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Name: Dzhamaluddin Omarov

Maria Zelenaya

Impact on crude oil demand by electric vehicles in Russia: 3 possible scenarios

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Preface

This work is a culmination of our Master of Science studies for Nord University in Energy Management program. Conducting this study provided us with a deep insight of scientific research and particularly enhanced our awareness of automotive industry transformation. It also helped us to realize how the knowledge that we have received in Nord University may be applied.

Over the last two years we were provided with the grounds for consideration on energy industry. The recent oil crisis encouraged us to debate the matter over our minds, considering the possibilities that can bring to bear the energy market shaping the oil industry. Worldwide electrification came to our mind. Getting more and more electrified the globe becomes a safer and more comfortable place. Some scientists even believe electricity in automotive industry to be an indispensable part of sustainable future. However, the process of electricity gaining momentum and popularity as a replacement for traditional solutions is too wide proses for a master thesis. We decided to narrow it down to the influence of private car transition from using conventional fuels to being charged from electric greed. Nevertheless, the rate of such transition is quite unpredictable, especially in the modern vulnerable economic situation. After receiving related knowledge from university professors, we chose to explore scenario method as the best to our minds tool for our study.

We want to express our deepest gratitude to Professor Terje Andreas Mathisen, our supervisor, for his boundless help and guidance of our work. With his support we managed to structure our thoughts and ideas. Also, we want to thank our program coordinator Elena Dybtsyna and all professors at Nord University.

Bodø 18th May, 2022

Dzhamaluddin Omarov and
Maria Zelenaya

Abstract

Modern world faces a lot of challenges from hunger to chip shortage. However, despite all those difficulties, people are thinking about the future. We decided to build scenarios for a medium-term perspective – 5-7-year distance. The subject of our particular interest was the speed of the private car transition from internal combustion engine (ICE). Two main variables we prove to determine the market share of electric vehicles are the customers attitude and governmental policy.

As for the oil demand in 21st century it is mostly attributed to transportation sector. In Russia, one of the major oil consumers, more than a half of the oil expenditure is attributed to fuel material, especially light petroleum spirit. Replacement of traditional ICE by electric motor can notably dent the demand for oil. The taxing question of the future of electric car market and its possible influence on the oil demand is specified in our thesis. In particular, we worked out three different scenarios and we decided to name them as traffic light colors (green, yellow and red). In our case, the green is most desirable one with high rates of replacement of ICE cars by EV's and slowing down the oil demand. While the red stands for most dangerous case with expansive growth of ICE car number and immoderate oil demand.

List of Acronyms

AI = Artificial Intelligence

BEV = Battery Electric Vehicles

BP = British Petroleum

CIS = Commonwealth of Independent States

CO2 = Carbon dioxide

EIA = Energy Information Administration

EV = Electric Vehicle

GKU "AMPP" = Gosudarstvennoye Kazennoye Uchrezhdeniye Goroda Moskvy "Administrator Moskovskogo Parkovochnogo Prostranstva" [State Institution Of The City Of Moscow "Administrator Of The Moscow Parking Space"]

GM = General Motors

ICE = Internal Combustion Engine

IEA = International Energy Agency

PHEV = Plug-in Hybrid Electric Vehicle

R&D = Research and Development

SDG = Sustainable Development Goals

TED = Technology, Entertainment, Design (Conference)

TPED = Total Primary Energy Demand

TPES = Total Primary Energy Supply

TSMC = Taiwan Semiconductor Manufacturing Company

VAT = Value Added Tax

U.S. = United States (of America)

3D = 3 Dimensional

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Chapter 1. Introduction

This part provides a brief introduction to the topic of the study, its general background, capsule review of the basis forming material, central research idea and problem statement, its strategic aim and relevance. Furthermore, it highlights the study scope and limitations bringing out the problems of the study and outlines the structure of the study and reasoning behind it.

1.1 Background

The history of the human lasts for thousands of years and it is very hard to tell for sure how long have humanity existed. Throughout our existence people hardly considered their own behavior to be threatening to the exitance of the environment and the humanity itself. Until nowadays.

First attempts to think over the issue of being friendly to nature and develop sustainably were made quite a long time ago, as even the idea that people should not use more resources the planet is able to produce again was written out in 1713 in in “Sylvicultura oeconomica” (von Carlowitz, 1713). However, the trend for sustainability and worldwide awareness of global problems, such as climate change and lack of vital resources (United Nations, 2022) is gaining momentum no longer than a century.

