sustainable corporate policy with three key elements:

- Balance between economic, environmental and social systems and efforts to achieve long-term equilibrium between different interests
- Responsibility for actions at multiple levels (regional, national and global levels)
- Transparent communications and fair cooperation

As written before, the company has welcomed the ratification of the Paris Agreement whose goal is to limit global warming to less than 2 degrees above pre industrial levels. To do that, the company is combining measures like improvement in energy efficiency, used of gas instead of coal for power generation and procurement of electricity from

[55] https://www.volkswagenag.com/presence/nachhaltigkeit/documents/sustainability-report/2017/Nonfinancial_Report_2017_e.pdf

renewable sources (the 2017 level of electric energy form renewable resources is around 37%). The company has been optimizing its carbon footprint, reducing energy consumption per vehicle by -26,1% since 2010: direct and indirect Co2 emissions have fallen thanks to improved energy efficiency and reduced-carbon energy supply, also thanks to the fact that Volkswagen is building power stations and boiler plants which can generate heat and electricity. As for production, the company has included in the Strategy 2025 the Ecologically Exemplary Production which is necessary to achieve four key objectives by that year:

- Setting and achieving ambitious environmental targets for production
- Developing a long-term vision for environmental targets in production
- Improving employees' environmental awareness and incorporating relevant environmental aspects
- Achieving top positions in prestigious environmental rankings

By setting these objectives, the company has set goals to reduce the five key environmental indicators per vehicle (energy and water consumption, waste for disposal, Co2 and Voc emissions) by 45% within 2025 compared to stats analysed in 2010. To produce those 80 models within 2025 Volkswagen has to consider both renewable and non-renewable resources: the goal is to conserve resources over the entire life cycle of vehicles, reducing the environmental impacts of the materials using, prioritizing renewable and secondary raw materials. The real challenge is to reduce the consumption to reduce the energy necessary to realize these models, improving environmental impact.

As part of the 2025 Strategy, Volkswagen is developing technologies around efficiency and eco-friendliness of drivetrains and fuels with each new model generation. This is applied to internal combustion engines, hybrid and plug-in hybrid drivetrains and purely drivetrains and fuel cell systems. The modular toolkits allow company to use different drivetrains in combination and to install them flexibly on the production lines at their sites around the world. The Modular Electric Drive Toolkit (MEB) is the technological backbone of electric vehicles and is a unique selling point for the Volkswagen Group. It allows e-drivetrain components, auxiliary systems and interior features to be linked together intelligently. It will make the manufacture of e-cars more efficient and less

expensive in the long term. This will allow Volkswagen to focus production on e-mobility and to respond to the growing demand for electric vehicles.

The first model based on the new MEB is the Volkswagen I.D., which will be available this year. It will offer a range of up to 440 km for the price of a Golf diesel. E-cars will thus become affordable for millions of people. They will launch the I.D. as a 100 percent emission-neutral electric car – over the entire production process including battery cell manufacture.

Regarding the 2025 Strategy, the company is launching the Roadmap E, the biggest electrification offensive in the automotive industry. By the end of that year the company will have realized 80 new models (50 all electric vehicles and 30 plug-in hybrids) and according to the company's forecasts, one in four new vehicles from the group will feature a purely electric drivetrain. Depending on how market develops, it could be almost 3 million vehicles and to reach this result the company will invest €30 billion over the next 5 years. All the efforts the company is doing will change the face of its factories: Zwickau, Emden and Hanover will be turned into pure-play electric car plants. They will form Europe's largest e-production network. This transformation is also happening in China, in the Volkswagen's plant in Anting and Foshan meanwhile in US this will happen only in 2022, which means that by the end of 2025 the company will probably have changed its face.

As mentioned before, Volkswagen has reached an agreement with Ford and Argo for a partnership for automated and electric driving: Volkswagen has agreed to invest $2.6 billions into Argo at a valuation of $7 billions. This investment will be composed by $1 billion in cash and contributing its Munich-based Autonomous Intelligent Driving group (AID) which has almost 200 engineers and is being evaluated at $1.6 billion and it will merge with Argo. Ford will have a seat on the board of Argo. The deal among these 3 companies will be important for all of them since it will provide the possibilities to spread costs of these technologies over a larger number of vehicles. Both electrification and automation are likely to grow a significantly slower pace that was anticipated a few years ago. By combining development efforts on technologies that are less likely to be product differentiators the potential cost savings are enormous.

Figure 10 Collaboration with ARGO AI

With this partnership Volkswagen and Ford will hold an equal stake in Argo while neither have the majority since Argo has always been a separate business but this partnership will give to companies more working capital and engineering resources. Therefore by focusing on electrification, Ford will ~~now~~ have access to the MEB platform which is one of two electric vehicle platforms within the Volkswagen group analysed before.[56]

2.5 TESLA

One of the most interesting and recent companies related to hybrid car market is Tesla. The company was founded by in 2003 by two American entrepreneurs, Martin Eberhard and Marc Tappening (the first one as the CEO and the second one as the CFO). Elon Musk became the CEO in 2008 and in the same year the company released its first complete electric car: Roadster. While it was being tested, Roadster registered 394 km on a single charge, something never reached before by any hybrid cars in market. Also, tests showed that the results were almost like the ones obtained by the fuel sports cars since this model could accelerate from 0 km/h to 100 km/h in less than 4 seconds. The vehicle's electric motor was powered by lithium-ion cells that could be easily recharged from a standard electric outlet. The Roadster was considered immediately as a luxury car, not only for the performances during tests but also for the price that was about

56 https://www.volkswagenag.com/en/news/2019/10/scania_waste_partnerships.html

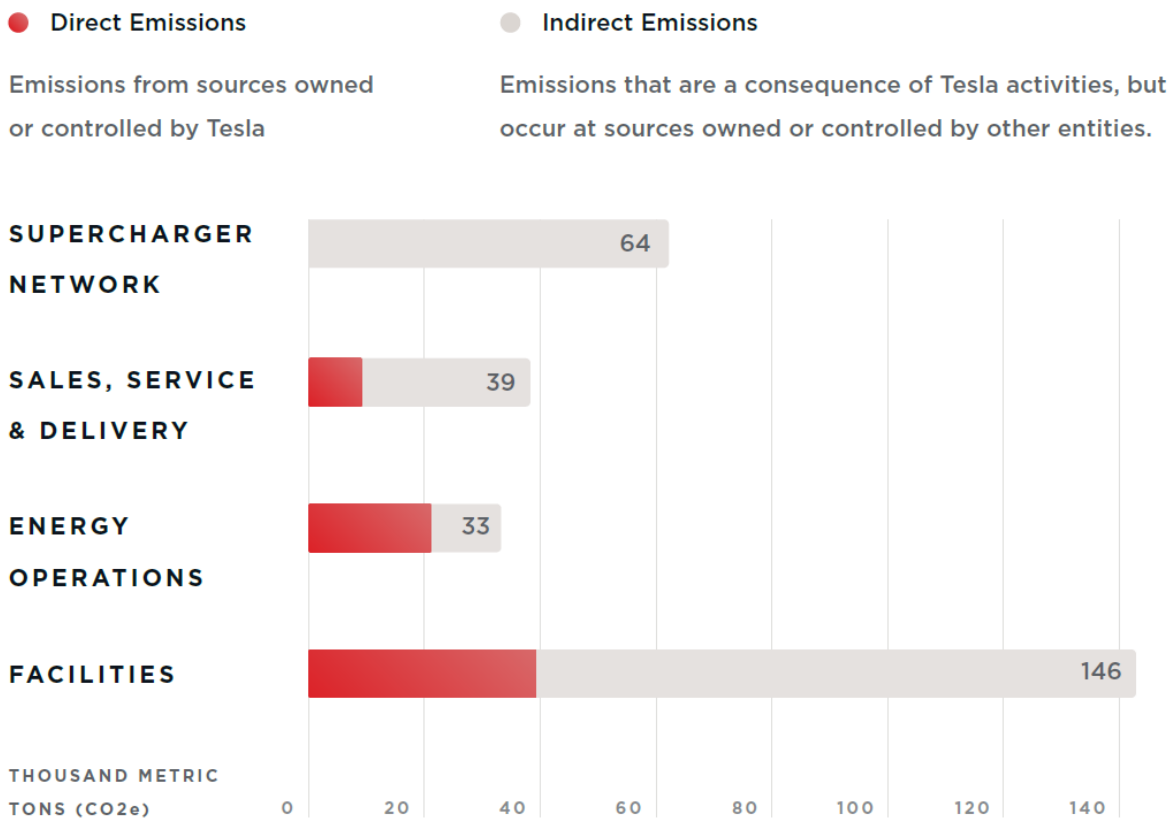
$109.000 when it was launched into the market. In 2012 the company stopped the production of Roadster and release the Model S sedan which was acclaimed for its performance and design. The duration of battery was like the Roadster one, but the batteries were not placed at the front of the car like in the previous model, but they were placed underneath the floor to give more extra storage space in front and improve handling because of its low center of gravity. In the same year the company built multiple superpower station around the USA and Europe to recharge cars. In 2015 it released the Model X and later in 2017 the Model 3 with an accessible price around $35.000. Last year, the company realized a line of batteries to store electric power from solar energy to use them in houses and for this thing the company decided to change the name of the company into Tesla Inc (to reflect that it no longer sold just cars). Their mission is to accelerate the transition to a sustainable energy: initially they produced an electric sport car to prove that people don't need to compromise performance, speed and comfort to drive all-electric. After this the company decided to focus on the mass market to follow its vision, producing Model S, Model X SUV, Model 3.

In order to create a sustainable energy ecosystem, Tesla manufactures a unique set of energy products that should enable everyone to produce and storage and consumption: homeowners can install multiple panels on their home using 100% renewable energy meanwhile utilities and businesses can use Powerpacks, which are scalable energy storage systems that provide greater control, efficiency and reliability across the electric grid.[57]

Tesla has expanded its global manufacturing, charging, sales and service footprint in recent years. In 2017 the company established a global carbon impact footprint across all these activities as we can see in the following picture:

[57] Tesla sustainability report 2018

Table 4: global carbon impact of Tesla



Like the companies described before, Tesla is extremely focused on energy efficiency and sustainable energy, which we can observe especially in the Fremont plant which was modernized in 2010 with a huge investment (around $3 billion dollars) to create one of the most advanced manufacturing facilities in the world. Its battery pack system monitors the facility's energy uses during days and cuts back energy taken from the grid during peak hours. Others important plants are the Gigafactory 1 and 2. They are completely based on renewable resources and their efforts include recycling 100% of any recyclable wood that comes into the plant and recycling 90% of the plastic pallets provided by suppliers. All the three manufacturing facilities are located within some of the cleanest electricity grid mixes and most aggressive Renewable Portfolio Standards Policies in US.

The company is building a charging system that enables quick, convenient and long-distance travels. This is a critical mix that all companies must consider producing electric vehicles. All these superchargers are strategically placed around US and Europe to give possibilities to the cars owners to take long trip with minimal stops whenever its

necessary. In 2012 Tesla opened 12.000 superchargers with a medium charging speeds up to 120 kW which means the complete charge time is around 30 minutes. All Tesla vehicles produce significantly less Co2 than any other competitors. In EU, over the 85% of energy delivered by Superchargers is produced by clean, low-carbon energy sources, including the solar, wind and hydropower ones. Despite the numerous efforts of Tesla to follow its vision, the company has recognized that it cannot reach all the objectives alone; therefore, they have decided to open source Tesla patents, making them accessible to anyone who wants to design and build electric vehicles

Tesla held the top spot in global electric car sales last year, but all the other competitors are definitely increasing their spot in the market regarding the one related to electric cars: all the three great competitors we have analyzed have planned to increase their hybrid portfolio by 2025, on the contrary, Tesla is more focused on developing new technologies rather than focusing on their spot in the market. According to Volkswagen's forecasts the company is planning to sell more than 22 million vehicles by the end of 2028 (11.6 million should come from the Chinese market).

CHAPTER 3: MARKET ANALYSIS OF FORD, TOYOTA, VOLKSWAGEN AND TESLA

3.1 THE CURRENT SITUATION

The diffusion of energy-sustainable transport innovations, such as hybrid-vehicles, is important at a time when climate change, diminishing energy resources and energy security are serious issues.[58] Nowadays the transport sector contributes approximately to 20% of the worldwide GHG emissions and it is expected to double in the next 20 years. This prevision and the increasingly stringent legislation about emissions are the reason why different car companies (especially Ford, Toyota and Volkswagen) are focusing on the hybrid car market. We have seen in the last chapter the history of the hybrid cars and how they were born and all the companies' leaders in the hybrid market in terms of technologies and performances. Also, we have seen the kind of engines existing among all the models already produced and the ones that will come in the following decade. Therefore, we can basically point out 4 different types of hybrid models:

1) Electrically-chargeable vehicles (ECVs): they include full battery electric vehicles and plug-in hybrids, both of which require appropriate recharging infrastructure.
2) Battery electric vehicles (BEVs): they are fully powered by an electric motor, using electricity stored in an on-board battery that is charged by plugging into the electricity grid.
3) Plug-in hybrids (PHEVs): they have an internal combustion engine (running on petrol or diesel) and a battery-powered electric motor. The combustion engine supports the electric motor when required, and the battery is recharged by connecting to the grid.
4) Hybrid electric vehicles (HEVs): they are powered by an internal combustion engine (running on petrol or diesel) but also have a battery-powered electric

[58] Ozaki, R., & Sevastyanova, K. (2011). Going hybrid: An analysis of consumer purchase motivations. *Energy Policy*, *39*(5), 2217–2227. https://doi.org/10.1016/j.enpol.2010.04.024

engine that serves to complement the conventional engine. Their electricity is generated internally from regenerative braking and the internal combustion engine, so they do not need recharging infrastructure. The hybridisation level ranges from mild to full.[59]

We have observed that the development of hybrid technologies is going fast, performances are increasing at a pace never seen before, construction of network for charging cars battery to give to customers possibilities to charge they cars without any concerns and a strong increase of battery durability for all the models (sedan, utilitarian cars and SUVs). What we really want to see is whether hybrid cars are going to change the face of the electric automobile market in the next decade or if the fuel engine will continue to be the dominant choice for customers. The market of hybrid and electric cars is growing quickly even if the total amount of those vehicle is still limited compared to the ones sold in the gasoline and diesel market. This growth is stimulated by multiples incentives that come from governments: one of the most important examples is Norway where the plug-in cars (BEV or PHEV) have reached the 48% of the car market share since they are exempt from VAT. Even though the mix between all the engines change between States, especially based on legislation and incentives in the last two years the global market of electric vehicles has registered a remarkable growth since more than 1.1 million cars were sold, determining an increase of +57% compared to 2017 and a +223% compared to 2016.

3.2 PORTER'S ANALYSIS OF HYBRID AND ELECTRIC VEHICLE MARKET

THREAT OF NEW ENTRANTS

Before analysing the hybrid market, we do have to consider some important variables to understand why companies are paying great attention to it.

First, we do have to considers barriers in this market since they are elements that can hinder the expansion of hybrid and electric vehicles. Barriers can be political, economic, social and technological factors that have a certain influence on this market

[59] https://www.acea.be/industry-topics/tag/category/electric-vehicles

POLITICAL FACTORS

Political factors arise due to the governments' failure in intervention in the market which gives rise to barriers.

1) Tax benefits and direct subsidies are key elements that are provided by countries to stimulate customers to give up on gasoline and diesel engines in order to convince the individual to prefer hybrid and electric ones. States are moving in this direction, but for the fact that hybrid and electric vehicles are much more expensive than these ones belonging to the same brand they are not enough.
2) Charging installation permits and lack of providing charging infrastructure: some buildings and station do not allow chargers set up or do not have electrical capacity to hold charging points.
3) Not standardized charging system: not standardized charging systems create a sense of unsurety in minds of customers and it determines different times to charge battery depending on the power of stations.

ECONOMIC FACTORS

Economic barriers arise from the inability of governments to provide financial assistance to the customers. It is the most crucial barrier faced by the governments and the buyers.

1) Electric cars are generally more expensive than their internal combustion counterparts

2) Battery Expenses/Costly Charging/High electricity cost. In spite of the Battery technology advancements, and 60% fall in price of battery since 2010, the high price of battery and short life contributes to be a big negative for the buyers.

SOCIAL FACTORS

Social Barriers are the barriers hindering the growth of electric cars arising from not being provided the basic information and service of these electric cars. It may be caused by the negligence of governments to provide all the necessary knowledge to the customers which may "remove" the interest of the car buyer. The stronger the intention to engage in a behavior, the more likely should be its performance

TECHNOLOGICAL FACTORS

We can identify three different things that determine the technological barriers:

1) Lack of charging infrastructure and difficulties to find charging stations
2) Failure of batteries since technology is limited
3) Few manufacturers and models in the current market. Things should change in the decade that has just started (2020-2030)
4) Slow charging unless one decides to acquire models at a high price endowed with supercharge technology

At the moment it seems there are so many barriers in this market because of all these variables, but since companies and governments are cooperating to improve the electric and hybrid industry, this should change quickly in the next years. Prices for electric and hybrid models are still high, but due to the system of incentives that States are providing and the main companies' quick development of technologies, prices will diminish giving all customers a chance to buy those cars. As for the social factors, they are probably the strongest barriers to break down since buying hybrid and electric cars means changing the mindset of customers related to the automotive sector (considering the necessity to charge vehicles instead of refueling them at service stations or the lack of knowledge about performances, the recharging time and the vehicle autonomy for example).

THREAT OF SUBSTITUTES

The impact of substitutes in this market is high since the low switching cost is a strong force. There is a moderate substitute availability (even if this force will be much more evident in the following 5-10 years) and a moderate force of performances regarding substitutes. Since switching costs are low, a strong competition characterizes this industry and customers can easily decide to prefer one brand over another or even prefer public transport if there is no suitable infrastructure network for charging electric vehicles.

BARGAINING POWER OF BUYERS

As analysed before, switching costs are low, there is a moderate substitute availability and a low volume of purchase which give customers a chance to purchase cars from

other providers. According to the Porter's Five Forces analysis this factor imposes a strong force against companies that operate in the market of electric and hybrid vehicles, but at the same time, since the range of these vehicles is not that high now, companies can exploit their brand awareness to keep their customers. Basically, the low volume of purchases reduces the customers' influence on companies even if it is still strong.

BARGAINING POWER OF SUPPLIERS.

As for the suppliers' level and their size, the bargaining of suppliers is still low, which allows companies to keep their control on suppliers. Also, all providers are moderately sized, so they have limited influences on the automotive industry environment. So, this force is a secondary strategic management priority.

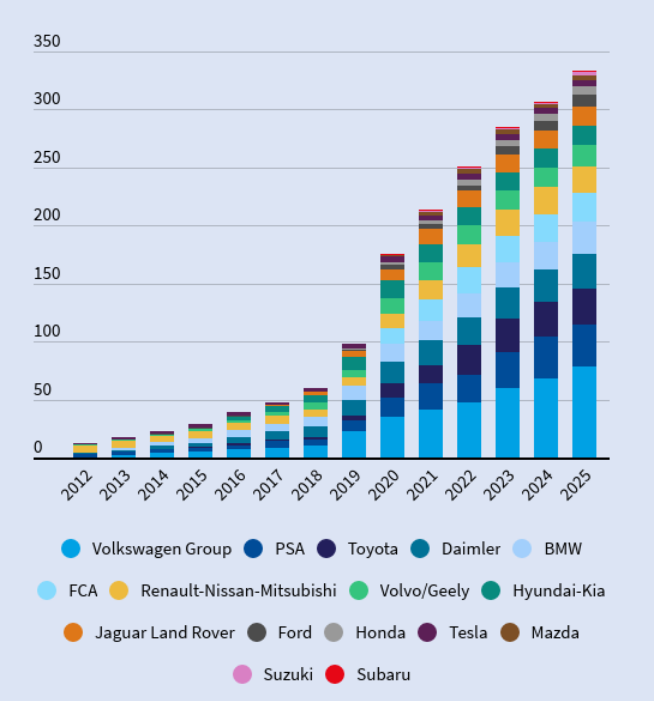
3.3 THE NEW EUROPEAN CAR MARKET[60]

The Eu has agreed to reduce Co2 emissions for new cars in the 2020-2030 decade: the news standards will require the reduction of Co2 emissions by 15% in 2025 and 37% in 2030 compared to the estimated levels in 2021. According to forecasts, the year 2020/2021 is going to be a tipping point for the hybrid car market. In the last decade the EV market was limited to a niche of early adopters but in the next 10-20 years things are going to change. The current forecasts show that most of carmakers are ready to put all their efforts in electrification, leaving behind the traditional fuel approach. After the 2010/2020 decade, the number of electric vehicles is about to grow fast: from a total amount of 60 BEV, PHEV and FCEV models available at the beginning of 2018, the production estimated by the of 2020 is going to be around 176 models, 214 by the end of 2021 and 333 by the end of 2025. This quick development will also be determined by the new limit of 95g/km Co2 which will come into force by the end of 2021. Based on forecasts made by T&E (Transport and Environment) the total amount of unit that will be produced between 2020 and 2025 will reach more than 4 million cars and vans with

[60] T&E (Transport & Environment). (2019). *Electric surge: Carmakers' electric car plans across Europe 2019-2025. July*. www.transportenvironment.org

a pick in 2025 when more than 60% of cars produced will be hybrid. The following pictures represents these forecasts:

Table 5: Forecasts

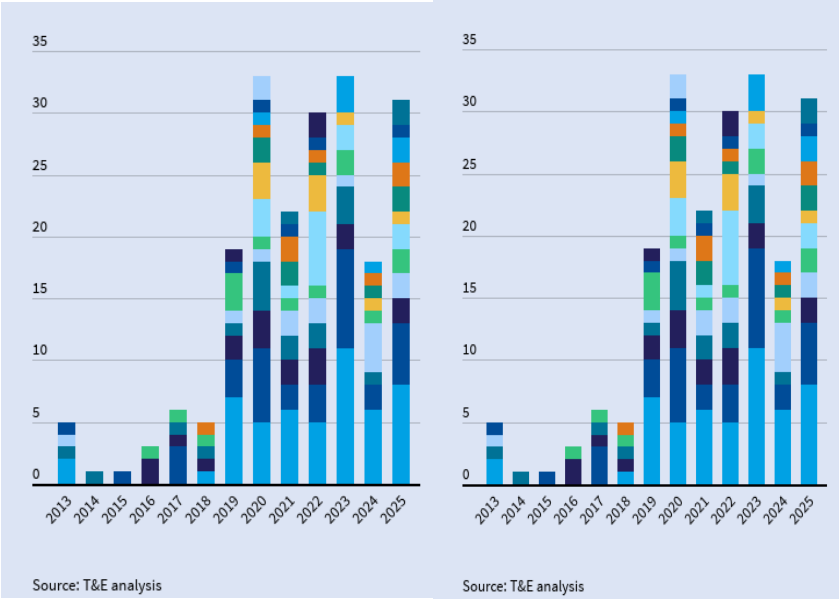


Looking at the picture we can see how production forecasts become more solid in the 2020/2021 biennium (necessary for the new legislation). This graphic shows the industrial opportunities existing in Europe, especially in the Western countries characterized by a higher rate of industrialization, but also in Central and Eastern Europe through import/export activities. If we consider together the numbers related to Volkswagen Group, PSA (Group of Peugeot and Citroen), Renault-Nissan and Daimler, we can observe how they will represent two-thirds of EV production in Europe by 2025, meanwhile Toyota (12 new models) and Ford (5 models) will be more powerful in their born countries. The supply of EU-manufactured batteries is expected to be sufficient by the beginning of 2023: actually only 16 large-scale lithium-ion battery cell manufacturing facilities exist or are likely to come online across Europe and, by the end of 2023, more will come and the total amount of energy that will be produced will be around 130 GWh, growing up to 274 GWh in 2028 (based on T&E forecast). The only increased production of hybrid vehicle will not be the only condition for a success change in the car market: it

will be necessary a reform of national vehicle and corporate fleet taxation, aimed at reaching the highest environmental benefit and, at the same time, ensuring equity and stimulating cars producers to achieve their targets. At the same time the European Union should ensure the fact that recharging infrastructure will be built around the entire continent, especially in urban areas and on all key's roads.[61]

On the basis of these forecasts, we should analyze what kind of hybrid vehicles will be popular in the next decade. According to the forecasts, around 33 BEV models will be produced in 2020, 22 in 2021, 30 in 2022 and 33 in 2023. The market leader in the EU will be Volkswagen Group, followed by PSA, Daimler, Renault and Toyota. The following graphs represent all these forecasts:

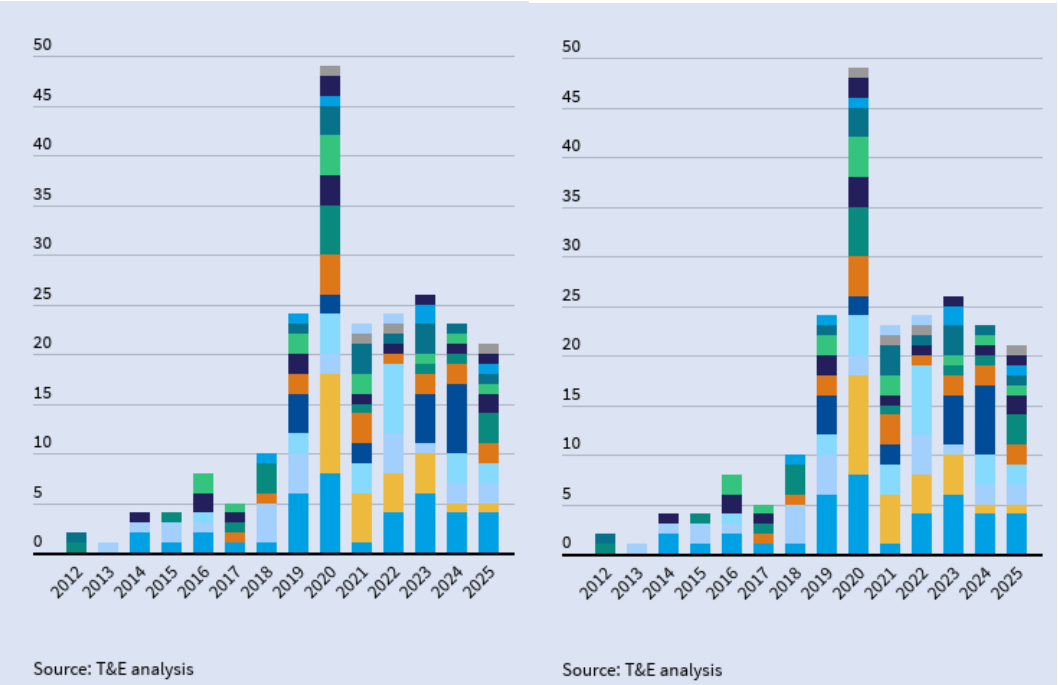
Table 6: Forecasts



As for the PHEV models, their future will be like the one related to BEV market, but the growth will be slower after 2020 (the year in which Co2 limit will change). The top PHEV manufacturers will be Volkswagen group with 27 models available in 2025 and the Fiat-Chrysler Group (FCA) with 17 models, followed by Toyota (15), BMW (14) and PSA (14).

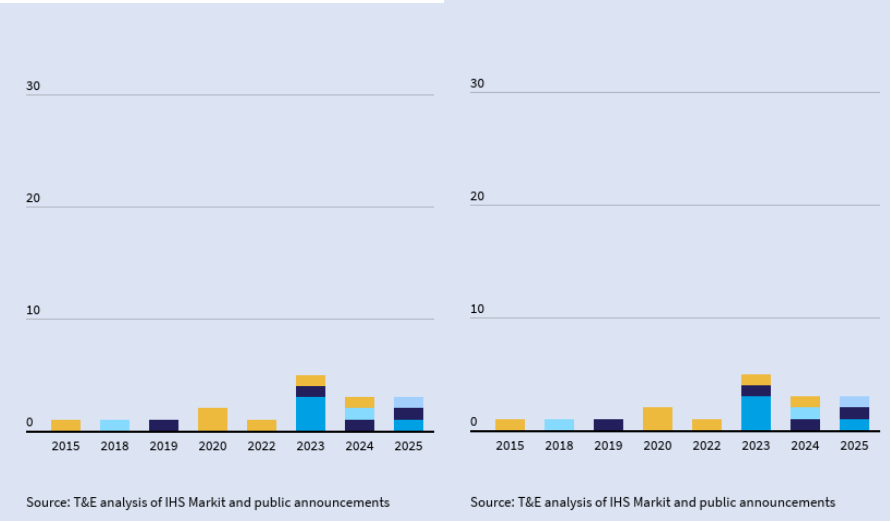
Table 7: Forecasts

[61] https://insideevs.com/news/373278/plugin-car-sales-europe-h1-2019/



As far as the FCEV models are concerned, the increase numbers will be slower than the types analyzed before. Only 14 FCEV models are expected in 2025 up from two models that exist today (Toyota Mirai and Hyundai Nexo). The Volkswagen Group, Toyota and Daimler are expected to have four models each on the market in 2025.

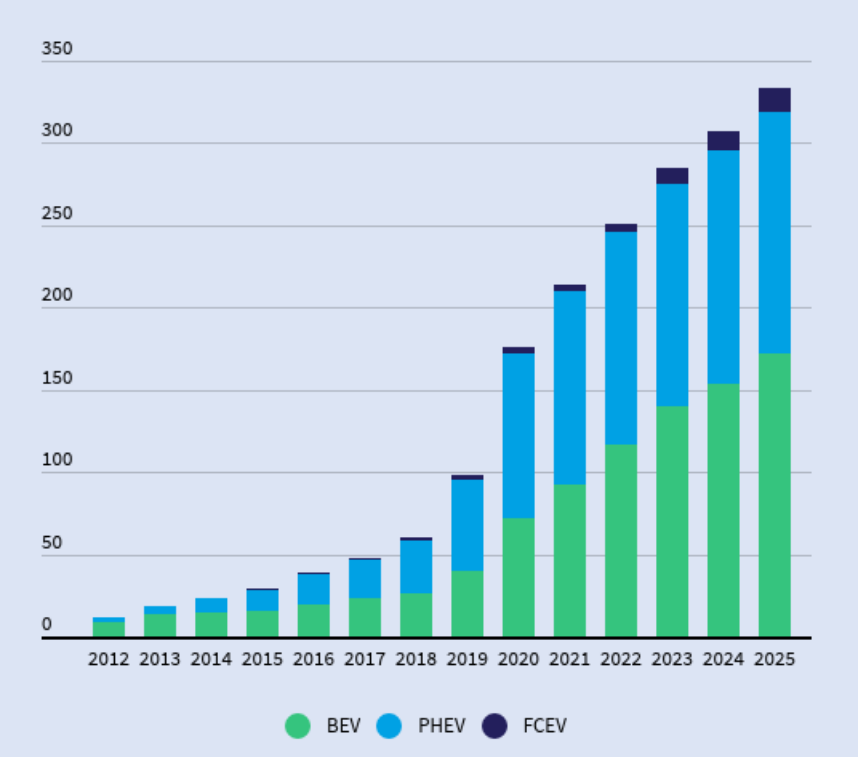
Table 9: Forecasts



On the bases of these results we can observe that the market of BEV is at least 10 year beyond the technology of FCEV. The reason is related to the fact that FCEV technology is still under development and it's almost like a prototype rather than a confirmed

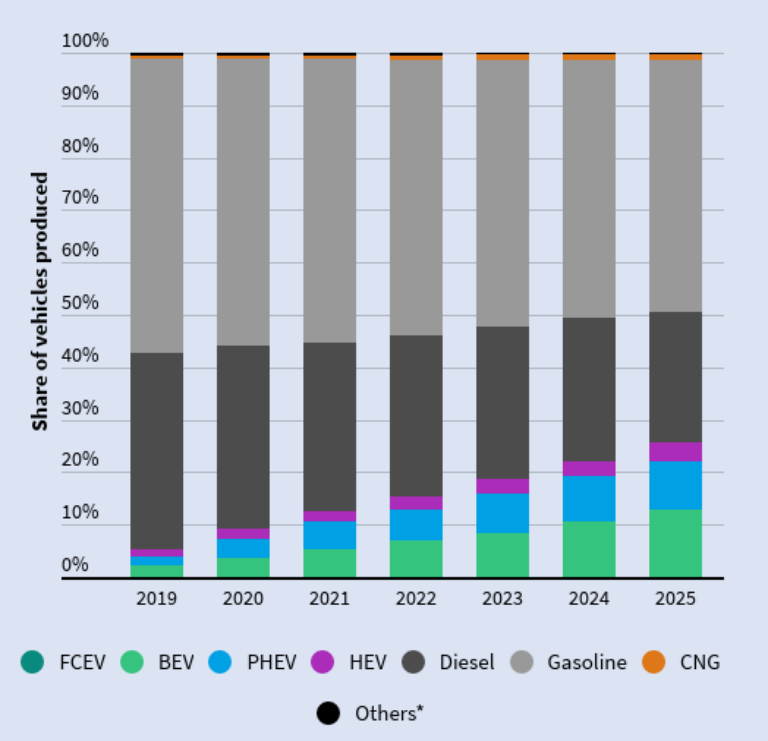
model. If we put together all these numbers, we can observe the total amount of available EV models on the market in Europe as we can see in the following graph:

Table 10: Forecasts



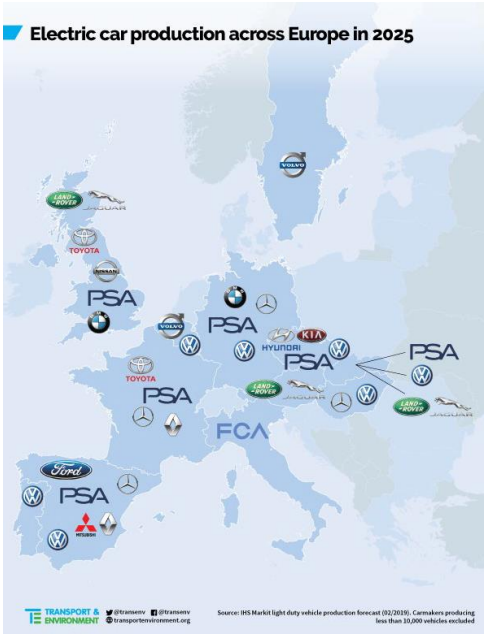
According to data, in 2024 the market should reach its maturity and by that year companies should have already invested €145.8 billion in electric cars and batteries, reaching success of the EU transition to e-mobility. The peculiarity of these market is that almost all the EV models produced Europe won't be exported in foreign countries/regions since these don't necessarily have a proper legislation or charging infrastructure to support this technology. The number of electric vehicles produced in Europe is expected to increase from three quarters of a million in 2019 to more than 4 million in 2025. In terms of market share this means an increase from 4% up to 22% in 2025 with 13% of BEVs and 9% PHEVs. On the other hand, the market share of gasoline and diesel will decrease: the one related to diesel will be huge due to new legislation, meanwhile the gasoline one will be slower as shown in the following chart:

Table 11: Forecasts of diesel market share



The chart below shows that there is a hypothetical representation of the carmakers that are expected to produce EVs and in which countries. We can observe that Spain, Germany, UK and France are expected to have at least four different carmakers producing a significant number of electric vehicles in 2025, Czech Republic and Slovakia have 3 different carmakers which will be significant for their economies.

Figure 11: European car market according to forecasts (2025-2030)



Moreover, we do have to consider the number of incentives that European States give customers to buy electric and hybrid models. In Germany, where the market is still under development, State gives a total amount of €4000 to customers that want to buy these vehicles and all the BEVs and PHEVs cars are exempted from the road tax for 10 years from the time of purchase. In France incentives are around €6000 plus other 4000 for customers that buy hybrid vehicles to substitute the diesel ones that are more than 11 years old. In the United Kingdom incentives are up to 35% of the cost of vehicles (until a total amount of €5100 for a BEV car and €2800 for a PHEV car). Furthermore, the "polluter pays" principle was applied, which is not so much an incentive to purchase electric vehicles, but a disincentive to buy fuel cars following the idea that "who pollutes, pays". This means higher annual traffic taxes for the most polluting vehicles: because of this system the owners of cars with higher emissions "pay" even for the ones who do not have them, reducing the cost for the state and at the same time favoring hybrid and electric car purchases. It is precisely through this principle that Norway is leading the transition towards electric mobility by setting itself as a model to be followed globally. These incentives are probably necessary to increase the market share of hybrid and electric vehicles, but they are not enough: considering its entirety, the set of motor-battery-energy, before further development, must be beneficial and sustainable. At the moment, the first concrete applications are beginning to be glimpsed but, despite the technological ferment that revolves around batteries, it will still take a long time to get them, because of the lack of the necessary infrastructure. All companies are investing in R&D about infrastructures to create a network among Europe like the one we saw in the IONITY in the previous chapter. Even if it's not so popular in Europe, Tesla is the most important example of those infrastructures since with the Tesla Supercharger System the time necessary to recharge a battery is around 13 minutes. Anyway, this technology is not that popular, so customers have to wait for more than 2 hours to charge their cars, hence the most widespread technology is not that practical.