The population of the world is constantly growing. Despite decreasing rates – since 1969 – world population is still growing approximately by 1% every year (Worldometer, 2021). On the figure 1 below, the population growth is depicted since 1951.

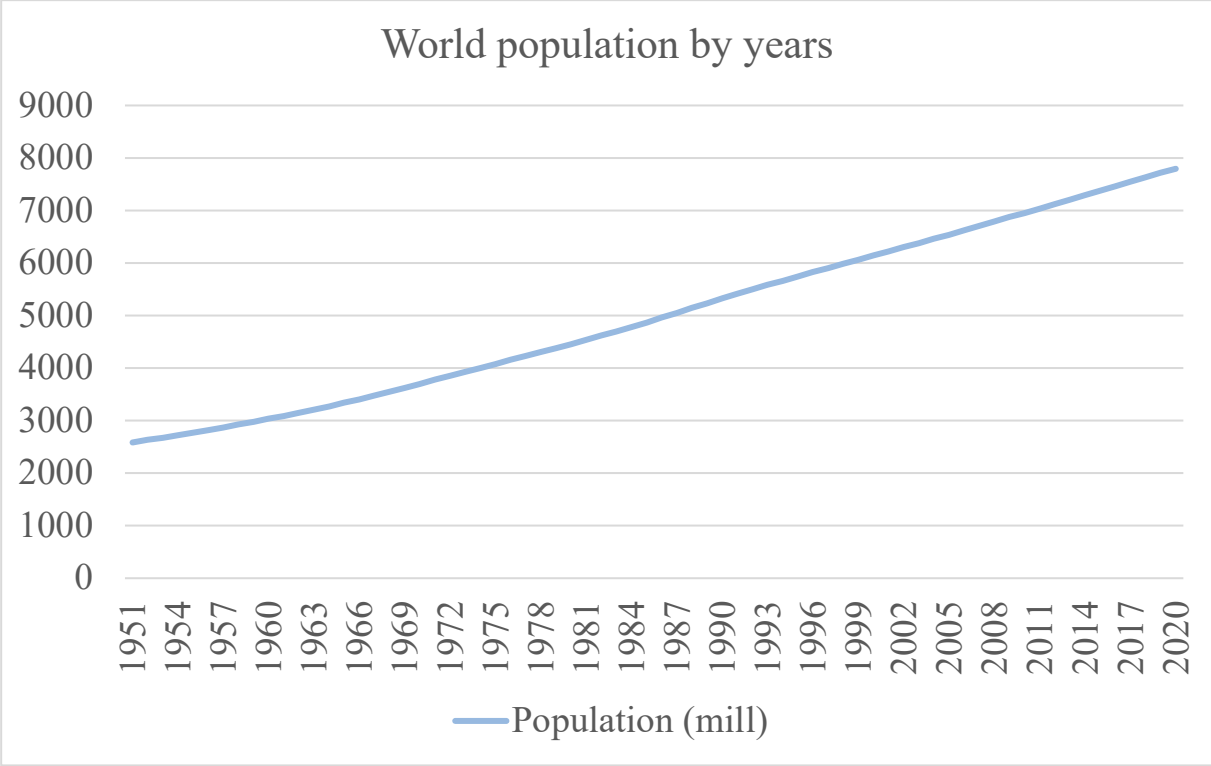


Figure 1. World population by years. Source: (Worldometer, 2021)

Nowadays, more and more people are getting concerned about the future of the planet. As a result, lots of document, plans and perspectives have already been built on the topic of sustainability.

Modern countries policies are to be based on several binding international agreements. One of them is The Paris agreement that acknowledges climate change as a common concern of humankind (United Nations, 2015). The central principle of this outstanding achievement of diplomacy is that countries have a common but differentiated responsibility. It offers governments flexibility in implementation; however, it increases the uncertainty of the result (Claes & Hveem, 2016). Nevertheless, even though the effect of this agreement is so complex and holistic that it can be hardly foreseen, it is a significant step towards the low-carbon future.

Another critical accomplishment of global diplomacy is SDG goals. The Sustainable Development Goals are the blueprint for reaching a better and more sustainable future for all (United Nations, 2021).