3.4 THE VOLKSWAGEN GROUP IN THE EUROPEAN MARKET

There is no doubt that Volkswagen Group will be the European leader in the production of BEV will produce almost 1 million units by the end of 2025[62]. The related sub-brands of Audi, Seat and Skoda will all be producing BEVs using the MEB platform provided by the parent company. For PHEVs models, the trend will be similar even if the Group is expected to produce less than the BEVs with a total amount of 250.000 units by the end of 2025. The total amount of electric vehicles realized by Volkswagen by the end of 2025 should be around 1.2 million of units. Following the TRANSFORM 2025+ strategy and the TOGETHER 2025 strategy the company has decided to take a specific position in green economy inn hybrid and electric car market. In particular, the company has included in that strategy a plan for decarbonization to reduce Co2 emissions throughout the entire life cycle of products and services, a continuous reduction of the carbon footprint, a reduction of European new-car feet Co2 emissions to 95g/km and reduction of greenhouse gas emissions from energy supply to production facilities in German by 40% per unit produced by 2020. The company will focus on a clearer brand positioning across the various regions and segments, increasing their efficiency and productivity. At the same time Volkswagen will make huge investments in e-mobility and connectivity. The Volkswagen brand is evolving into a leading, profitable volume manufacturer and is also trying to play a leading role in the new world of automobility since the objective is to be the market leader by the end of 2025. The TRANSFORM 2025+ strategy will take place in 3 different phases:

- The brand will be completely rebuilt, reconstructing the core business and completing a transformation of the value stream, developing new competences taking advantages of partnerships
- The Group intends to take the lead in the e-mobility based on its strength as a leader and profitable company. The focus is to create new mobility devices.
- Becoming the leader in the mobility by the end of the 2020-2030 decade.

A key element of the new strategy is positioning the Group at the top of the volume segment close to the premium competitors: in the next 5 years the company will launch

[62] Audi: about 300,000 BEVs; Volkswagen: 300,000; Porsche: 160,000; SEAT: 75,000 and Skoda: 50,000

more than 10 models per year, focusing in the first period on SUVs market where there is a lack of the electric ones: by the end of 2020 the global SUV lineup of Volkswagen will be composed by 20 models and the total amount of SUVs sold in the following year will be around 40% of sales volume. The campaign launched by Volkswagen will be purely based on hybrid and electric vehicles, extremely customer-oriented offerings, such as customized charging infrastructure solutions and mobile online services. The reason why there is an optimistic view around Volkswagen is given by the Modular Electric Toolkit (MEB): this can set a benchmark for the electric car industry, creating the iconic car for the electric age. Part of the brand core is the e-mobility since the company doesn't want to be a niche producer, but the core of the electric car industry. By 2025 the company will be expected to have about 80 million active users in the world: this means that the brand might have the leading digital ecosystem in the entire automotive industry. The following chart represents what the company expects to do in the next decade:

Figure 12: Strategy for the next decade by Volkswagen

In the last year (2019) the company delivered 1.763.800 vehicles representing a rise +0,9%. In Western Europe they sold almost 1.46 million of vehicles corresponding to a

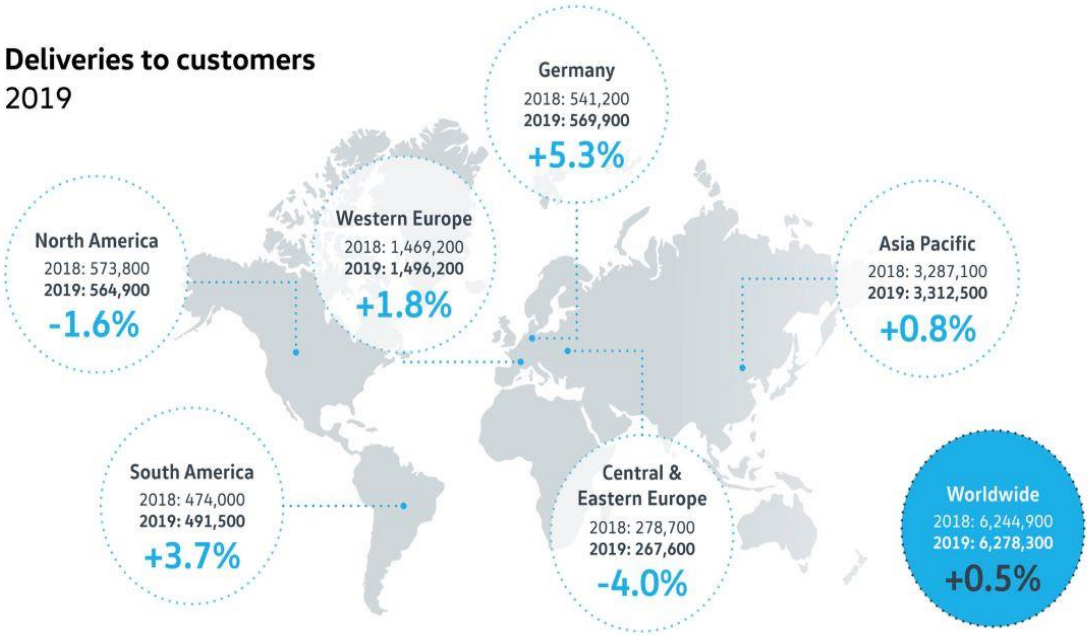
growth of 1.8%. At a global level, the company increased the volume on units sold during 2019.[63]

Table 12: Results in this year of Volkswagen sales

Overview of deliveries by the Volkswagen brand:

Deliveries to customers by market	Dec 18	Dec 19	Change (%)	2018	2019	Change (%)
Europe	130,300	140,100	+7.5%	1,747,900	1,763,800	+0.9%
Western Europe	106,400	116,400	+9.4%	1,469,200	1,496,200	+1.8%
Germany	39,300	44,500	+13.0%	541,200	569,900	+5.3%
Central and Eastern Europe	23,900	23,700	-1.1%	278,700	267,600	-4.0%
Russia	11,200	9,800	-12.5%	106,100	104,400	-1.6%
North America	49,700	45,800	-7.9%	573,800	564,900	-1.6%
USA	32,000	27,900	-12.9%	354,100	363,400	+2.6%
South America	39,600	46,600	+17.6%	474,000	491,500	+3.7%
Brazil	31,600	39,100	+23.8%	335,800	391,800	+16.7%
Asia-Pacific	305,200	369,800	+21.2%	3,287,100	3,312,500	+0.8%
China incl. HK	289,900	354,200	+22.2%	3,110,000	3,163,200	+1.7%
Worldwide	540,600	615,200	+13.8%	6,244,900	6,278,300	+0.5%

Figure 13: Results of 2019 of Volkswagen Sales for EV and Hybrids

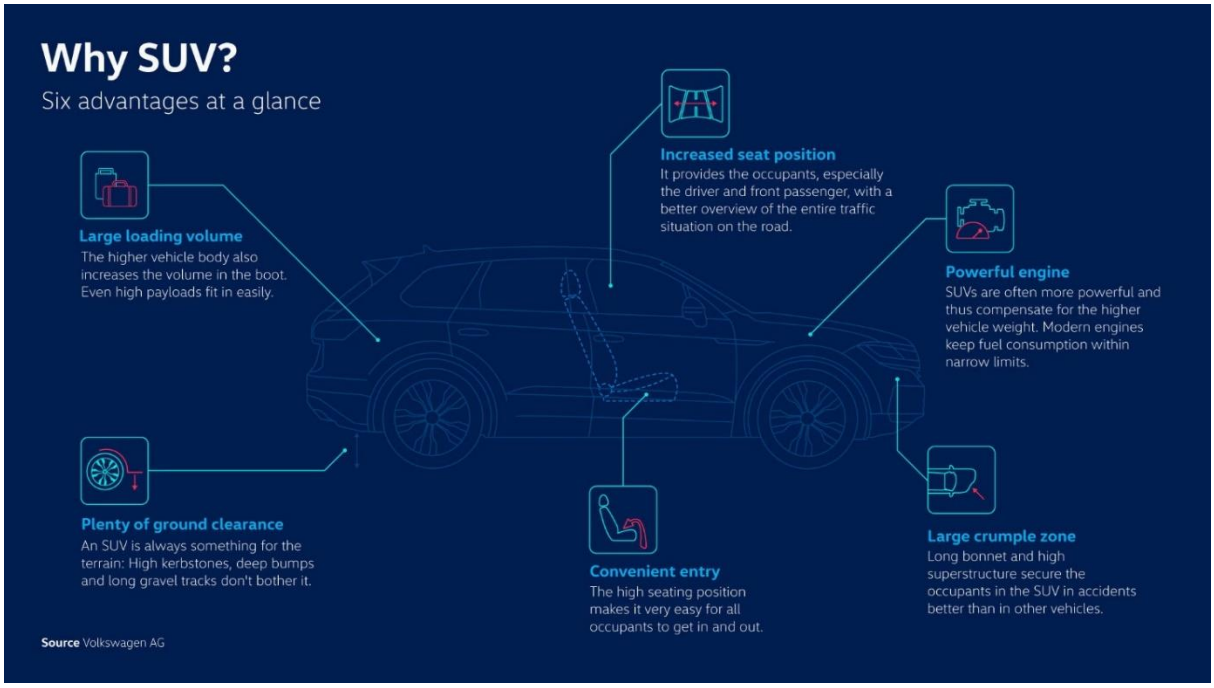


[63] https://www.volkswagenag.com/en/news/2020/01/VW_Brand_deliveries_12_19.html

3.4.1 VOLKSWAGEN MODELS AND SUBSIDIARIES

As we have previously seen in 2025 TRANSFORM strategy, in 2019 Volkswagen started a model offensive based especially on SUVs. This is caused by the fact that SUVs are well seen by families for their field of vision, safety and comfort. These things and the performances guaranteed by SUVs are considered “all-around vehicles”. The following picture shows six advantages:

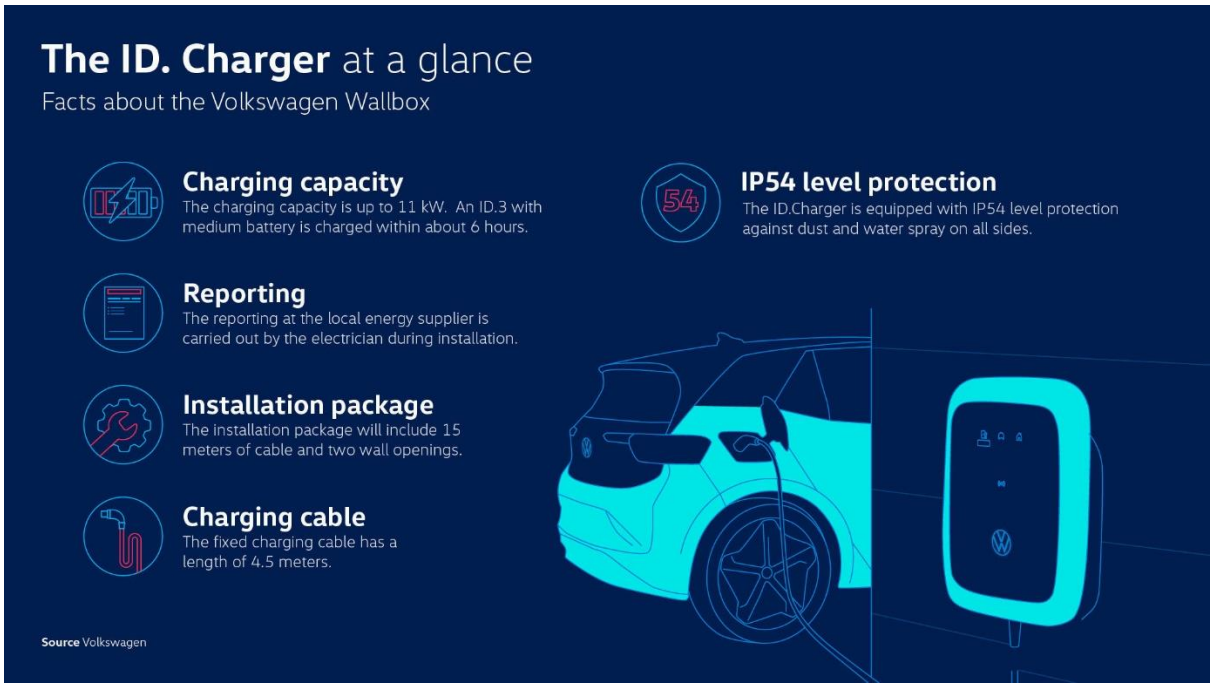
Figure 14: The focus for the decade



The brand is planning to produce more than 30 SUV models by 2025, offering powerful zero-emission SUVs based on the MEB technology. In the course of this year the company will present ID CROZZ and ID ROOMZZ which are two electric SUVs with an output system of 225 kW and a top speed of 180 km/h. The ID CROZZ will be the first will be the first Volkswagen SUV from a completely electric series to offer space comparable to that of the Tiguan Allspace (7 seats). At the end of 2019 Volkswagen presented the ID.3 model, which is the first model of a completely new generation of pure electric vehicles, highly efficient and fully connected and it is considered as the symbol of the new decade for the company. It is the world’s first vehicle to be produced in a Co2 neutral way and thus handed over to customers without a so-called “Co2 backpack”. The new battery is sourced from 100% green electricity. This new vehicle is based on the new modular electric drive matrix (MEB), designed for a pure electric drive

with a system that offers from 330 km up to 550 km with short charging times (charging capacity of 11kW and 6 hours necessary to a full charge of the battery).

Figure 15: The new ID



At the end of last year, the company also decided to present the first hybrid Golf of its history. It is characterized by the new electric TSI technology, a 48V lithium-ion battery enable to give multiple advantages: fuel savings around 10% and highly agile and comfortable starting. The company will also release in the course of 2020 two plug-in hybrid versions (150 kW and 180kW) with a 13Kwh lithium-ion battery which enables longer electrical ranges and ensures that the Golf is temporarily a zero-emission vehicle.

Since Volkswagen Group is huge, we have to consider other subsidiaries in order to analyze the hybrid portfolio of the group[64]:

- Audi: one of the most famous subsidiaries is pursuing its electrification strategy with its comprehensive plug-in hybrid offensive. Audi is presenting the hybrid variants of the models A8, A7 Sportback, A6 and Q5 with an electric range of more than 40 kilometers in the WLTP cycle. All new plug-in-hybrids by Audi use a turbo-charged gasoline engine with direct injection that works together with an electric motor that is integrated in the transmission. A lithium-ion battery

[64] Volkswagen Sustainability Annual Report 2019

beneath the luggage compartment floor supplies the electrical energy. As a result, the electric motor can support the combustion engine during acceleration. The result will show a high start-off performance and powerful acceleration. The new plug-in hybrid models will be available for order during the year 2020.[65]

- Skoda: in 2019 the company announced that almost 10 new electric models would be released by the end of 2025 following its e-Mobility strategy: six of them will be all-electric, the others will be plug-in hybrids. The first two models that will be released is the new SUPERB PHEV, a plug-in hybrid version of SKODA flagship that combines an internal combustion engine with electric drive and offers the option for a purely electric ride, and the PHEV CITIGO (first purely electric car), a city car with compact dimensions and emissions-free. In the course of 2020 the company will present an electric SUV, the mass-produced version of its VISION E concept, a 5-foor coupe SUB that should offer an autonomy of up to 500 km. According to forecasts, Skoda will have released almost 50.000 vehicles by the end of 2025
- Seat: in 2019 the company became the leader of the JAC Volkswagen project in China, a joint venture for electric vehicles and presented six new electric and plug-in models that will be release in the following years: Mii and el-Born will be the first two electric models, while Leo and Tarraco will feature a plug-in hybrid version using the MEB platform provided by the parent company. According to forecasts, Seat will release almost 75.000 vehicles by the end of 2025
- Bentley: Volkswagen group is also developing a hybrid model for the premium sport car marker with the new Bentayga Hybrid, with a plug-in electric engine with a lithium battery that can cover 50 km in pure electric mode, one of the most efficient in that kind of market. The time for recharging takes from 2,5 hours up to 7 depends on the power of the model. A 50-km autonomy doesn't seem that much, but it's one of the first sport cars to use this technology, so it's almost like a pioneering model in a market that is still strongly linked to gasoline and diesel.

[65] https://www.audi-mediacenter.com/en/press-releases/efficient-and-powerful-the-new-plug-in-hybrid-models-audi-q5-a6-a7-and-a8-11334

- Porsche[66]: between all the subsidiaries is probably one the most advanced in terms of hybrid technology. The electric era began years ago: in 2013 the 918 Spyder was presented as a superior hybrid in the sports car segment. The company has developed the new Cayenne E-Hybrid that combines the best driving dynamics in its class with maximum efficiency. It's a plug-in model that drives up to 44 kilometers with an average speed of 135 km/h without using gasoline or diesel. Company has already developed the Panamera 4 E-Hybrid that is already popular among European customers, accounting for 67% of all Panamera deliveries in Europe. According to their head of sales and marketing, by the end of 2025 Porsche will have accounted for as many as half the vehicles sold by the company.[67] According to forecasts, Porsche will have released almost 160.000 vehicles by the end of 2025.

According to the last available income statement, Volkswagen AG recorded an inflow of cash funds amounting to €2.75 Billions, less transaction costs of €19 million, from the hybrid capital issued in June 2018. Additionally, there were noncash effects from the deferral of taxes amounting to €6 million. The hybrid capital is required to be classified as equity instruments granted. The calling of the first tranche of the hybrid capital issued in September 2013 resulted in a reduction of equity in the amount of €5 Millions in the reporting period.

According to the Volkswagen Group's forecast, the company expects a significant increase in sales revenue over the next 10 years: Volkswagen estimates that its sales revenue from services related to networked vehicles will reach €1 billion per year by 2025.[68] The company expects a doubling of operating margin from 2% of 2015 to 4% by the end of 2020 with a further 6% by 2025. In the next years, the Volkswagen brand will keep its investments stable about €4.5 billions. According to its forecasts he operating

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[66] Dr. Ing. h.c. F. Porsche AG. (2018). *Annual and Sustainability Report of Porsche AG 2018 - Performance*. 30–49. https://newsroom.porsche.com/en/annual-sustainability-report-2016.html

[67] https://newsroom.porsche.com/en/annual-sustainability-report-2018.html

[68] https://www.volkswagenag.com/en/news/2016/11/transform-2025.html

profit before special items should increase from 6.5% to 7.5% in 2020, from 7.5% to 8% by the end of 2025. The ROI in the Automotive Division should be between 12% and 14% between 2020-2025. The Group will continue to pursue its strategic targets for the capex ratio and the R&D cost ratio. Each should be 6 percent from 2020 onwards. The aim is to achieve net cashflow of at least EUR 10 billions and a net liquidity in the Automotive Division of more than EUR 20 billions by then.[69]

Table 13: Financial Results in this year of Volkswagen

Key financial targets	2016 Actual	2017 Actual	2018 Actual	2019 Outlook	2020 Strategic Targets	2025 Strategic Targets
Operating return on sales Before Special Items	6.7%	7.4%	7.3%	6.5-7.5%	6.5-7.5%	7-8%
Return on investment Automotive Division before Special Items	13.9%	14.4%	13.1%	12-14%	12-14%[2)]	>14%[2)]
Capex ratio Automotive Division	6.9%	6.4%	6.6%	6.5-7%	6%	6%
R&D cost ratio Automotive Divison	7.3%	6.7%	6.8%	6.5-7%	6%	6%
Cash Automotive Division — a) Net Cashflow[1)]	€ 4.9 bn	€ 10.3 bn	€5.6 bn	≥ €9 bn	≥ € 10 bn	> € 10 bn
Cash Automotive Division — b) Net Liquidity	€ 27.2bn	€ 22.4 bn	€ 19.4 bn	> € 15 bn[2)]	> € 20 bn[2)]	~10% of Group turnover

In order to do a quick recap about the future of Volkswagen we can say that the company has already planned to introduce almost 75 electric models and 60 hybrid vehicles in the next decade following its 2025 TOGETHER AND TRANSFORM strategies. The group's incremental increase in its electric production ambitions is more than four times larger than the total amount of cars sold by Tesla[70]. Over the next few years, Volkswagen intends to become the world market leader in e-mobility and will have been investing €33 billions in these efforts throughout the group by 2024, including €11 billions in the Volkswagen brand. Under the latest plans, the strategic target of one million electric cars is expected to be reached end of 2023, two years earlier than

[69] https://www.volkswagenag.com/en/news/2019/11/volkswagen-confirms-strategic-financial-targets-of-together-2025.html
[70] https://www.ft.com/content/9c99411c-07ab-11ea-a984-fbbacad9e7dd

previously predicted. The Volkswagen brand expects 1.5 million electric cars to be produced in 2025.[71]

3.5 TOYOTA

Toyota started to develop prototypes of hybrid vehicles at the beginning of the 60s and today is the most important car manufacturer using this technology. In 1997 companies launched Toyota Prius that has sold more than 12 million units in 20 years and in 2005 it was nominated "car of the year" in the European market. In that year Toyota founded Lexus, the premium brand of hybrid vehicles. In the last 20 years co the company has sold more than 15 millions of hybrid vehicles and more has to come in the following decade (2020-2030): by the end of 2025 Toyota's and Lexus' models will be available only with hybrid and electric engines and, by the end of 2030 they have planned to sell more than 5.5 million hybrid units for each year, including at least 1 million at zero emissions. Toyota has always been as innovative as Tesla in the hybrid car market: Toyota Hybrids can use electric power to pull away and even cruise at speeds up to 50 km/h. They are known as 'Hybrid-electric' vehicles because they incorporate two energy sources: a petrol engine and an electric motor. Toyota's engines are Atkinson cycle heat engine and represent the most efficient engine in the world, supported by electric engines and a high-capacity battery that stores electricity for electric motors and recharges itself while driving. The heart of Toyota's Full Hybrid Electric technology is called gear epicyclic. A complex name for a mechanism consisting of a few gears, incredibly simple and robust, which connect three rotating shafts: the heat engine, an electric motor and the wheels, which are integral with the second electric motor. This system can be operated by each motor individually or in collaboration. When you slow down or brake, it allows you to recover that energy that would be wasted on heat.

The Japanese company has outlined a roadmap that will see the entire Toyota and Lexus lineup come with electric drivetrain options by 2025, with battery only and plug-in hybrids a key part of this strategy. The company has set the "Toyota Environmental Challenge 2050" based on the Guiding Principles at Toyota, considering Environmental issues as a paramount importance, and has its promotion structure to address such

[71] https://www.volkswagen-newsroom.com/en/press-releases/volkswagen-significantly-raises-electric-car-production-forecast-for-2025-5696

issues. In this plan Toyota has determined six environmental challenges that have to be achieved:

- New vehicle zero Co2 emissions challenge
- Life cycle zero Co2 emissions challenge
- Plant zero Co2 emissions challenge
- Challenge of minimizing and optimizing water usage
- Challenge of establishing a recycling-based society and systems
- Challenge of establishing a future society in harmony with nature.

In order to achieve these challenges, Toyota set in 2018 the 2030 Milestones, indicating the status of these six challenges to promote reductions of the environmental impacts and accelerate activities that have a net positive social impact. These are the milestones set by the company to realize those challenges mentioned before:

- Make annual global sales of more than 5.5 million electrified vehicles, including more than 1 million zero-emission vehicles (BEVs and FCEVs). The estimate of global average CO2 emissions reduction in g-CO2/km from new vehicles will be 35 percent or more, which may vary depending on market conditions, compared to 2010 levels.
- Reduce CO2 emissions by 25 percent or more over the entire vehicle life cycle compared to 2013 levels by promoting activities for the milestones of Challenges 1 and 3, and with support from stakeholders such as suppliers, energy providers, infrastructure developers, governments and customers.
- Reduce CO2 emissions from all plants by 35 percent compared to 2013 levels.
- Implement measures, on a priority basis, in the regions where the water environment is considered to have a large impact. Disclose information appropriately and communicating actively with local communities and suppliers.
- Complete establishment of battery collection and recycling systems globally. Complete set up of 30 model facilities for appropriate treatment and recycling of End-of-life vehicles.
- Realize “Plants in Harmony with Nature”— 12 in Japan and 7 overseas —as well as implement activities promoting harmony with nature in all regions where Toyota is based in collaboration with local communities and companies.

Contribute to biodiversity conservation activities in collaboration with NGOs and others. Expand initiatives both in-house and outside to foster environmentally conscious persons responsible for the future.[72]

In the following table we can see which the most important elements of the strategy are.

Milestone		
Challenge 1	**Challenge 2**	**Challenge 3**
Electrified vehicle sales: 5.5 million units ZEV sales: 1 million units	Reduce CO_2 emissions by 25% over the entire vehicle life cycle compared to 2013	Reduce CO_2 emission from plants by 35%

3.5.1 TOYOTA IN THE EUROPEAN MARKET

Toyota's history in the European market started in the 60s with small exportations of vehicles, but since those days they have invested in order to make Europe one of the most important markets for the company. During the 1990s the company transformed its activities in Europe. It set up local manufacturer operations to build cars specifically for European market selling more than 10 million vehicles, providing business worth more than €6 billions to a network of around 400 European suppliers.[73]

Figure 16: Toyota focus on European Market

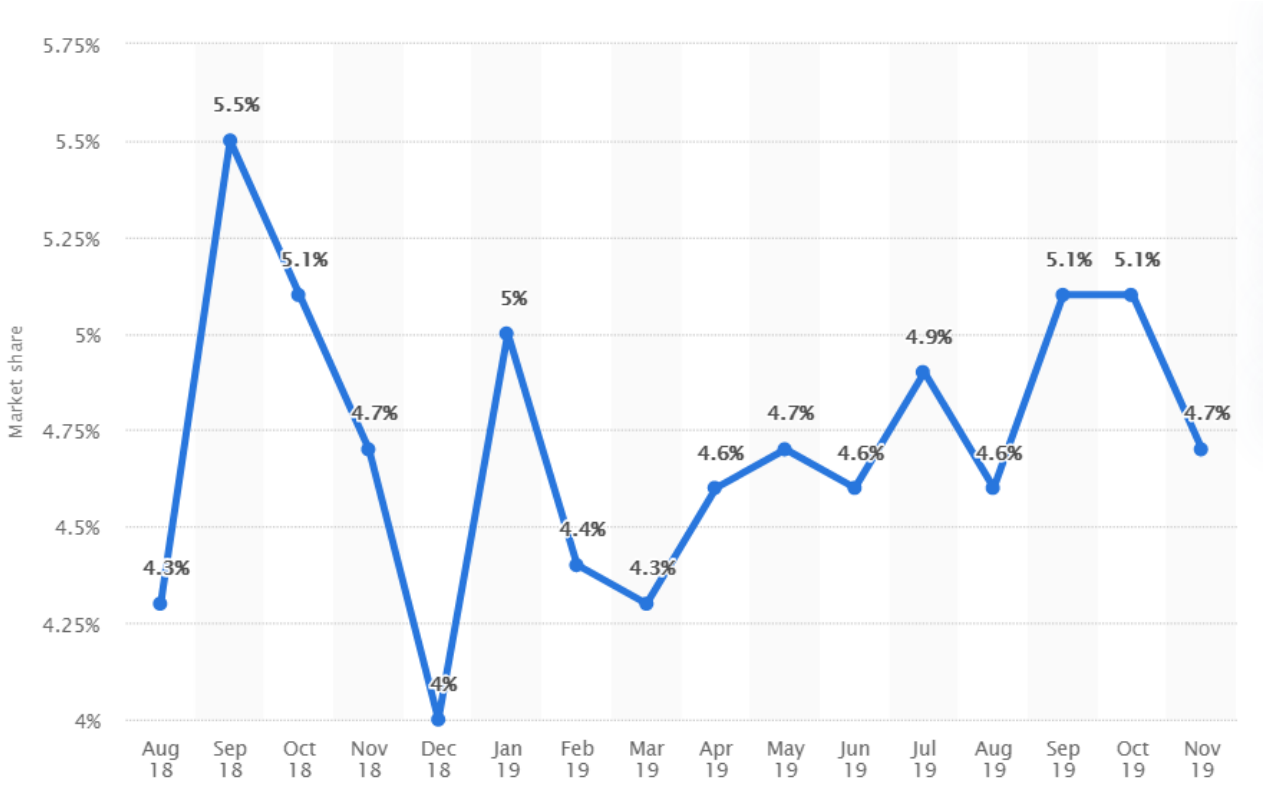
More than half of Toyota's European sales are hybrids and their success is contributing to the automaker's sustained profitability in the region, putting it in a position to achieve

[72] Sustainability Report of Toyota (2019)

[73] https://www.toyota-europe.com/world-of-toyota/feel/operations/made-in-europe/made-in-europe

the EU's toughest Co2 emissions reduction target that will come into force next year. Moreover, the company will increase the number of plug-in hybrids and battery-electric cars within 2030. In November 2019, Toyota's share of new car registrations in the EU dropped to 4.7% percent. Toyota-branded vehicles are sold by the Toyota Motor Corporation, which is ranked among the largest automobile manufacturers in the world. The following picture shows the trend of last year about Toyota's European market share:[74]

Figure 17: 2019 value of Toyota's share

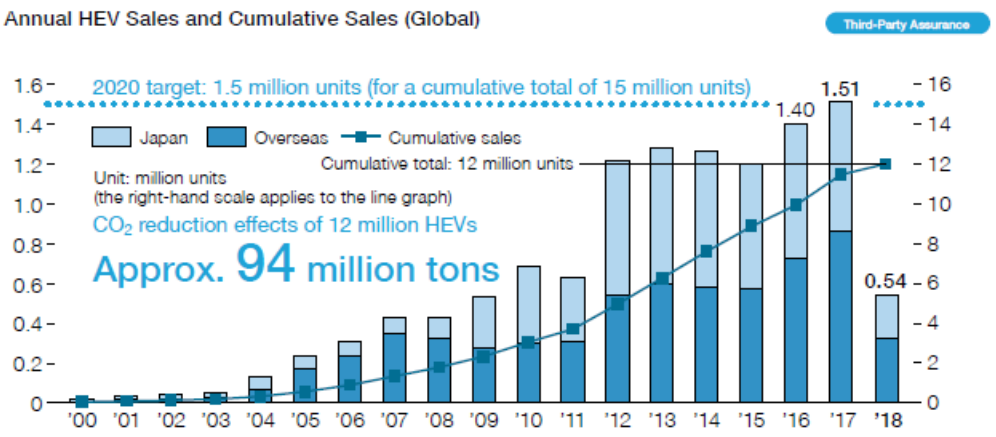


On the bases of the last Toyota Environmental Report released by Toyota (2018), company is aiming to achieve sales of at least 5.5 million electrified vehicles including at least 1 million zero-emissions BEVs and FCEVs by 2030 in Europe. Toyota will expand its range of electrified models and electric options through 2025. In 2020 company has started to expand BEV models to at least 10 in the first half of the decade in Europe. Also, the company will expand its lineup of FCEV's and PHEV's during this decade using the second generation of THS (Toyota Hybrid System) as core technology. As regards the

[74] https://www.statista.com/statistics/276310/toyotas-market-share-of-new-car-registrations-in-the-eu/

HEVs, the company will develop various types of hybrids systems such as high-power and simplified versions, expanding the lineup to meet customer needs and preferences.

Figure 18: Annual HEV Sales and Cumulative Sales



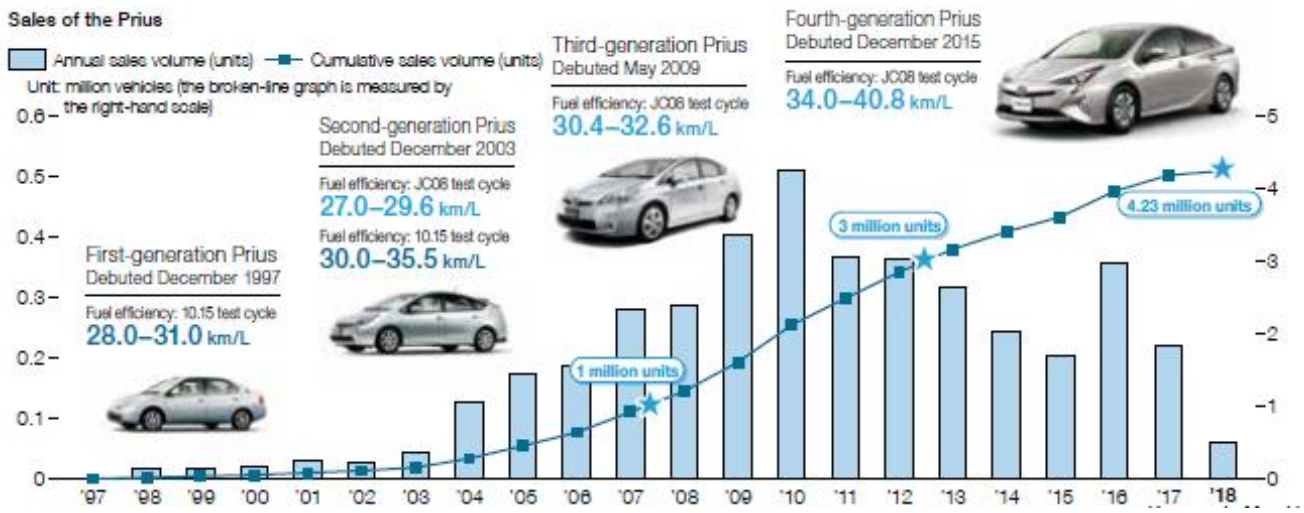
Each type of electrified cars has it its own specific characteristics and each alternative fuel has unique strengths and weakness too. Also, energy conditions, legislations and policies are different among all countries and this has brought Toyota to create mobility opportunities, emphasizing energy efficiency by developing and promoting these four types of hybrid and electric technologies optimizing them for each country and region.

3.5.2 TOYOTA'S MODELS AND LEXUS

Hybrid and electric technologies represent an evolution compared to the traditional ones. Toyota Prius was the first modern hybrid car to be introduced in the global market at the beginning of the new millennium and, as the name suggests, this is the first model produced.

The development of the first Prius had two missions: first of all to build a car for the century, secondly to transform the way Toyota makes cars. Through this, Toyota has managed to enter a market where other manufacturers have tried to enter for decades but without results. The Japanese company has entered a new market with many potential customers predicting that the hybrid sector would attract a good part of the market, as it was necessary to put together the needs of the environment with private transport. The Prius boasted full efficiency, approximately double that of gasoline vehicles in the same class at the time. In each generation of Prius, the company has enhanced environmental and driving performances, increasing the number of units sold:

Figure 19: History of Toyota Prius



Among generations of Prius, the company has obtained the support of many customers that have agreed to this new concept of car. Because of this, these new vehicles can contribute to decreasing the amount of GHG emissions to support the environment. According to Toyota's statements, the total amount of Co2 emissions from logistics, per ton-kilometers and for production activities is decreased:

Table 14: Emissions

FY	2014	2015	2016	2017	**2018**
CO_2 emissions from logistics (million tons)	0.290	0.278	0.275	0.282	**0.286**
CO_2 emissions per ton-kilometer (g-CO_2/tkm)	106.6	109.6	108.4	105.2	**104.2**

FY	2014	2015	2016	2017	**2018**
VOC emissions per area painted (g/m²)	18.8	17.2	15.8	14.6	**14.4**

Trends in VOC Emissions Volume in Vehicle Body Painting Processes by Consolidated Subsidiaries in Japan

FY	2014	2015	2016	2017	**2018**
VOC emissions per area painted (g/m²)	24.1	22.6	21.8	21.5	**21.5**

• Vehicle assembly plants of TMC and consolidated subsidiaries and other companies in Japan, a total of eight companies

Trends in VOC Emissions Volume in Bumper Painting Processes at TMC in Japan (Average for All Lines)

FY	2014	2015	2016	2017	**2018**
VOC emissions per area painted (g/m²)	310	282	253	193	**176**

Prius was the first model released by the company, but Toyota is working in more models with a wide range covering SUVs, Sedans and many others.

RAV4 Plug-in Hybrid

The upcoming model in the first half of 2020 is the RAV4 Plug-in Hybrid, one of the most popular SUV in the European market with more than 115.000 units already ordered at the end of 2019. It is gifted with the most recent Hybrid-Electric Toyota technology with a higher power, a better dynamic, huge performances (from 0 to 100 km/h in 6 seconds) and Co2 emission lower than 29 g/km. Toyota has exploited the new lithium battery with a high capacity and plug-in system to release on the most expected SUVs for 2020.

Figure 20: RAV4 model

Mirai

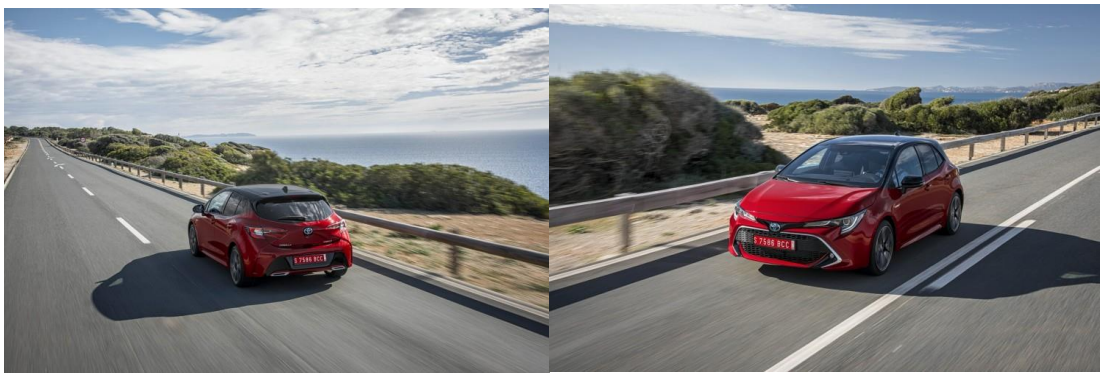
Later in this year the company will launch the second generation of MIRAI, immediately available for the European, North American and Japanese markets. It will be more than a simple eco-car: the technology used is the one related to the FCEV with an increased efficiency (30% more than the first generation) thanks to the new cell system with larger hydrogen tanks

Figure 21: Mirai Model

Corolla

The new generation of Corolla will be the first model to offer two different kinds of engine both Full Hybrid Electric: the first one with 1.8 L and 122 CV and the second one with 2L and 180 CV respectively with a reduction of nitrogen oxide emissions equal to 95% for the first one and 93% for the second respecting the new legislation.