Especially after the pandemic, there appears a possibility for these goals to guide the recovery, greener production, sustainable economy and resilient society (United Nations, 2021). SDG shape the future and establish tendencies in governance and social life.

Providing that Paris Agreement and SDG are two main pillars of human progress and survival, it becomes a top priority for many concerns and regulations. Every country, every company has to follow international and local governmental restrictions to minimize its operating effect on the nature.

The automotive industry, which accounts for 3% of all global economy (Ewing, 2021), is trying to keep up with modern trends. The whole thinking-about-environment concept forced a lot of new ideas and innovations to take place, which resulted in opening of a new room in the 162-year market (Rae & Binder, 2020). Although, electrical vehicles (EVs) are not modern invention, being made first in 1828 (Department of Energy, n.d.), even earlier than gasoline (1860) (Ewing, 2021), only modern innovations made EVs able to compete with regular petrol cars.

The term “electric vehicle” is highly associated with Tesla nowadays, even though there are plenty other EV manufacturers. An American EV company, founded in 2003, and with its first car the Tesla Roadster launched in 2008 (Tesla, n.d.), is a leader in EV sector by market share (Statista, 2022). This company brought many innovations to this sphere and forced other car manufacturers to go greener. The giants of automotive industry like Toyota, Volkswagen and Ford Motor are led by this young but very expensive beginner.

Such drastic changes are a catastrophe for oil companies at the first glance. Less petrol cars there are, less the consumption of oil there is (Button K. J., 2010). In 2020 just under a half of oil was demanded by transportation means (Statista, 2021).

This threat is of major importance for Russia, that is in top 10 oil consuming countries (IEA, 2022) and at the same time is one of the biggest oil exporters (IEA, 2022).

There are at least two possible ways to treat these facts. First – Russia’s economy highly depends on oil: amount of oil consumed and sold to others. Moreover, keeping in mind unfriendly towards EVs climate and big distances, its more convenient for Russia to continue using petrol cars, however it has to keep with the trends of developed countries and think about nature for future generations sake. Russia stands on the verge of two roads and it has to balance between not plummeting its own economy and addressing climate agenda.

Another way of thinking is that a relatively small step for Russia is of a huge importance for the whole world meaning even a percent decreasing usage of oil is in volume already more significant and makes more effect than making a country of the bottom of the list of oil consumers a total zero oil consuming country. As an example, consumption of oil by Russia in 2019 was 3,7 Million barrels per day (4% of the World Total) - (EIA, 2022) which means 1% is 37 thousand barrels per day and Montenegro, Armenia and Greenland combined consuming less than 30 thousand barrels per day overall (8+7,5+ 6 Respectively) (EIA, 2022). This shows that steps taken on the national level when speaking about Russia is of a major importance for the whole world sustainability and makes us as researchers curious and thinking over the possible outcomes for the country and the globe.

Therefore, it is hard to tell exactly which way the development of the car industry, governmental initiative and public attitude on EV market will go, so in this work we are going to look at 3 possible scenarios and the ways oil demand will be affected in each of them.

1.2 Problem statement

Electric vehicle demand is relatively high, the interests in this sphere are even bigger, but the supply is highly limited by manufacturing powers and technological advancements. But even with such low supply energy companies have to change their approach to their activity. Many companies are spending their capitals on R&D of green innovations, and exploration of new markets.

As it was stated before, there is no clear understanding of what will Russia do in the future. And in order not to focus on one variant which may be incorrect, we decided to take into consideration three possible scenarios and give our forecast on each of them. Therefore, our problem statement could be formed as such:

To what extent will the oil demand change due to implementation of EVs in the:

1) **Green scenario**

High rates of replacement of petrol cars by EV

2) **Yellow scenario**

Low rates of replacement of petrol cars by EV

3) **Red scenario**

Number of petrol cars increasing

Our research will focus on estimating possible supply and demand levels in different regions of Russian Federation for each scenario, as well as calculating the effects of such. It will look at different measures which are already implemented by the government and local municipalities to support EV owners. Using secondary data and document analysis approach, we will compare Russian and Norwegian policies, to find differences and similarities, so we could base our predictions on the Norwegian example.

1.3 Purpose of the research

The future of Russian economy, like future of big energy companies, is highly connected to the oil demand and thus to levels of implementation of EVs. Our research will discuss three previously mentioned scenarios and their effects. Results of the research may be used in the future to be applied or for the future papers.

1.4 Scope and limitations

The main aim of this research is to group future oil demands based on estimated transition rates to EVs. It will take into consideration only personal vehicles – private cars or the ones of carsharing system. All other types of vehicles like busses, commercial vans, trucks and so on are left out of the scope of the study as there are no publicly or commercially available trucks, plains, or other ways of electrical transportation. Moreover, the available data is limited to personal vehicles that is the scope of our research.

As for the technical data of EVs, the currently existing technical specifications of modern cars are used. No future design or conceptual developments are taken into consideration as there is no definite evidence for future innovations and advancements. This will result in another restriction that focuses on the impact on oil demand only from electric vehicles and not from other factors.

Our research will not account for possible future sanctions, embargos, material shortages, financial crises and other force majeures. We will try to keep the data as average as possible to avoid anomalies and inconsistences.

1.5 Thesis structure

This research paper is divided into the seven chapters:

1. Introduction

It includes a brief research overview providing the statement of the research problem, research question, scope and limitations of the research and gives an idea of the importance and relevance of the research.

2. Fields of Study

This chapter is centered around electric vehicles and crude oil demand as key research areas taken into consideration in this paper. Furthermore, the definitions and basis for the research are given in this chapter.

3. Theoretical frameworks

This chapter provides relevant theoretical frameworks that serve as a basis for our study. It outlines demand and supply theory that is used for analyses and highlights both strengths and weaknesses of the scenario analyses, providing explanation why it is relevant for the research.

4. Methodology

This chapter depicts the philosophical positioning of the research, the data used, the methods used to proceed with the analyses. Moreover, the chapter includes the validity and reliability of the research. The main idea of this chapter is to prove that the way we deal with the data given in the second chapter within the theoretical framework mentioned in the third chapter is accurate, suitable and reliable.

5. Scenario building

In this chapter based on all the trends given in the second chapter with the help of theoretical framework and methodology we provide the basis: assumptions and uncertainties taken for scenario building. Moreover, the ground for both assumptions and uncertainties are outlined. All the factors mentioned are combines into two complex variables – consumers attitude towards EV and Governmental EV stimulations, that are used as the basis for scenarios.

6. Scenarios

This chapter depicts three scenarios of the development EV market in Russia that appear to be quintessential of all the mentioned above. Providing the idea that in green scenario the number of EV is to increase scenarios. Scenarios turn out to be not only the reflection of the current situation analyzed with the proper tools but a prospect of the new reality.

7. Conclusion

This chapter provides a summary of the research, its implications and future scope of research.

Chapter 2. Fields of study

This chapter introduces two main concepts addressed in this research, that are electric vehicles and transport and crude oil demand. Moreover, this chapter briefly introduces the historical origins of the concepts and discusses the current situation in detail. Furthermore, the definitions and basis for the research are given in this chapter.

2.1 Electric vehicle overview

History

The concept of electric car originates from early 1800s. At the beginning, first EVs didn't have a rechargeable battery, the batteries had to be replaced every time (WILSON, 2018). The first EV with rechargeable battery was built in 1884 by Thomas Packer (Auto Express team, 2020). That was one of the biggest innovations in EV industry. It offered an opportunity to decrease costs, prolonged usable life expectancy of the battery and improved efficiency. In fact, the idea of using rechargeable batteries in the car is used nowadays.

EVs were easy to use and despite having less range, they didn't require any manual action to start the engine, unlike gasoline or steam cars of that time.

EVs were popular until 1920s when the development of the roads infrastructure made it possible to travel longer distances and make longer journeys. Public required to drive much longer distances, than electric cars could.

Later an electric starter by Charles Kettering was introduced in 1912 (The Editors of Encyclopaedia Britannica, 2022). This invention removed the need for manual start in gasoline cars. That eliminated the major benefit the electric cars could provide at that time for their users. Those and some other factors made EVs of that time expensive, uncomfortable and ineffective in comparison to petrol cars.

In 1930-1990 there were some attempts to produce an EV to combat CO2 emissions, however those attempts were not successful and the idea of "going green" in automotive was not picked up (Idaho National Laboratory).