Figure 22: Corolla



Lexus[75]

In 1983 Toyota started a project named F1 ("Flagship" and "No. 1 vehicle"), known also as Lexus LS 400 aimed to develop a luxury car that would expand Toyota's product line. In 2005 the company introduced the first world's first hybrid luxury SUV, the RX 400h. Nowadays, the majority of luxury Self-Charging Hybrids on the road are Lexus delivering its millionth vehicle in 2016. Even if the premium market has registered a decrease in sales (-2%) in 2019, Lexus sales have increased by 5% to reach 40.450 units. This important growth was registered in Italy (+51%), Germany (+33%), Spain (+19%), Poland (+13%), France (+12%) and the UK (+8%).[76] This growth is driven by the launch of new models:

- ***UX Hybrid:*** This model is based on the Full Hybrid Electric technology that guarantees the lowest emissions in its category. The new Lexus UX Hybrid incorporates a fourth-generation Lexus Self-Charging Hybrid system that is more

[75] Alvia, I. S. M. (2008). LEXUS: A Premium Brand. *The Ritsumeikan Business Review*, *47*(2), 71–89. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.494.1439&rep=rep1&type=pdf

[76] https://newsroom.lexus.eu/lexus-international-releases-2019-mid-year-sales-report/

efficient in the industry, capable of delivering 184 HP of power. The heart of the powerful mix, represented by the petrol and electric engines, is the crossover power control unit, now 20% smaller and 10% lighter than previous Lexus systems.

Figure 23: Lexus UX

- ***Lexus RC:*** the first coupé model with the Full Hybrid Electric technology which combines an efficient petrol engine with a high-performance electric motor: 223 CV with Co2 emissions of up 113g/km, the lowest in the market for this performance.

Figure 24: Lexus RC

According to the Toyota Annual Report of 2019 company consolidated vehicle sales for 2019 amounted to 8,977,000 units, an increase of 130,000 units compared to last year. On a consolidated basis, net revenues for the period totaled 30,225.6 billion yen (€24,712.9 billion), an increase of 4.2 percent. Operating income increased from 2,399.8 billion yen (€1,962.14 billions) to 2,467.5 billion yen (€2,017.5 billions), while income before income taxes was 2,285.4 billion yen in 2019 (€1.868,61 billions). Net income has decreased from 2.493,9 billion yen (€2.038,6 billions) in 2018 to 1.882,8 billion yen (€1.538,1 billions) in 2019.[77] As for the European market, the company has sold Vehicles

[77] https://global.toyota/en/newsroom/corporate/22185284.html

for a total amount of 523,550 units, an increase of 30,956 units. Operating income, excluding the impact of valuation gains/losses from interest rate swaps, increased by 8.7 billion yen ($79.816 millions) to 70.6 billion yen ($647.706 millions).[78]

[78] Toyota Annual Report 2019

3.6 FORD IN EUROPE

Ford has outlined its electrification strategy for Europe with the goal of electrifying every single model by the end of 2030. At the end of 2019 the company announced 16 new versions or all-new models, six of them are plug-ins:

- 7 mild hybrids
- 3 full hybrids
- 4 plug-in hybrids
- 2 all electric

Ford is planning to be the leader in the electric car market with a high variety of electric vehicles that will be released in the new decade, focusing also on a charging infrastructure and specific mobility service: in 2019 Ford announced that all the models that were going to be launched in the market would have and electric and/or a hybrid option. This includes new nameplates and new versions of existing vehicles. Either one of, or a combination of, mild-hybrid, full-hybrid, plug-in hybrid or full battery electric options will be offered, providing one of the largest line-ups of electrified options for European customers.

All the next generation electric vehicles will have a next-generation connectivity for over the air-updates and company is setting charging solutions for its electric-vehicle customers. As seen in the previous chapter, Ford is a founder member of IONITY which is a group of companies whose goal is to build 400 fast-charging points in key European locations by the end of 2020, with a charging capacity of 350 kW. This should reduce charging times compared to existing systems. Ford will also be partner with NewMotion[79] to provide a one-stop-shop for charging points in 28 countries across Europe. Joerg Beyer, the executive director of engineering of Ford in Europe has declared: "Ford's nuanced powertrain strategy is designed to help our customers find the right solution to make their electrified vehicle experience easier and more enjoyable", which underlines the future of the company in the following decade.

[79] This company has brought an evolution in electric charging, providing EV-drivers with easy to use smart charging solutions, connected to the largest network of Europe.

As mentioned in the last chapter, Ford has adopted an interesting strategy that includes going "all-in" in the hybrid and electric market: at the end of 2019 the company announced a huge investment of $11 billion dollars in electrification (part of them intended to the European market) necessary to produce more than 40 new vehicles by the end of 2022. Following the "all-in" strategy the company has announced that it will cut more than $14 billions in costs over the next 5 years and shift capital investment away from sedans and internal combustion engines to develop more trucks and electric/hybrid cars. To do that the company has made a deal with Volkswagen to use the German auto maker's electric vehicle architecture - its modular electric toolkit - to build more than 600,000 electric vehicles to sell in Europe starting in 2023.

Ford has adopted the same strategy as Volkswagen and Ford, building its strategy around HEV, PHEV, BEV and hydrogen vehicles, but compared to other companies, Ford has invested more in manufacturing plans and other sites, rethinking the way company use energy is crucial to lowering its facility GHG emissions and playing our part in addressing climate change. As well as maximizing efficiency, we also look for ways to make a more positive impact by using more renewable energy, setting a more aggressive target to reduce operational emissions and making our transport more fuel efficient. Through this company has achieved 30% reduction per vehicle eight years early. The strategy should target a total reduction of 18% by 2023, reaching a goal announced in 2010 and which should have been reached 2025.[80]

Figure 25: Ford strategy in the next 20 years

[80] https://media.ford.com/content/fordmedia/feu/it/it.html

Regarding new vehicles for the following years, Ted Cannis (Ford's global director of electrification) announced at the Frankfurt Motor Shop of 2019: "We're coming in at the right time. We could do all sorts of different things, but we're going to play to what we're good at: commercial vehicles, vans, pickups, performance vehicles and SUVs. We have loyal customers, we know our base and the margins are better. It's just the right business." Ford has already come up with new models presented in the Frankfurt Motor Shop, showing the most extensive line-up of electrified vehicles:[81]

Kuga Plug-in Hybrid

It's a variant of the all-new-mid-size SUV, Ford's most electrified vehicle ever and the first to offer mild-hybrid, self-charging, full-hybrid and plug-in powertrains. It combines a 2.5-liter petrol engine, electric motor and generator, and 14.4 kWh lithium-ion battery delivering 225 PS and a pure electric driving range in excess of 50 km and 1.2l/100 efficiency and with 29 g/km Co2 emissions.

Figure 26: Kuga Model

[81] https://insideevs.com/news/343755/ford-goes-electric-in-europe-bold-electrification-plans-announced/

Explorer Plug-In Hybrid

These will be offered in two distinctive high-specification variants that are Explorer St-Line and Explorer Platinum. Powered by a combination of Ford's 3.0-litre EcoBoost V6 petrol engine, electric motor and generator, the Explorer Plug-In Hybrid delivers 450 PS and 840 Nm of torque. The SUV will also offer 40 km (25 miles) zero-emissions, pure-electric city driving range, alongside anticipated 3.4 l/100 km fuel efficiency and 78 g/km CO2 emissions.[82]

Figure 27: New Explorer

Tourneo Plug-In Hybrid

This eight seats Tourneo Custom Plug-In Hybrid is designed to contribute to reduce local emissions and enable operation in growing number of ultra-low-emission vehicle being introduced across Europe and it will be available by the second half of 2020. The Tourneo Custom Plug-In Hybrid's front wheels are driven exclusively by an electric motor/generator, powered by a 13.6 kWh lithium-ion battery pack. The hybrid powertrain targets a zero-emission driving range of up to 50 km (31 miles) or 500 km

[82] https://media.ford.com/content/fordmedia/feu/en/news/2019/09/10/Frankfurt-2019.html

(310 miles) using the range extender, alongside anticipated 3.3 l/100 km fuel efficiency and 75 g/km CO_2 emissions.

Figure 28: Tourneo model

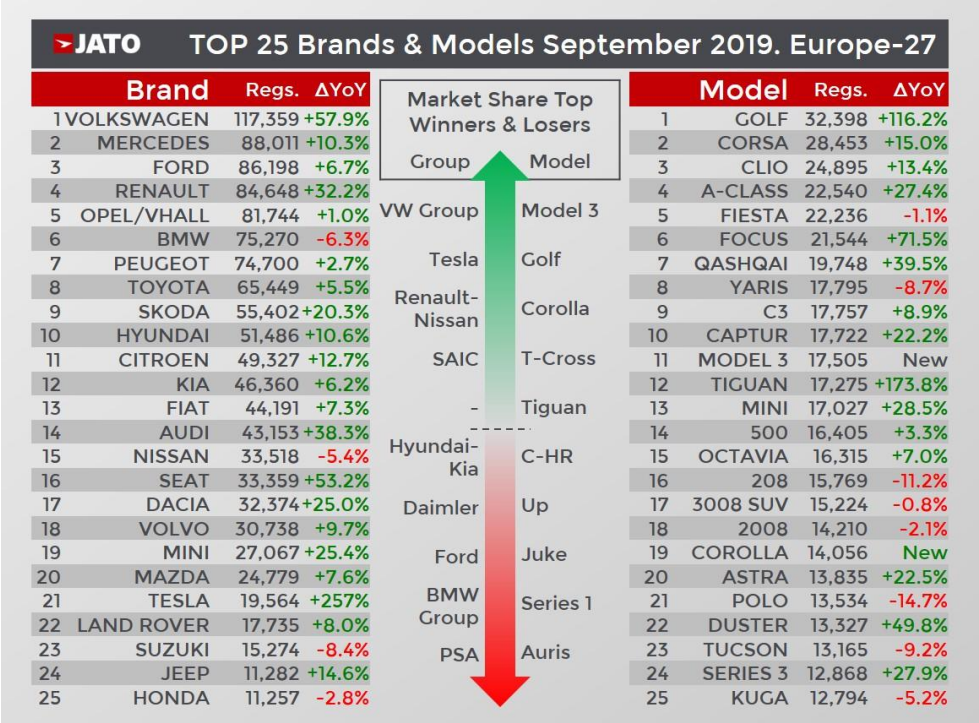
At the end of 2019 the president of Ford in Europe declared: "Ford will be a more targeted business in Europe, consistent with the company's global redesign, generating higher returns through our focus on customer needs and a lean structure. Implementing our new strategy quickly enables us to invest and grow our leading commercial vehicle business and provide customers with more electrified vehicles, SUVs, exciting performance derivatives and iconic imported models."[83] As mentioned before, Ford has launched a new model, redesigning its business focusing on electrification since the EU is preparing to publish rules that require a reduction of CO2 by 15% for passenger cars and light commercial vans in 2025 compared to 2021, and, in 2030, by 31% for light commercial vans and 37.5% for passenger cars compared to 2021.[84] The EU Commission will investigate the introduction of Real Driving CO2 and Life Cycle Assessment elements. Unfortunately, financial forecasts for Ford are not available yet, since the company rebuilt its business in 2019.

[83] https://media.ford.com/content/fordmedia/feu/en/news/2019/06/27/ford-looks-to-the-future-in-europe--business-redesigned-for-prof.html
[84] https://corporate.ford.com/microsites/sustainability-report-2018-19/assets/files/sr18-form-10-k.pdf

3.7 TESLA

Since Tesla started its electrification plan in 2008, the company has not set a strategy for the 2025 in terms of electrification: all the three great competitors we have analyzed have prepare strategy within the 2025 to increase their hybrid portfolio meanwhile Tesla has already implemented that strategy 10 years ago. Therefore, Tesla is working more on the charging infrastructure system. In 2012 Tesla opened 12.000 superchargers with a medium charging speeds up to 120 kW which means the complete charge time is around 30 minutes. In 2017 Tesla announced "Megacharger", a charging system with a superior power that should be used especially for van and trucks. In 2019 the total amount of Tesla Model 3 delivered was 17,505 enabled Tesla to reach a historic 11th position in the top-selling car rank and it was the first time that an electric car had come so close to entering Europe's top 10 model rankings.[85]

Figure 29: Tesla rank position at the end of 2019



[85] Cheong, T., Song, S. H., & Hu, C. (2016). Strategic Alliance with Competitors in the Electric Vehicle Market: Tesla Motor's Case. *Mathematical Problems in Engineering*, *2016*. https://doi.org/10.1155/2016/7210767

Company is offering three different models:[86]

Tesla Model S

It was the first luxury electric sedan in the history of car market, characterized by a maximum high speed of 261 km/h and acceleration 0-100 in just 2.6 seconds. The first model was based only on rechargeable batteries. This allowed planners and designers to be free from the constraints imposed by the heat engine, transmission and exhaust organs in their work. This design guarantees the car stability by significantly lowering the center of gravity, as well as giving greater volume to the passenger compartment and the boot compared to a car with a typical fuel engine.

Figure 30: Tesla model S

[86] https://www.tesla.com/it_IT/blog?redirect=no

Tesla Model X

It’s the first SUV designed by the company, its Tesla's fully electric powertrain offers excellent performance in all weather conditions, thanks to all-wheel drive, adaptive air suspension and more powerful acceleration than any other SUV: from 0 to 100 km / h in 2.9 seconds. Also, it offers one of the best autonomy available in the market (507 km with a full charge).

Figure 31: Tesla model X

Tesla Model 3

The Tesla Model 3 is an electrically powered 4-door D-segment sedan equipped with a rechargeable lithium-ion battery, produced by the Californian company Tesla since July 2017. This model delivers an all-electric range of 402 km and the Long-Range version of 518 km and it is equipped with 4G and Wi-Fi connectivity, which allows it to receive over the air the software updates that Tesla releases to solve some problems or implement new functions.

Figure 32: Tesla Model 3

3.8 WORLD HYBRID AND ELECTRIC MARKET[87]

All the policies we analyzed in the first chapter are not only related to the European hybrid and electric car market but also to the global one. Companies are now investing around the world, increasing their market share and infrastructures in this market.

3.8.1 CHINA

Table 15: China projects

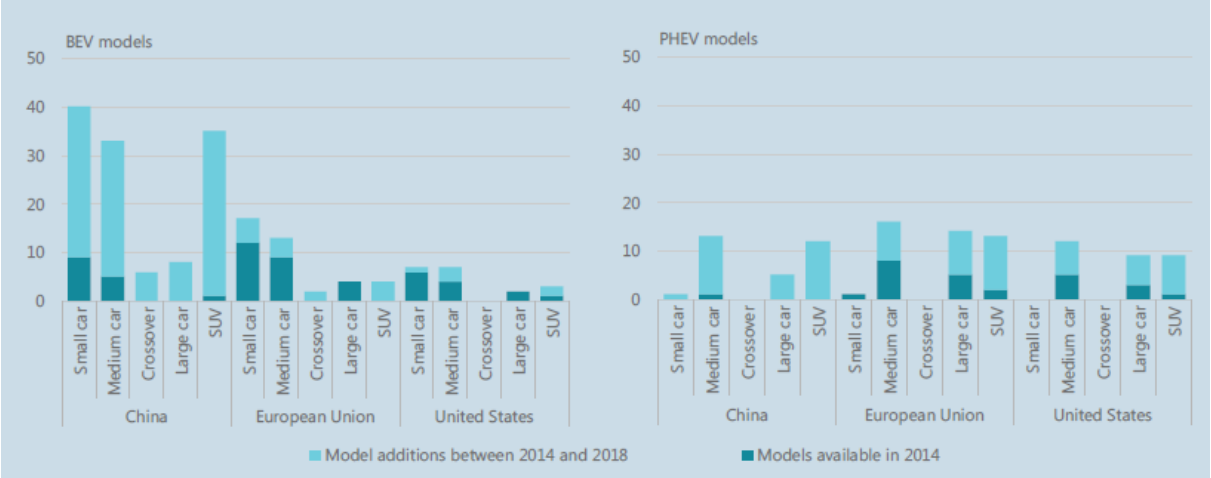
Country	Policy type	Description
China 	**Regulations** (vehicles)	Proposal to tighten average fuel economy for PLDV fleet in 2025. From January 2019, investments in new ICE production plants are prohibited. Voluntary standard for BEV fuel economy.
	Incentive (vehicles)	Gradual reduction of the subsidies available to the electric car industry.
	Industrial policy	New energy vehicle (NEV) credit mandate requires OEMs to produce a minimum share of NEV cars.
	Incentive (chargers)	Local incentives for private home charging and public charging.
	Target (chargers)	Around 150 000 public chargers by 2020.

Almost 45% of the world's electric car fleet is in China. The stock of electric cars in China is almost doubled compared to the last year, reaching almost 2.3 million vehicles. In the last 5 years the Chinese government has promoted policies to protect the environment and to reduce the amount of GHG emissions. The use of differentiated incentives for vehicles based on their battery characteristics (e.g. zero-emissions vehicle credits and subsidies under the New Energy Vehicle mandate). According to projections, China is leading statistics with a 57% regarding all road transports but this percentage will increase up to 70% in the 2030 scenario about the electric and hybrid market.

[87] Farhan, M. (2016). *Marketing of Electric Cars. Feb.*

If we focus on the BEVs and PHEVs models, China has the highest volume of electric car sales worldwide followed by Europe and the United States:[88]

Figure 33: Chinese current situation



The three main global markets differ in the availability of BEV and PHEV models: there are about 16 models in the US while the European market has twice as many. A great range of available models (almost 114) populates the Chinese market and this can be explained through the fact that the car market in China has a higher fragmentation than the other markets and it has a larger size too. China also shows important differences with other markets because one-third of its BEVs models are in the SUV category. This may reflect pressure on domestic manufacturers to sell an increasing number of "new energy vehicles", requiring BEVs to broaden into different market segments, and by the growing consumer preference for SUVs, making them an attractive option to gain market share.

Moreover, the charging infrastructure has increased to support the development of BEVs: the estimated private charges is one private charger per 1.5 cars. For the pubic ones, almost half of the newly installed publicly accessible chargers were fast, whereas in Europe and the United States a large majority were slow chargers.

The national New Energy Vehicle Subsidy Program supports the adoption of EVs, is focused on vehicle range, energy efficiency and battery pack and it should stimulate innovation, inducing consolidation in the battery manufacturing industry. This program involves subsidies for battery electric cars. China is playing a key role in Volkswagen's

[88] Global Electric Vehicles Outlook 2019

strategy and in its de-carbonization program. In 2019 the company released 14 electric and hybrid models and it is planning to release 70 more models by the end of 2028. Volkswagen has already presented the new ID ROOMZZ, a large electric SUV which will arrive in the Chinese market in 2021 meanwhile Audi has presented the AI:Me model as the German group considers China the global driver of electro-mobility since it has a very clear stance on industrial policy, making electro-mobility a "de facto industrial and socio-political goal" as declared by Stephan Wollenstain, the CEO of Volkswagen Group China.[89] At the end of 2020 Volkswagen will start a production in two factories, in Shanghai and Foshan, with a potential of 600.000 vehicles.

Furthermore, in 2019 Ford launched the first electric SUV in China called the Territory EV and the company is planning to sell more than 30 models in the next decade according to the plan launched by Ford last year called Ford China 2.0. Ford has also made a deal with China's Jiangling Motors with the goal to launch an electric version of the Mustang Mach-E in China that should start in 2021.

At the beginning of 2020 Tesla launched the new $2 billion electric-car factory in China making a deal with Nio, a Chinese company that delivered more than 20.000 electric cars in 2019. The new plant should have the capacity to deliver more than 250.000 vehicles per year.

Toyota has made a partnership with BYD (Build Your Dreams) to develop electric vehicles to roll out electric sedans and SUV's under the Toyota brand in China during the first half of the 2020s.[90]Additionally, BYD and Toyota plan to staff the new company by transferring engineers and the jobs currently involved in related R&D from their respective companies. The Japanese car maker also wants to start with two fully electric mid-range SUVs. These are BEV versions of the sister models C-HR and IZOA, built Toyota's joint ventures with GAC and FAW (Chinese car companies). In China, Toyota is also working on spreading electrification and developing vehicles which meets Chinese customer's needs in collaboration between Toyota Motor Engineering & Manufacturing

[89] https://www.volkswagenag.com/en/news/stories/2019/04/volkswagen-electrifies-china.html
[90] https://cleantechnica.com/2019/11/08/toyota-byd-form-joint-venture-to-manufacture-electric-cars-in-china/

China (TMEC), and the R&D centers established at Chinese joint-venture companies with China FAW Group Corporation (FAW) and Guangzhou Automobile Group.

All companies are interested in the Chinese market since the government has spent more than $60 billions to support the fledging electric-car industry, including research-and-development funding, tax exemptions and financing for battery-charging stations.[91]

3.8.2 JAPAN

The Ministry of Economy and the Ministry of Land, Infrastructures and Transport introduced new standards for the fuel economy, especially for diesel vehicle in 2019. According to the new regulation, the electric mobility will improve the efficiency of the car market. Government has also used tax incentives for the purchase of hybrid vehicles, PHEVs, BEVs and FCEVs. It exempts PHEVs, BEVs and FCEVs purchase and weight taxes as part of the clean energy vehicle subsidies scheme. Japan aims to reduce 80% of greenhouse gas (GHG) emissions from vehicles produced by domestic automakers (90% for passenger vehicles) – including exported vehicles – to be achieved by 2050 with a combination of hybrid electric vehicles (HEVs), BEVs, PHEVs and fuel cell electric vehicles (FCEVs). Fuel economy standards for trucks were revised and an update of fuel economy standards for cars was announced. For the charging infrastructure system, the government has invested almost 1 billion dollars in previous years, supporting research and development projects for the next decade. As for batteries, the industry makes explicit references to a co-operative approach across industrial stakeholders, to the formulation of policies on joint procurement and stock of resources.

Table 16: Japan projects

Country	Policy type	Description
Japan 	**Regulations** (vehicles)	Fuel economy standards for HDVs in 2025. Fuel economy standards for LDVs in 2020 and 2030.
	Incentives (vehicles)	Tax incentives and/or exemptions for the acquisition of HEVs, PHEVs, BEVs and FCEVs.
	Targets (vehicles)	15-20% EV sales in PLDVs by 2020 and 20-30% by 2030.
	Industrial policy	Reduction of 80% of GHG emissions per vehicle produced by Japanese automakers by 2050.
	Incentives (chargers)	Available for charger deployment.
	Targets (chargers)	Targets for public chargers in cities and along highways.

[91] https://www.washingtonpost.com/business/2020/01/16/next-china-trade-battle-could-be-over-electric-cars/

In Japan, Toyota is the dominant company and it is investing in hydrogen-fueled vehicles and releasing new models. The company has announced that it will share its hybrid technology with other companies to help other states to reach economies of scale faster. In order to develop a better-quality type of battery, Toyota and Panasonic have created a joint venture with the aim of developing solid state batteries in the first half of the 2020s and intends to do so for various automakers. In Japan, Toyota is investing in hydrogen-fueled vehicles and releasing new models.

3.8.3 USA

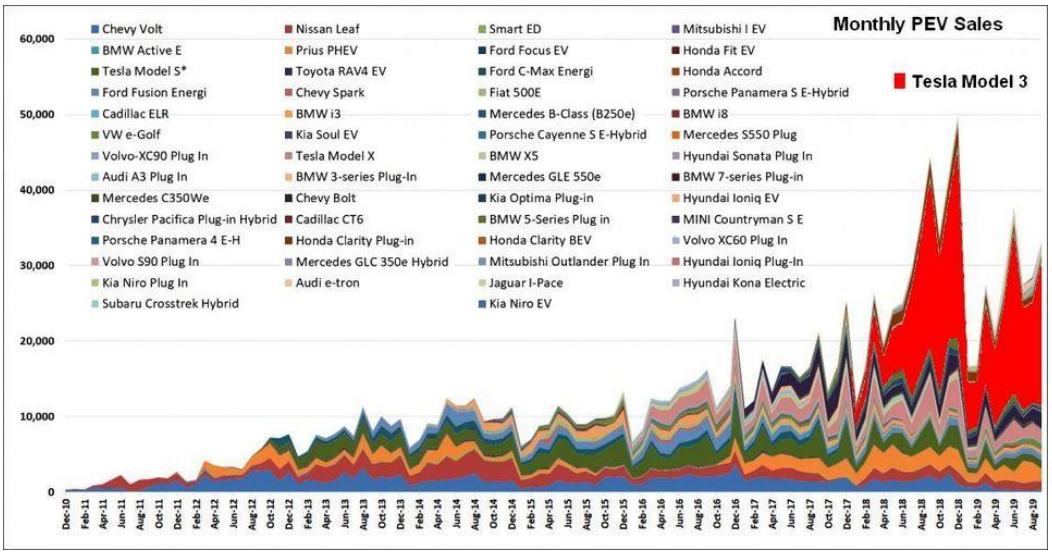
In 2018, the US Environmental Protection Agency (US EPA) announced a review of the GHG emissions standards for new LDVs sold in the US between 2022 and 2025. The US department of Energy's Vehicle Technologies Office supports a variety of work to lower the cost and increase the convenience of EVs by collaborating with national laboratories and industry to improve batteries and electric drive systems. As far as infrastructures are concerned, the United States is among the countries that have ramped up their ambition to install fast charging facilities along highways. California has invested more than 900 million dollars to deploy 250.000 charging points by 2025. Other states like New York and New Jersey have announced that they will invest more than $1.3 billions. The US Department of Energy's Vehicle Technologies Office (VTO) supports a variety of work to lower the cost and increase the convenience of EVs by collaborating with national laboratories and industry to improve batteries and electric drive systems. An example is VTO's Batteries, Charging and Electric Vehicles Program, which supports R&D and aims to reduce the cost of EV batteries to less than USD 100/kWh, and ultimately to USD 80/kWh, increase the range of EVs to 300 miles, and decrease charging time to 15 minutes or less.

Table 17:US projects

Countries	Policy type	Description
United States of America 	**Regulations** (vehicles)	The federal government has proposed to freeze GHG emission standards for LDVs from 2022 to 2025. Twenty US states have signalled willingness to adhere to the previously declared update of corporate average fuel economy (CAFE) standards. ZEV mandate in ten states.
	Target (vehicles)	California aims to have 5 million EVs on the road by 2030.
	Industrial policy	US Department of Energy's Vehicle Technologies Office supports the development of battery and electric drive systems.
	Incentives (chargers)	Incentives to deploy charging infrastructure are provided in more than half of US states.

If we think about all these markets, the US one is probably behind the others. In 2019 the growth of electric cars was due to the Tesla Model 3 which represented half of plug-ins sold in the that year. Total sales of all EVs except the Model 3 were down of 20% respect of 2018 and the EV share of US sales was less than 2%:[92]

Figure 34: Monthly PEV sales



Almost half of the EV vehicles in the previous graph were sold in California where state and local incentives were added to the federal tax credit and a complicated Zero Emission Vehicle mandate requires that EVs be a certain percentage of sales. In the US market EV sales are still low, government mandates and incentives will play a key role in the next decade to increase the hybrid and electric car market share: nine states have already joined, and many others will come.

[92] https://www.forbes.com/sites/uhenergy/2019/11/18/whats-happened-to-us-electric-vehicle-sales/#3997e4d27909

CHAPTER 4: HOW WILL COSTUMERS REACT IN THE NEW CAR MARKET?

4.1 THE FOCUS IS ON THE USERS

In the previous chapters, we saw how policies and companies are affecting the car market with a strong focus on hybrid and electric vehicles. All the forecasts analysed show that these models will change the car market, but this change doesn't depend only on companies, since it is up to customers to make the decision to buy a specific car rather than another one. For consumers, choosing an automobile is often a complicated and high-involved process as it is not a cheap product and the mental process that brings people to choose a car instead of another is complicated because customers have to consider many variables and characteristics. Basically, customers use "purchase parameters" that should determine which car fits better with their preferences and many of them are variables that can be regrouped in five macro variables:

- Price and quality ratio
- Autonomy of the battery
- Performances
- Quality of materials
- Availability of infrastructure necessary for recharging battery for EV models.

These purchase parameters tend to form the final decision-making or –breaking standards for purchase. There are intrinsic and extrinsic motives that bring people to buy hybrid and electric cars:

- Intrinsic variables: consumers may decide to buy a hybrid or electric cars to reduce the impact of emissions in the environment
- Extrinsic variables: consumers may decide to buy a hybrid or electric car just for an "external perspective" which means popularity, image and social status

Basically, customers do a trade-off between all the variables considered in the evaluation process that can be driven by intrinsic or extrinsic variables. If we consider just a customer, it is so difficult to analyse his mental process and identify his preferences but, if we consider a group of customers there will be some common

elements for sure. These can include cost, practicality/performance, aesthetics, the 'lifestyle/image' associated with some makes/models, social influence and the car's environmental credentials like fuel economy/emissions.

PWC Autofacts[93] has developed a mathematical model to quantify the effects of the five "eascy" (electrified, autonomous, shared, connected and yearly updated) dimensions, therefore starts with user ("persona"). By determining behaviours related to personas, it is possible to calculate the individual personal mileage and therefore the overall car mileage in a particular market. According to the report, this model can define three different segments:

- Modern persona: characterized by different preferences like mobile connectivity, inter-modal transport, shared services, autonomous taxis and buses and electrified public transport. This persona should be represented by the millennials.
- Transitory persona: with an age between 35-50, is characterized by long-distance journeys and daily use of own car, car shared with family, safety and connectivity facilities and public transport.
- Traditional persona: with an age over 50 whose attitude is linked more to the "old" fuel car market; so, the car is seen just as a means of transport, and modern mobility options don't play any roles. It owns a car, without any consideration for the electric and hybrid market.

So, the modern persona will be a significant driver in the development of more sustainable and convenient mobility solutions in the next years meanwhile middle-age people will be sceptical regarding the new electric market.

It is also necessary to consider many variables.

1) Attitude and openness to various forms of mobility

[93] Koster, A., Kuhnert, F., & Stürmer, C. (2018). Five trends transforming the Automotive Industry. *PwC*, *1*(1), 35–45. https://www.pwc.com/gx/en/industries/automotive/assets/pwc-five-trends-transforming-the-automotive-industry.pdf

2) Regional and cultural differences
3) Distinguishing features within the user groups are the age structure and whether they live in an urban or rural environment.

Combining these variables and segments, we can predict how the hybrid and electric car market will develop in the following years in the three main markets (US, Europe and China):

Table 18: Focus on the user

	EU	US	China
modern 2017 33 % 2030 38 % +5 percentage points, relative increase of +15%	• Technical innovations are part of everyday life: Use of smartphones and apps for urban transport • Sustainable and healthy lifestyle demands pragmatic view of cars as transportation • Increased inter-modal transport (car versus public transport) • Car ownership less important as a status symbol • Rural areas still use cars e + a + s ++ c ++	• Huge interest in digital technology and innovative mobility concepts • Young, urban users in particular choose variety of transport options that do not involve owning a car • Rural areas are still dependent on cars due to insufficient infrastructure for long-distance travel • Journeys in urban areas often rely on inter-modal approach (e.g. Park+Ride) e + a ++ s ++ c ++	• Young, urban generation experiences economic upswing • New technologies are actively embraced • Car-sharing and ride-sharing services very popular (e.g.: Didi Chuxing App with >400 m users) • Need for own car limited to social status • Long-distance journeys in rural areas continue to rely on own car e ++ a ++ s ++ c ++
transitory 2017 41 % 2030 39 % –2 percentage points, relative decrease of –5%	• Individuality and consumption behaviour promote the formation of different mobility profiles • Primarily young, urban users use alternatives such as car-sharing • The still traditionally-oriented user group continues to prefer owning a car for reasons of comfort, status and flexibility e a s + c +	• Both traditional and modern values • Car ownership is anchored in mobility attitude • Public transport plays a bigger role in cities • Basically open to new mobility alternatives e + a s + c	• Symbolic for the start of the economic upswing • Shared attitude to modern mobility solutions • Traditional prevailing use of own car in rural areas • Widespread use of public transport e ++ a + s + c +
traditional 2017 26 % 2030 23 % –3 percentage points, relative decline of –12%	• Mainly rural population that tends to shy away from technological innovations • Ownership or access to own car is the norm • In urban environments, they often turn to public transport to avoid congestion and parking problems e – a – – s – c –	• Predominantly older groups of society with deeply entrenched values and convictions • Larger share of rural population in segment comparison • Mobility is almost exclusively equated with own car • Not interested in innovative mobility concepts e a – s – c – –	• Public transport preferred, especially in cities • Comparatively open to technological developments • Car use for reasons of flexibility and comfort • Car ownership to express social status e + a s – c

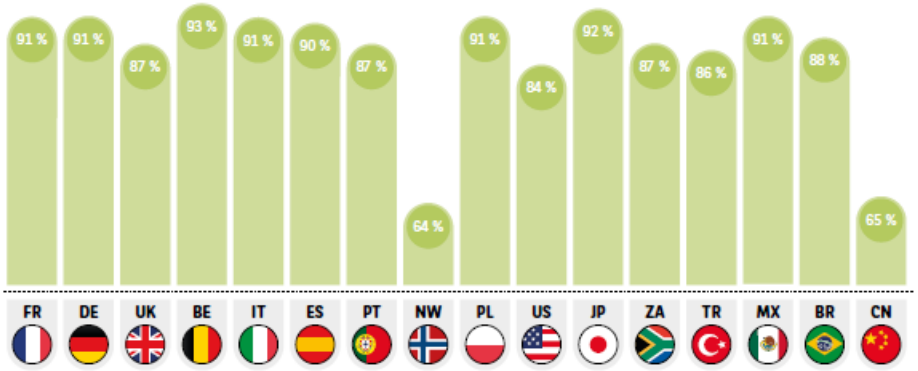
According to forecasts it seems the Chinese market will be the faster to reach a technological change for cultural and political conditions linked to the huge environmental problems, since the level of air pollution in Chinese cities is the highest in the world.

4.2 THE EUROPEAN CAR MARKET

According to a Findomestic survey[94], 83% of respondents affirm that the limits given by the autonomy of the battery constitutes the weakest point in the electric vehicles. 70% think this characteristic reinforces the image of a reserved vehicle to motorists who travel short distances: in fact, for long distance, the autonomy of the battery is not even comparable to the ones offered by a common fuel car (except for Tesla models whose autonomy reach 500 km with a single charge). Anyway, it is also true that most customers don't drive for more than 100 km each day. Battery autonomy will be a strong force until the technology succeeds in finding different solutions: 88% of respondents associate the use of an electric vehicle with the obligation to have access to a charging point at home or in the workplace. For many it is a constraint that involves an adaptation of their home, as the installation of a compatible charging socket would entail an additional cost, but since most of the customers have a private parking area, it shouldn't be that difficult to find a charging infrastructure. The availability of infrastructure is not the only problem, since the time to recharge is another important element. 75% of respondents associate the electric vehicle with long time to recharge battery and 70% expect to have a recharging time lower than 45 minutes. Actually, the private ones require different hours while public charging infrastructures are faster: especially with the IONITY projects and many others, in the following years it will be possible to recharge 80% of the battery in less than 30 minutes. In this market, from the customers' perspective, there is a barrier that is more psychological than functional since there is some resistance from consumers for the reasons listed above. It's a common opinion (86% of the interviewers) that electric and hybrid vehicles are more expensive than the fuel ones. This is effectively true since the prices of electric cars are higher, which is the main reason why people are still not completely involved in this.

[94] *Il mistero dell ' auto elettrica*. (n.d.).

Figure 35: Survey



If we consider all the costs linked to electric vehicles, 42% of the respondents do not consider the idea of buying an EV paying the full price (without incentives). So financial incentives are fundamental to reduce prices and the customers' willingness to pay for hybrid and electric models instead the fuel ones. In this stage of market, it's extremely necessary in order to intensify the market exchanges. According to this report, one of the most important issues is the battery and its duration: 71% of customers believes that duration of battery is still low (27% estimate at 3-4 years, 20% at 5-10 years and only 4% more than 10 years). The loss of durability is absolutely true even if it's progressive: Although they can be subjected to a defined number of charge and discharge cycles, they do not lose all their capacity, but a not negligible part of it. Below 75%, they are no longer properly suited to the needs of cars. For a lithium battery, the first feedback indicates a lifespan of ten years. The car manufacturers offer a guarantee of approximately 5 years for the motorists who wish to purchase it (8 years for Tesla) while for those who prefer rental, car manufacturers change them below 70%.

The last important element ~~that we have to consider~~ is the price of reselling an EV: When it comes to adopting new technology, being able to estimate the residual value of your vehicle and easily reselling it can be reassuring. However, 84% of the interviewees believe that the evolution of used cars prices, and therefore the value of the vehicles at the time of resale, is still unknown. This assessment is made particularly difficult by the fact that about a third of the value is contained in the battery whose capacity decreases progressively and in the very limited number of VE on the market. 74% of the motorists surveyed agree on this small number. It is not surprising that the Norwegians are an exception in this regard (49%), in fact, the greater maturity of the local market justifies

the early arrival of the used VE. In order to reassure potential buyers, car manufacturers create specific brands or offers entirely dedicated to the resale of a VEU (used electric vehicle), such as the Nissan Club and the Occasion ZE at Renault. A good reason to encourage motorists to take this step by freeing themselves, in part, from the high price of a new VE while relying on the brands of car manufacturers to ensure the reliability of their used vehicle.