As the pace of innovation is constantly increasing and innovation that appeared once in a hundred years sometime in the past, now takes less than a day to emerge. Once, an American engineer and a co-founder Gordon Moore, stated that the saturation of transistors of the chips would double every two years (TARDI, 2022). Now, with quantum computers, AI, 3D and other highly advanced digital factors, this pace is increasing even more.

Scientists highlight six waves of innovation cycles. Figure 2 shows how long it took for each cycle to end and what are the key elements of them.

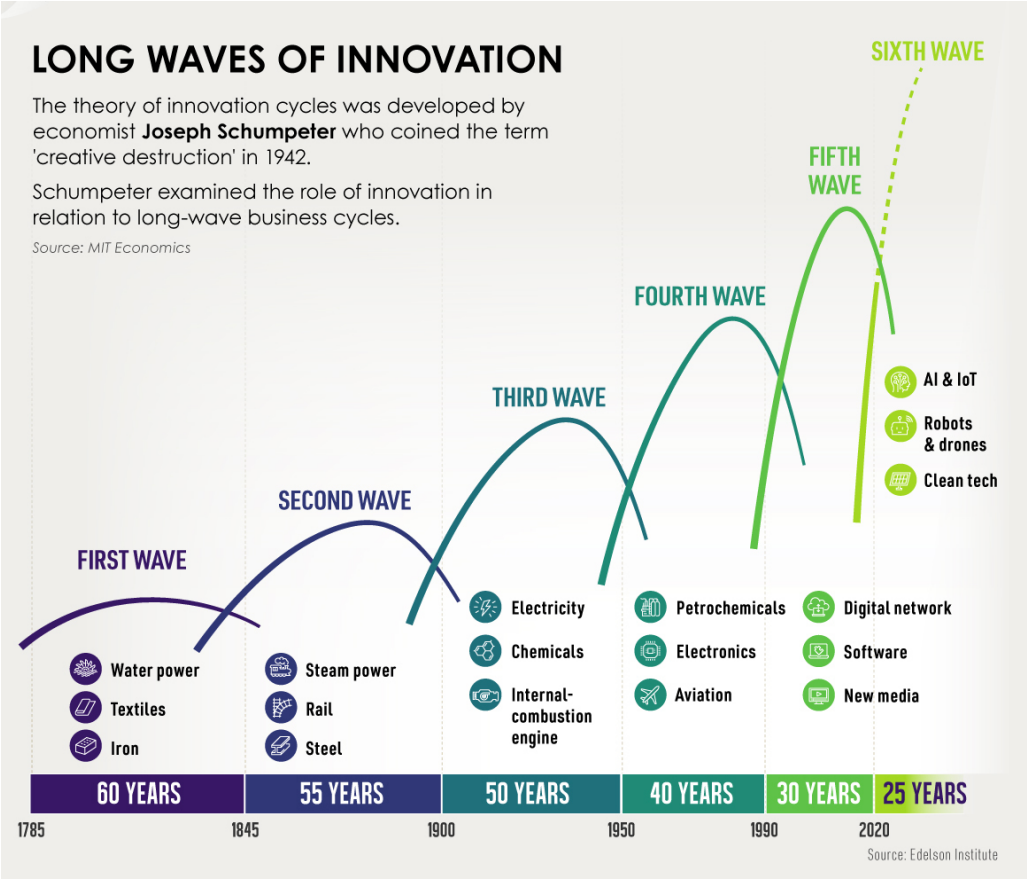
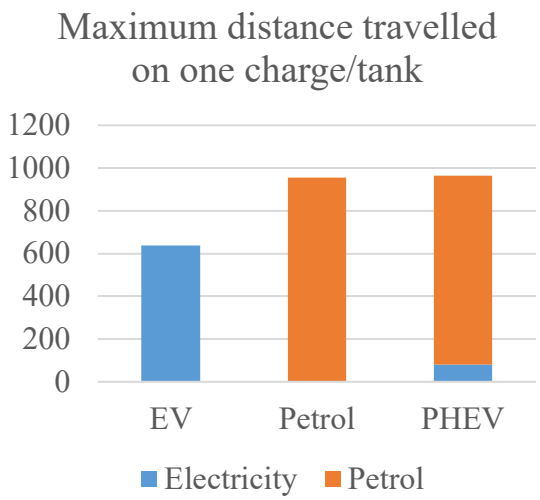


Figure 2. Long waves of innovations. Source: (Neufeld, 2021)

Later new legislative and regulatory actions gave the push for innovations in EV sphere. As a result, several successful projects have been started.

Since Plug-In hybrids (PHEV) use both electricity and petrol to run in the figures 1 and 2 parts of the PHEV column represent electricity and petrol respectively.



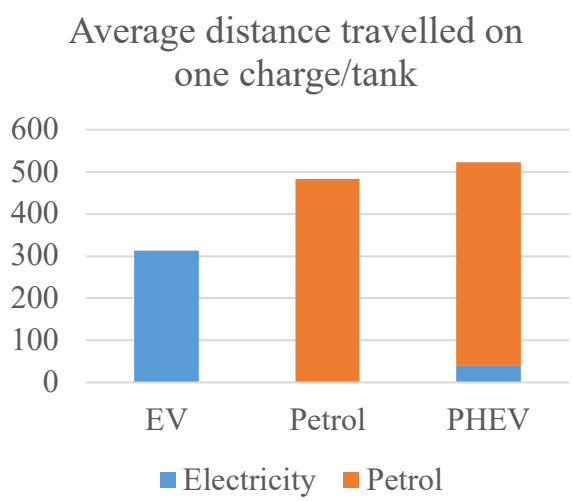


Figure 3. Maximum distance travelled on one charge/tank. Source: **(SIMPSON & BARLINGEN, 2021; ChooseMyCar Staff Writer, 2019; Institute of Transportation Studies, 2022)**

Figure 4. Average distance travelled on one charge/tank. Source: **(SIMPSON & BARLINGEN, 2021) (Butterworth, 2022) (Lambrecht, Longest Range Plug-In Hybrids For 2021, 2021)**

As we can see, petrol cars are able to cover bigger distances which is important for rural areas with long distances to cover.

However, there are many concerns for using petrol cars which include fuel prices, air and noise pollution, maintenance prices and so on.

For a big and advanced cities EVs are a better option than using petrol cars since people need to commute short distances and there is an access to power grid.

Production

Electric vehicles are becoming more and more popular, they get more competitive advantages every year and the whole industry tends to "go greener". Many big companies, including Mercedes-Benz, GM, Volvo and Ford (Plumer & Tabuchi, 2021), announced their plans to stop producing petrol cars and to swift entirely to EV in the next 10-20 years.

- Mercedes-Benz pledges to start producing only EVs from 2025 (Mercedes-Benz, 2021).
- GM promises by 2025 to design 30 new global electric vehicles (GM).

For the last 10 years EV market is buoyant as genuine innovations and political will made a scant market flourishing and attractive. More detailed overview of the marked is depicted at the Figure 5 bellow, which shows global EV sales by years from 2012.