Developed for a long time in Anglo-Saxon countries and increasingly appreciated elsewhere, car leasing also offers a solution to the anxiety generated by battery life. In fact, by renting the VE or its battery for 3 or 4 years as it often happens, you keep the risk and fear of travelling along with an outdated battery under control. Similarly, negotiated upstream in advance, the uncertainty related to the residual value of the battery disappears.

4.3 THE UNITED STATES' MARKET

A Bloomberg survey has shown that in the US car market, customers are not only trading sedans like BMW3 Series for Tesla Model 3 but also less-luxurious brands like the Toyota Prius and Honda civic. In particular, we can establish preferences among customers according to the following rank [95]:

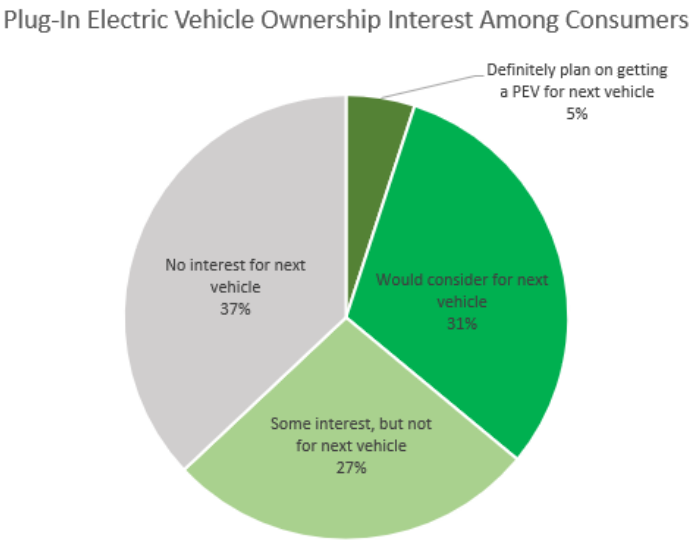
1) Toyota Prius with an average price of $27,080
2) BMW series 3 with an average price of $46,477
3) Nissan Leaf
4) Honda civic and Honda Accord

A different survey shows that Tesla was at the top of 2019 with 33% of all respondents saying that it is the company most trusted for electric vehicles. Toyota was second with 14%, then Honda 8%, General Motors 7% and Ford 6%. Anyway, in a specific question Tesla was ranked lower than Toyota in another survey question, the "most popular brands among shoppers that are likely to purchase an EV in the next six months." Here, the Japanese carmaker was ranked No. 1, at 54%, and Tesla got second, at 52%. Toyota

[95] https://www.forbes.com/sites/brookecrothers/2019/11/17/tesla-model-3-owners-ditch-toyota-prius-and-bmw-3-series-but-conflicting-results-in-brand-survey/#198cfdb22658

electric vehicles have earned their popularity in the US market thanks to Prius which was the pioneer in the hybrid market and this credibility has carried over to the EU's market.

A survey made by Consumer Reports and the Union of Concerned Scientists has showed that the interest in hybrid and electric vehicles is strong in US. The survey shows that 63% of Americans are interested in these vehicles and that 31% could consider buying it in the next years. 39% of potential buyers with an average income between $50.000 and $100,000 per year are considering an electric vehicle for their next purchase meanwhile for individuals with less than $50.000 income per year the percentage goes down to 31%. According to the survey,[96] 36% of prospective car buyers in the U.S. would consider getting a PEV within the next two years, and an additional 27% have some interest in a PEV, but not for their next vehicle.



A key factor that influences American car buyers' interests in purchasing a PEV is the type of car Americans are considering for their next vehicle. More than half of prospective car buyers who are likely to buy a compact would consider getting a PEV, as would around two-fifths of those who are likely to get a sedan, small SUV, sports car, or minivan. Even about 30 percent who are in the market for larger vehicles like

[96] https://www.ucsusa.org/resources/surveying-consumers-electric-vehicles

medium/large SUVs or even pickup trucks would at least consider getting a PEV, which is strong considering the very limited selection in this class.[97]

Overall, 75% of car buyers in the U.S. believe that the use of hybrid and electric cars can contribute decreasing the level of pollution and oil consumption among the country. Moreover, customers think that incentives and tax incentives for PEVs should be available for all consumers, independently of the income brackets in which people belong.

There is also a strong consensus (72%) that automakers should make PEVs in a variety of types (for example SUVs and minivans) and 50% of costumers believes that the federal government should invest money to help consumers purchase PEVs.

So more than 50% of customers agree that lower purchase prices and longer driving ranges would be more effective in increasing their interest in getting a PEV.

4.4 CHINA CAR MARKET

China is an emerging market, and as such, it has been defined as "a country in which its national economy grows rapidly, and its industry is structurally changing". China needs to do a lot of changes and to go through a lot of challenges, but according to Donnelly & Beckley (2010), two are the most important. First, the structural problems that will help create a more viable and sustainable auto industry, secondly, China must catch up with the more advanced global competitors, especially in areas such as design, technology and brand equity. In the context of international competition, China must address these issues, if they desire to achieve the targets they have set until 2020-2030, which is to hold a 10% share of the global car market outside their domestic borders.[98]

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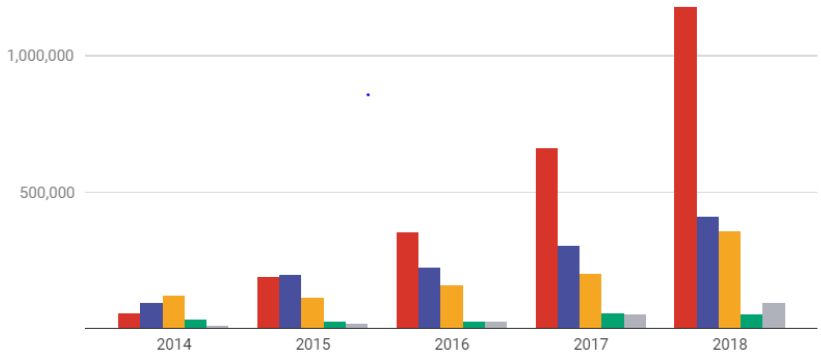
[97] *Electric Vehicle Survey Findings and Methodology*. (2019). *July*. www.ucsusa.org/EVsurvey2019www.cr.org/advocacy

[98] Penev, A., & Penev, A. (2011). *Chinese Consumer Attitudes towards the Electric Vehicle Authors : Responsible coordinator : Objective :*

China's electric car market is growing much faster than electric vehicle sales in Europe, the United States, Japan and the rest of the world combined.[99]

Figure 36: Survey



China: red Europe: blue US: yellow Japan: green

A key element of the price of an electric vehicle is the cost of its batteries and China already makes more than half of the world's electric vehicle batteries. Battery prices continue to fall. Industry analysts now suggest that within five years it will be cheaper to buy an electric car than a gas- or diesel-powered one. In 2018 more than 1.2 million EV and hybrid vehicles were sold, registering an impressive growth rate of 71%. Battery electric vehicles (BEVs) contributed 75 percent of these sales, with the remainder accounted for by plug-in hybrid electric vehicles (PHEVs). By 2024, sales are forecast to surpass 5 million units, of which 70 percent will be BEVs. Despite policy changes and diminishing government subsidies, consumers look enthusiastic about these vehicles: in the first half of 2019 sales of EV in China rose substantially and the expansion of consumer choice s fostering market maturity. So, costumers are now thinking harder about they want, and their preferences related to this market. When it comes to vehicle size, Chinese consumers increasingly favor A-class NEVs, with these accounting for more than half the market in the first six months of 2019, up from 43 percent a year earlier. This is in keeping with the trend in traditional internal combustion vehicles, where A-class vehicles now make up two-thirds of sales. B-class models are also increasingly favored in both segments, at the expense of the smallest A-minus-class cars.

[99] https://www.marketwatch.com/story/china-not-tesla-will-drive-the-electric-car-revolution-2019-05-14

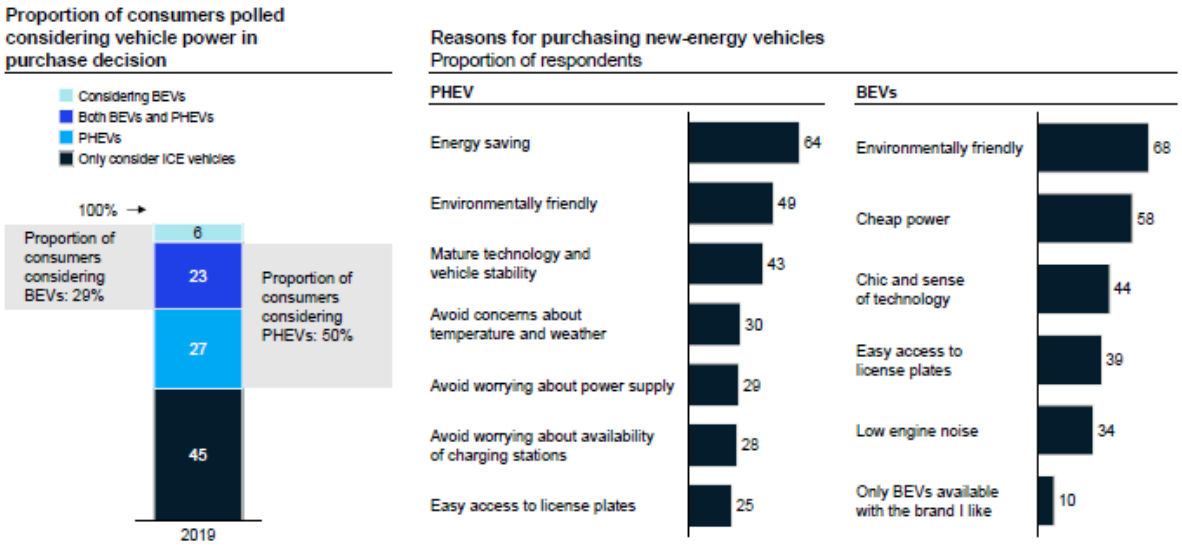
In terms of powertrain, BEVs increasingly dominate PHEVs. Although market penetration of new EVs has increased, it remains relatively low compared with consumers' apparent willingness to buy these kinds of cars, indicating robust potential for future sales. Chinese costumers' awareness towards NEVs is improving and since 2017, the proportion of consumers willing to embrace NEVs has risen to 55% from 20%. Also, residents in large cities are more open to new EVs than those from lower-tier cities. Automakers have worked hard to educate consumers, while central government subsidies, and local government perks like expedited or permitted license plate approval, and travel privileges, have all played a part in shifting market sentiment. Expanding charging station infrastructure is also lifting consumers' confidence in EVs. A large part of customers understands new electric vehicles and have gained preliminary knowledge of their performance and use. According to McKinsey's report[100], 60% of respondents of different ages have a basic or deep understanding of the capabilities off various powertrains. According to numbers, we can observe that people between 25 and 44 years are the ones who better understand these technologies, while the youngest are not that involved according to the following chart.

Figure 37: Survey

[100] Guan, M., Gao, P., Wang, A., Zipser, D., & Shen, P. (2019). *McKinsey China Auto Consumer Insights 2019 - Navigating the road ahead in the world's largest auto market. October*. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/china-auto-consumer-insights-2019

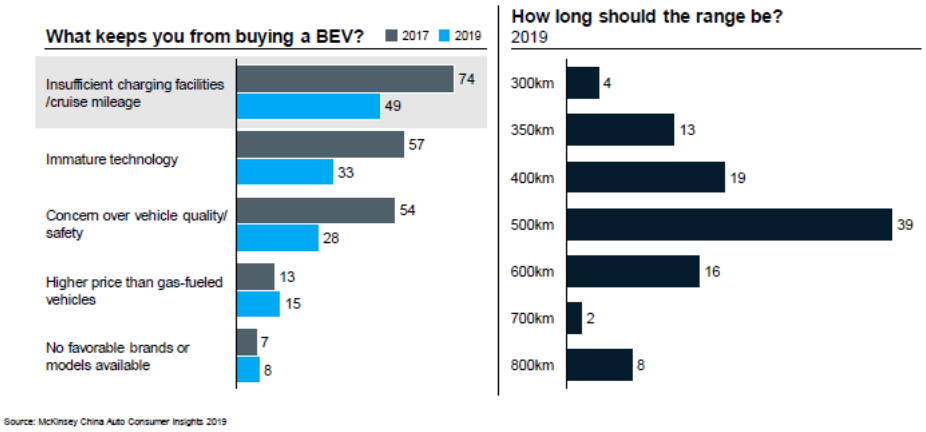
In general, the consumers that chose BEVs o PHEVs believed the most valuable advantages of new EVs were environmental friendliness and energy efficiency. Consumers recognize to be in that environment, and they recognized the advantages related to EVs and hybrid ones. The consumers who want to buy PHEVs are mainly motivated by mature technology and better endurance, but also for safety and stability in different weathers. According to the report, these are all the variables considered by customers:

Figure 38: Survey



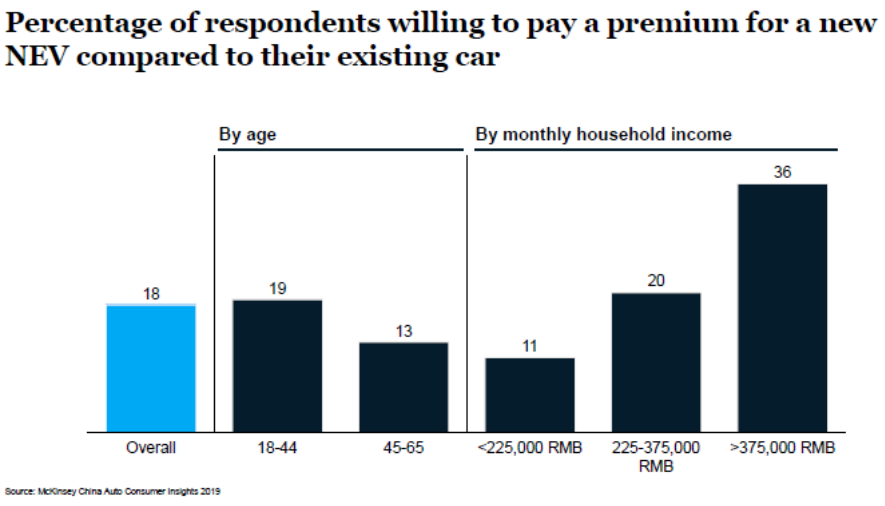
According to data, customers are improving their decision-making process since in choosing a new electric vehicle, the total cost (purchase cost and cost of daily use) in the primary consideration which is higher than the common vehicles. All the doubts related to this technologies concern availability of charging infrastructure, range, technological maturity and safety. In terms of charging infrastructure, the owners of new EVs in lower-tier cities are more dependent on public charging facilities than those in big cities: the coverage in these areas is still weak and drivers suffer long times for access to power. 60% of the problems can be attributed to insufficient charging facilities and the remote locations of those in operation. Also, the range should be higher: only Tesla offers an autonomy around 500 km, while the others are not even close to 400 km:

Figure 39: Survey



Anyway, Chinese costumers are improving their decision-making, considering many variables, but are they willing to pay a premium price for a new electric vehicle or hybrid model compared to existing car? 18% of respondents told they are willing to pay a higher price for NEVs. This is especially true for high-income populations, where the proportion is 36%. Respondents aged 18 to 44 showed greater willingness than those aged above 45. This suggests the long-term demand outlook for new EV sales is secure. The figure below shows the enthusiasm of high-income users, as well as middle-aged and young consumers, for new technology, not to mention their willingness to upgrade consumption.

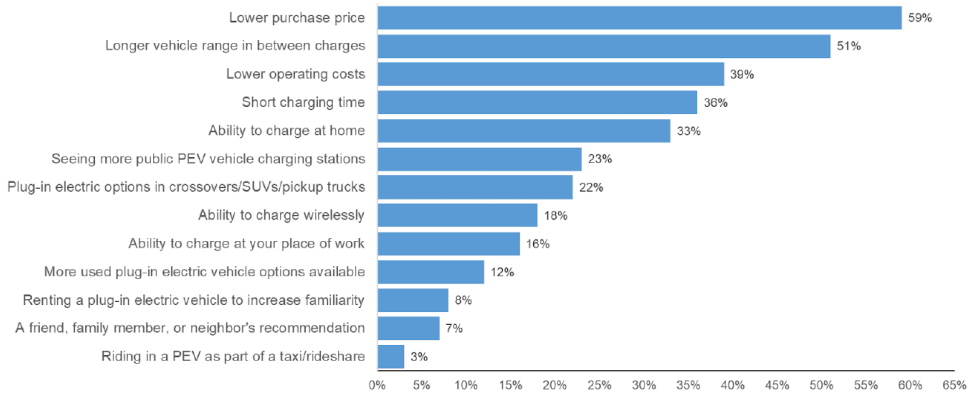
Figure 40: Survey



The following chart shows all the variables considered in this chapter that affect customer choices around the world, since there are common problems related to this

market especially linked to prices, charge infrastructure, recharge time and ability to charge a home

Figure 41: Final result of survey



CONCLUSION

In the last years, all governments around the world have decided to create new policies in order to reduce the huge level of pollution reached around the world. In the year 2015 the European Union and 195 countries adopted the Paris Agreement[101], a multilateral treaty, according to which governments agreed to act in their national context to hold the world temperature "well below" 1.5°C while also pursuing efforts to stay below 2°C. This agreement and many other policies are aimed to make all countries focus on green economy and sustainability. According to the "The Green Paper", which identifies the relationship between companies and the external environment, these elements must change the ecosystems in which companies operate, particularly those related to the automotive market, since it is responsible for more than 20% of GHG emissions around the world.

Car industry is changing rapidly, focusing on new technologies, particularly those related to electric vehicles and the hybrid ones. This rapid change around the world will cause consequences for the entire industry and its value chain. All the elementary structures and attitudes will have to change fast in order to reach all the objectives prefixed by companies by the end of 2030. In order to remain successful, manufacturers and suppliers will have to offer customer-oriented innovations, since only Tesla appears in the 10 most innovative companies. So, investments are what really matters: first, their size, in fact all the companies previously analyzed are planning to invest a lot of billions for the following decade (2020-2030). Moreover, the type of investments that are necessary to restructure the automotive industry is important too, which means that manufacturers and suppliers need to redistribute their budgets quickly and in a targeted manner.

Researches and developments should focus on software and service but also on manufacturing feasibility and the modularization of vehicles. Software needs to enhance the performance of the products, while services need to offer the customer additional functionality and improved user-friendliness which, in turn, must be able to be

[101] http://www.law.uwa.edu.au/__data/assets/pdf_file/0006/3090579/CHAPTER-14.pdf

integrated into the hardware easily. The transition that companies are facing in this following decade can create a huge vulnerability for them since they will have to face falling margins and make far greater investments in electro-mobility and new customer-oriented innovations.

The focus of companies on markets will change in the future years since all companies are bringing their attention to the Asian market, especially concentrating on the Chinese one where electric car market will be developing faster than the others (this will happen especially because of the level of pollution there).