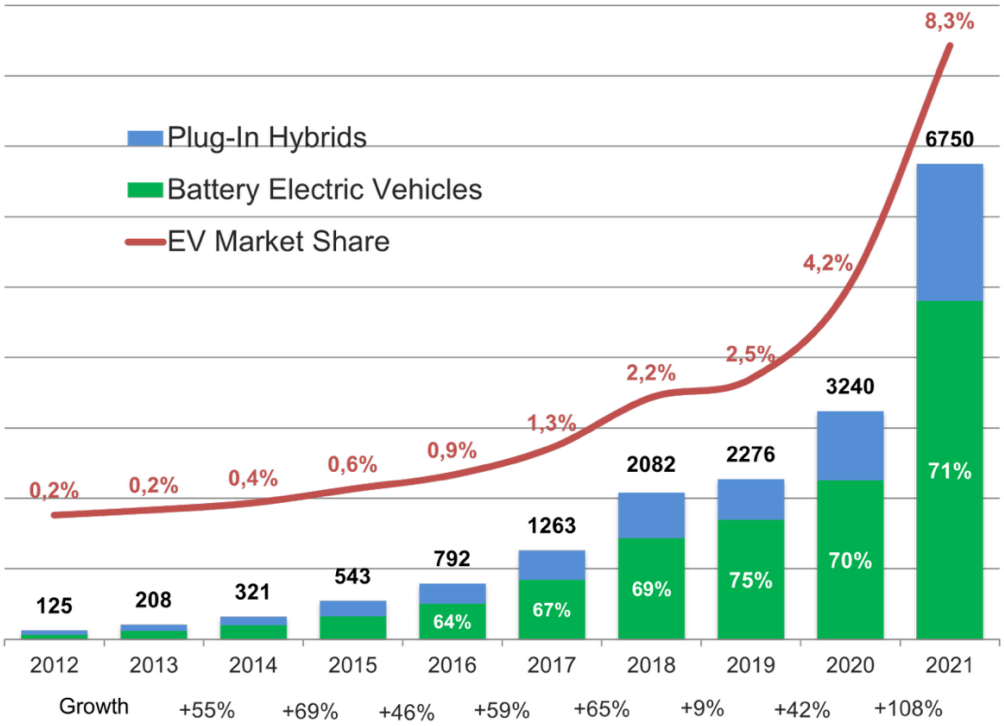


Figure 5. Global BEV&PHEV sales. Source: (Irle, 2022)

The most important criteria for the car is how far and how fast it can go. If in terms of speed EVs are not so different from regular petrol cars, in terms of distance travelled on one charge or refill varies. Above, on Figures 3 and 4 (Kurczewski & Normile, 2022); (ChooseMyCar Staff Writer, 2019); (Lambrecht, Longest Range Plug-In Hybrids For 2021, 2021); (JuiceBlog , 2020); (Admin, 2021), you can see maximum and average range travelled on one charge or fuel tank respectively are provided.

We can see that for the last ten years number of EVs sold increased by approximately 6 times. It can be clearly stated that the demand for and electric vehicle is growing, therefore, the supply should as well. In fact, recently one of the biggest EV producers (both by market value and by average selling rate (Turner & Case, 2022)) Tesla has rescheduled its delivery calendar and now European customers would have to wait for 8 months to receive their cars for its most popular Model 3 (Tesla, 2022). Such delays prove that the demand is greater than supply and companies have to increase their manufacturing powers. Car industry giants, except Tesla, do

not only adjust their old factories to produce electric cars, but they also create new ones. Tesla is opening another Gigafactory in Germany to cover growing demand (Tesla, 2022).

With growth of the population, number of privately-owned cars is increasing. At the figure 6, the number of cars registered every year since 1960 is shown. Even though, we can notice various accelerations and decelerations in the pace over the years, overall, the number of new cars registered is increasing.

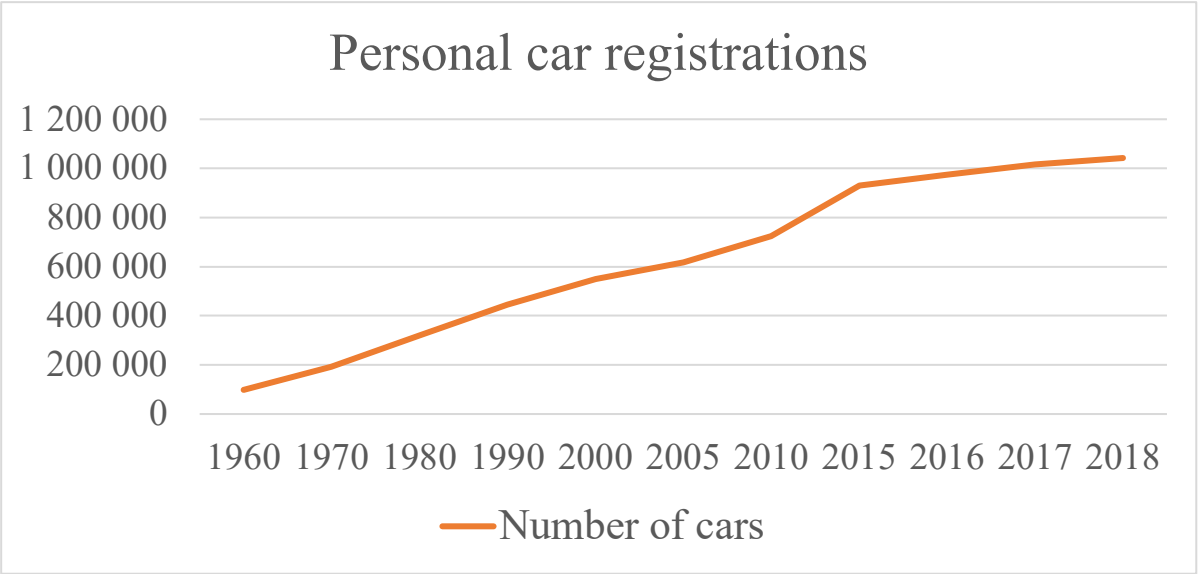


Figure 6. Personal car registrations by years. Source: (Davis, Williams, & Boundy, 2018)