Toyota, Volkswagen Ford and Tesla are all investing in the electric market since they are all planning to become “fuel independent” by the end of 2030. According to their strategy EV production has the potential to replace the declining diesel manufacturing, notably in less wealthy regions heavily reliant on traditional manufacturing today. Toyota, Ford, Volkswagen and Tesla have all set they strategy for the next decade with the goal to reach a leadership in their own continental markets and all with a strong focus on the Chinese one. According to surveys, customers look like they are increasing their interest in this new market, even if some doubts related to battery and performances are still affecting their choices and preferences. On the other hand, all the state policies are contributing to rise people’s awareness on these problems and doubts. The transition from polluting fossil fuels to renewable energy, and from car-centered mobility to alternative mobility modes is already underway in most countries, demonstrating that it’s not only a technological challenge but a political one.

In conclusion, not only must Eco-sustainable development be able to meet the needs of present generations without compromising those of the future ones, it also has to succeed in planning long-term economic progress to contribute to a greater benefit for the ecosystem, its inhabitants and the automotive industry too.

BIBLIOGRAPHY

- Dizionario “il Sabatini Colletti”
- World Economic Forum. Marsh & McLennan Companies., & Insurance, Z. (2019). Global Risks Report 2019.
- Kolbasov, O. S. (1992). UN Conference on Environment and Development. Izvestiya -Akademiya Nauk, Seriya Geograficheskaya, 6(June), 47–54.
- Chemiluer-Gendreau, M. (2011). Rio political declaration on social determinants of health. Mundo Da Saude, 35(4), 467–472. https://doi.org/10.1787/9789264095281-12-en
- Wass_2014_SustainabilityAssessmentandIndicators-ToolsinaDecision-Making. (n.d.).
- Allen, C., & Clouth, S. (2012). Green economy, Green growth, and Low-carbon development–history, definitions, and a guide to recent publications. Division for Sustainable Development, Department of Economic and Social Affairs, United Nations, New York, August., (1), 1–63. Retrieved from https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=634&menu=1516
- Owen, A. D., & Hanley, N. (2004). The economics of climate change. The Economics of Climate Change, 98(2), 1–297. https://doi.org/10.4324/9780203495780
- Frey, M. (2013). La green economy come nuovo modello di sviluppo. ImpresaProgetto - Electronic Journal of Management, 3, 1–18.
- Module 1 Introduction to the Workshop. (n.d.). 8–26.
- Archie, C. B. (1991). The Pyramid of Corporate Social Responsibility: Toward the Moral Management of Organizational Stakeholders. Business Horizons, (August), 153–170.
- Carroll, A. B. (1991). The pyramid of corporate social responsibility: Toward the moral management of organizational stakeholders. Business Horizons, 34(4), 39–48. https://doi.org/10.1016/0007-6813(91)90005-G
- Green Paper. Commissione delle Comunità Europee. Bruxelles, 18.7.2001. (n.d.).

- Johnston, R. B. (2016). Arsenic and the 2030 Agenda for sustainable development. Arsenic Research and Global Sustainability - Proceedings of the 6th International Congress on Arsenic in the Environment, AS 2016, 12–14.
- Wewerinke-Singh, Margaretha; Doebbler, C. (2016). The Paris Agreement: Some Critical Reflections on Process and Substance. University of New South Wales Law Journal, 39(4), 37–53. https://doi.org/10.1016/0008-6223(96)89488-7
- Bodle, R., Donat, L., & Duwe, M. (2016). The Paris Agreement: Analysis, Assessment and Outlook. Climate and Carbon Law Review, 10(1), 5–22. https://doi.org/10.2307/43860128
- Stephan, B., Lee, I., & Kim, J. (2019). Crashing the Climate - How the Car Industry Is Driving The Climate Crisis.
- Altenburg, T., & Assmann, C. (2014). Green industrial policy: concept, policies, country experiences. In Oxford Review of Economic Policy (Vol. 30). https://doi.org/10.1093/oxrep/gru025
- Gregori, G. L., Cardinali, S., & Palanga, P. (2011). imprese delle Marche. (January).
- Toyota Motor Corporation. (2016). Sustainable Management Report 2016 Annual Report. 61.Retrieved from http://www.toyota-global.com/sustainability/report/ar-smr/pdf/sustainable_management_report16_fie.pdf
- Building an Equitable. (n.d.).
- Owen, A. D., & Hanley, N. (2004). The economics of climate change. The Economics of Climate Change, 98(2), 1–297. https://doi.org/10.4324/9780203495780
- VOLKSWAGEN. (2015). Bentley - Volkswagen Group Annual Report 2015. Volkswagen. Retrieved from http://annualreport2015.volkswagenag.com/divisions/bentley.html
- Adén, E., & Barray, A. (2008). Go Green in the Automotive Industry. 190.
- Vaz, C. R., Shoeninger Rauen, T. R., & Rojas Lezana, álvaro G. (2017). Sustainability and innovation in the automotive sector: A structured content analysis. Sustainability (Switzerland), 9(6). https://doi.org/10.3390/su9060880

- Report, A. (2014). वार्षिक प्रतिवेदन Annual Report Annual Report.
- Energy, E. A. for S. of. (2017). Activity Report 2017 Table of Contents. 1–25.
- World Economic Forum. Marsh & McLennan Companies., & Insurance, Z. (2019). Global Risks Report 2019.
- Volkswagen. (2018). Full speed ahead to the future.
- Wass_2014_SustainabilityAssessmentandIndicators-ToolsinaDecision-Making. (n.d.).
- K Swag E N G R O U P, V. L. (2017). Key Figures Volume Data 1 in thousands.
- Maes J., Teller A., Erhard M., Grizzetti B., Barredo J.I., Paracchini M.L., Condé S., Somma F., Orgiazzi A., Jones A., Zulian G., Vallecilo S., Petersen J.E., Marquardt D., Kovacevic V., Abdul Malak D., Marin A.I., Czúcz B., Mauri A., Loffler P., Bastrup-, W. B. (2018). Mapping and Assessment of Ecosystems and their Services: An analytical framework for mapping and assessment of ecosystem condition in EU. https://doi.org/10.2779/41384
- The World Bank. (2011). The World Bank Annual Report 2011. World Bank Annual Report.
- Ford, W. C. J., & Fields, M. (2016). Optimized risk profile.
- Ford. (2018). Ford 2017 Annual Report. 3,65. Retrieved from https://s22.q4cdn.com/857684434/files/doc_financials/2017/annual/Final-Annual-Report-2017.pdf
- Georgeson, L., Maslin, M., & Poessinouw, M. (2017). The global green economy: a review of concepts, definitions, measurement methodologies and their interactions. Geo: Geography and Environment, 4(1). https://doi.org/10.1002/geo2.36
- Allen, C., & Clouth, S. (2012). Green economy, Green growth, and Low-carbon development–history, definitions, and a guide to recent publications. Division for Sustainable Development, Department of Economic and Social Affairs, United Nations, New York, August., (1), 1–63. Retrieved from https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=634&menu=1516

- Frey, M. (2013). La green economy come nuovo modello di sviluppo. ImpresaProgetto - Electronic Journal of Management, 3, 1–18.
- Global, K., & Problems, E. (2014). Environment and Wellbeing. (2013), 3–21. https://doi.org/10.1007/978-3-642-54678-5
- United Nations System. (2009). Green Economy : A Transformation to Address Multiple Crises. An Interagency Statement of the United Nations System. (December 2009). Retrieved from http://www.unep.ch/etb/pdf/2009 statement deliver as one/Interagency Joint Statement. E rev1.pdf
- Frese, T. (2001) (1), 20–23.
- Archie, C. B. (1991). The Pyramid of Corporate Social Responsibility: Toward the Moral Management of Organizational Stakeholders. Business Horizons, (August), 153–170.
- Chemiluer-Gendreau, M. (2011). Rio political declaration on social determinants of health. Mundo Da Saude, 35(4), 467–472. https://doi.org/10.1787/9789264095281-12-en
- Module 1 Introduction to the Workshop. (n.d.). 8–26.
- Carroll, A. B. (1991). The pyramid of corporate social responsibility: Toward the moral management of organizational stakeholders. Business Horizons, 34(4), 39–48. https://doi.org/10.1016/0007-6813(91)90005-G
- Electric Vehicle Survey Findings and Methodology. (2019). (July). Retrieved from www.ucsusa.org/EVsurvey2019www.cr.org/advocacy
- Il mistero dell ' auto elettrica. (n.d.).
- Penev, A., & Penev, A. (2011). Chinese Consumer Attitudes towards the Electric Vehicle Authors : Responsible coordinator : Objective :
- Guan, M., Gao, P., Wang, A., Zipser, D., & Shen, P. (2019). McKinsey China Auto Consumer Insights 2019 - Navigating the road ahead in the world's largest auto market. (October). Retrieved from https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/china-auto-consumer-insights-2019
- Koster, A., Kuhnert, F., & Stürmer, C. (2018). Five trends transforming the Automotive Industry. PwC, 1(1), 35–45. Retrieved from

https://www.pwc.com/gx/en/industries/automotive/assets/pwc-five-trends-transforming-the-automotive-industry.pdf

- Bodle, R., Donat, L., & Duwe, M. (2016). The Paris Agreement: Analysis, Assessment and Outlook. Climate and Carbon Law Review, 10(1), 5–22. https://doi.org/10.2307/43860128
- Farhan, M. (2016). Marketing of Electric Cars. (Feb).
- Ozaki, R., & Sevastyanova, K. (2011). Going hybrid: An analysis of consumer purchase motivations. Energy Policy, 39(5), 2217–2227. https://doi.org/10.1016/j.enpol.2010.04.024
- T&E (Transport & Environment). (2019). Electric surge: Carmakers' electric car plans across Europe 2019-2025. (July). Retrieved from www.transportenvironment.org
- Cheong, T., Song, S. H., & Hu, C. (2016). Strategic Alliance with Competitors in the Electric Vehicle Market: Tesla Motor's Case. Mathematical Problems in Engineering, 2016. https://doi.org/10.1155/2016/7210767
- Wewerinke-Singh, Margaretha; Doebbler, C. (2016). The Paris Agreement: Some Critical Reflections on Process and Substance. University of New South Wales Law Journal, 39(4), 37–53. https://doi.org/10.1016/0008-6223(96)89488-7
- Alvia, I. S. M. (2008). LEXUS: A Premium Brand. The Ritsumeikan Business Review, 47(2), 71–89. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.494.1439&rep=rep1&type=pdf
- Dr. Ing. h.c. F. Porsche AG. (2018). Annual and Sustainability Report of Porsche AG 2018 - Performance. 30–49. Retrieved from https://newsroom.porsche.com/en/annual-sustainability-report-2016.html
- Kolbasov, O. S. (1992). UN Conference on Environment and Development. Izvestiya - Akademiya Nauk, Seriya Geograficheskaya, 6(June), 47–54. https://doi.org/10.4135/9781412971867.n128
- Ocampo, J. A. (2013). The macro-and mesoeconomics of the green economy. Getting Development Right: Structural Transformation, Inclusion, and

Sustainability in the Post-Crisis Era, 153–172. https://doi.org/10.1057/9781137333117_8

- Johnston, R. B. (2016). Arsenic and the 2030 Agenda for sustainable development. Arsenic Research and Global Sustainability - Proceedings of the 6th International Congress on Arsenic in the Environment, AS 2016, 12–14. https://doi.org/10.1201/b20466-7
- W in Nin G P O R T F O L I O M O B Il I T Y E X P Erien C E S Creating Tomorrow , Together. (2018).
- Green Paper. Commissione delle Comunità Europee. Bruxelles, 18.7.2001. (n.d.).
- Electric Vehicle Survey Findings and Methodology. (2019). July. www.ucsusa.org/EVsurvey2019www.cr.org/advocacy
- Il mistero dell ' auto elettrica. (n.d.).
- Penev, A., & Penev, A. (2011). Chinese Consumer Attitudes towards the Electric Vehicle Authors : Responsible coordinator : Objective :
- Guan, M., Gao, P., Wang, A., Zipser, D., & Shen, P. (2019). McKinsey China Auto Consumer Insights 2019 - Navigating the road ahead in the world's largest auto market. October. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/china-auto-consumer-insights-2019
- Koster, A., Kuhnert, F., & Stürmer, C. (2018). Five trends transforming the Automotive Industry. PwC, 1(1), 35–45. https://www.pwc.com/gx/en/industries/automotive/assets/pwc-five-trends-transforming-the-automotive-industry.pdf
- Bodle, R., Donat, L., & Duwe, M. (2016). The Paris Agreement: Analysis, Assessment and Outlook. Climate and Carbon Law Review, 10(1), 5–22. https://doi.org/10.2307/43860128
- Farhan, M. (2016). Marketing of Electric Cars. Feb.
- Ozaki, R., & Sevastyanova, K. (2011). Going hybrid: An analysis of consumer purchase motivations. Energy Policy, 39(5), 2217–2227. https://doi.org/10.1016/j.enpol.2010.04.024
- T&E (Transport & Environment). (2019). Electric surge: Carmakers' electric car plans across Europe 2019-2025. July. www.transportenvironment.org

- Cheong, T., Song, S. H., & Hu, C. (2016). Strategic Alliance with Competitors in the Electric Vehicle Market: Tesla Motor's Case. Mathematical Problems in Engineering, 2016. https://doi.org/10.1155/2016/7210767
- Wewerinke-Singh, Margaretha; Doebbler, C. (2016). The Paris Agreement: Some Critical Reflections on Process and Substance. University of New South Wales Law Journal, 39(4), 37–53. https://doi.org/10.1016/0008-6223(96)89488-7
- Alvia, I. S. M. (2008). LEXUS: A Premium Brand. The Ritsumeikan Business Review, 47(2), 71–89. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.494.1439&rep=rep1&type=pdf
- Dr. Ing. h.c. F. Porsche AG. (2018). Annual and Sustainability Report of Porsche AG 2018 - Performance. 30–49. https://newsroom.porsche.com/en/annual-sustainability-report-2016.html
- Guan, M., Gao, P., Wang, A., Zipser, D., & Shen, P. (2019). McKinsey China Auto Consumer Insights 2019 - Navigating the road ahead in the world's largest auto market. October. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/china-auto-consumer-insights-2019
- Toyota Annual Report 2016-2017-2018-2019
- Ford Annual Report 2016-2017-2018-2019
- Volkswagen Annual Report 2016-2017-2018-2019
- Volkswagen Annual Report 2016-2017-2018-2019

SITOGRAPHY

- https://doi.org/10.1787/9789264095281-12-en
- https://doi.org/10.4324/9780203495780
- https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/china-auto-consumer-insights-2019
- https://italiarapparigi.esteri.it/rapp_ocse/it

- http://www.oecd.org/
- http://www.oecd.org/greengrowth/green-growth-indicators/
- http://www.oecd.org/greengrowth/green-growth-indicators/
- https://www.unenvironment.org/
- https://www.enea.it/it
- http://www.isprambiente.gov.it/it/certificazioni/emas
- https://www.energysage.com/electric-vehicles/buyers-guide/top-hybrid-companies/
- https://www.automobilemag.com/news/hybrid-history/
- https://doi.org/10.1201/b20466-7
- https://www.europarl.europa.eu/news/en/headlines/society/20190313STO31218/co2-emissions-from-cars-facts-and-figures-infographics
- https://edition.cnn.com/2019/09/02/perspectives/electric-vehicle-design/index.html
- https://edition.cnn.com/2019/07/18/cars/electric-car-market-sales/index.html
- https://en.wikipedia.org/wiki/Fuel_cell_vehicle
- https://www.forbes.com/sites/altheachang/2011/08/31/ford-toyota-hybrid-partnership/#588e37eb4fed
- https://www.theguardian.com/business/2019/mar/20/toyota-team-up-with-suzuki-to-build-hybrid-cars-in-uk
- https://www.greenstyle.it/green-economy-ford-pubblica-rapporto-2017-sulla-sostenibilita-231859.htm
- https://www.theguardian.com/environment/2019/oct/10/climate-crisis-what-carmakers-say
- https://www.repubblica.it/motori/sezioni/attualita/2019/12/06/news/ford_e_mcdonald_s_una_partnership_all_insegna_della_sostenibilita_-242709145/?refresh_ce
- https://www.greencarcongress.com/2015/09/20150918-epaarb.html
- https://en.wikipedia.org/wiki/Volkswagen#Hybrid_vehicles
- https://www.bbc.com/news/business-34324772
- https://iopscience.iop.org/article/10.1088/1748-9326/aa8850
- https://www.fitchratings.com/site/pr/1013282

- https://www.volkswagenag.com/en/group/fleet-customer/e-mobility/MEB.html
- https://www.volkswagenag.com/en/news/2019/10/scania_waste_partnerships.html
- https://insideevs.com/news/373278/plugin-car-sales-europe-h1-2019/
- https://www.volkswagenag.com/en/news/2020/01/VW_Brand_deliveries_12_19.html
- https://www.audi-mediacenter.com/en/press-releases/efficient-and-powerful-the-new-plug-in-hybrid-models-audi-q5-a6-a7-and-a8-11334
- https://www.volkswagenag.com/en/news/2016/11/transform-2025.html
- https://www.volkswagenag.com/en/news/2019/11/volkswagen-confirms-strategic-financial-targets-of-together-2025.html
- https://www.ft.com/content/9c99411c-07ab-11ea-a984-fbbacad9e7dd
- https://www.volkswagen-newsroom.com/en/press-releases/volkswagen-significantly-raises-electric-car-production-forecast-for-2025-5696
- https://www.toyota-europe.com/world-of-toyota/feel/operations/made-in-europe/made-in-europe
- https://www.statista.com/statistics/276310/toyotas-market-share-of-new-car-registrations-in-the-eu/
- https://newsroom.lexus.eu/lexus-international-releases-2019-mid-year-sales-report/
- https://media.ford.com/content/fordmedia/feu/it/it.html
- https://insideevs.com/news/343755/ford-goes-electric-in-europe-bold-electrification-plans-announced/
- https://media.ford.com/content/fordmedia/feu/en/news/2019/09/10/Frankfurt-2019.html
- https://www.volkswagenag.com/en/news/stories/2019/04/volkswagen-electrifies-china.html
- https://cleantechnica.com/2019/11/08/toyota-byd-form-joint-venture-to-manufacture-electric-cars-in-china/
- https://www.forbes.com/sites/uhenergy/2019/11/18/whats-happened-to-us-electric-vehicle-sales/#3997e4d27909

- https://www.pwc.com/gx/en/industries/automotive/assets/pwc-five-trends-transforming-the-automotive-industry.pdf
- https://www.forbes.com/sites/brookecrothers/2019/11/17/tesla-model-3-owners-ditch-toyota-prius-and-bmw-3-series-but-conflicting-results-in-brand-survey/#198cfdb22658
- https://www.ucsusa.org/resources/surveying-consumers-electric-vehicles
- www.ucsusa.org/EVsurvey2019www.cr.org/advocacy
- https://www.marketwatch.com/story/china-not-tesla-will-drive-the-electric-car-revolution-2019-05-14

FIGURES

TABLES