The production in fact, is also increasing. It has its ups and downs, but mainly they are caused by crises and other inconstant factors. As we can notice on the graph bellow, the first dump since year 2000 was in 2007-2010 when economic crisis occurred. Next big decrease has happened in 2018 due to coronavirus pandemic. In 2021 the production slightly increased, but a halt is expected because of political conflicts.

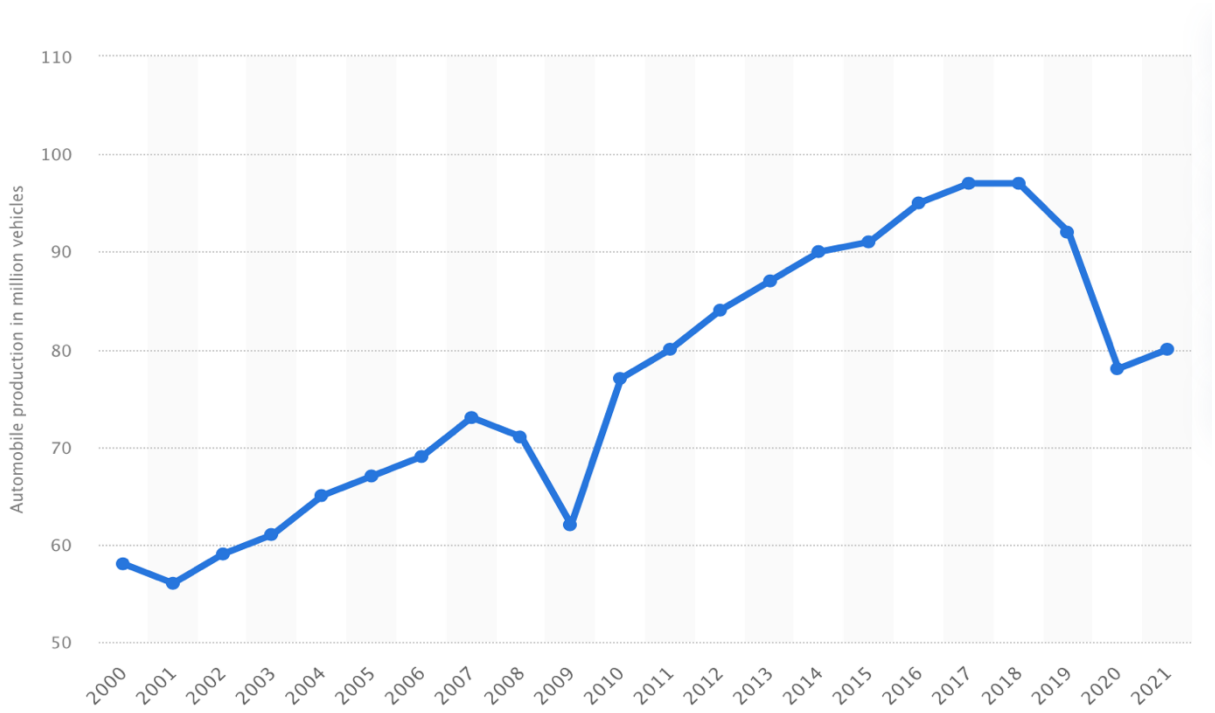


Figure 7. Cars produced worldwide. Source: (Placek, 2022)

Figure 7 clearly shows what are the expected levels of production for the next years (if no other Force majeures would happen). According to today's "green" trends and car manufacturers promises to stop producing petrol cars, we can assume, that expected levels of production would be reached by manufacturing EVs.

Currently world is involved in a chip's crisis. This particular crisis is very drastic for automotive industry in general. It has been caused by several key factors like worldwide lockdowns due to coronavirus and low supply of chips.

There is one particular Taiwanese company that holds over 52% of all chips market share. That company is called TSMC. On the graph bellow, we have presented the list of top manufacturers by their market share.

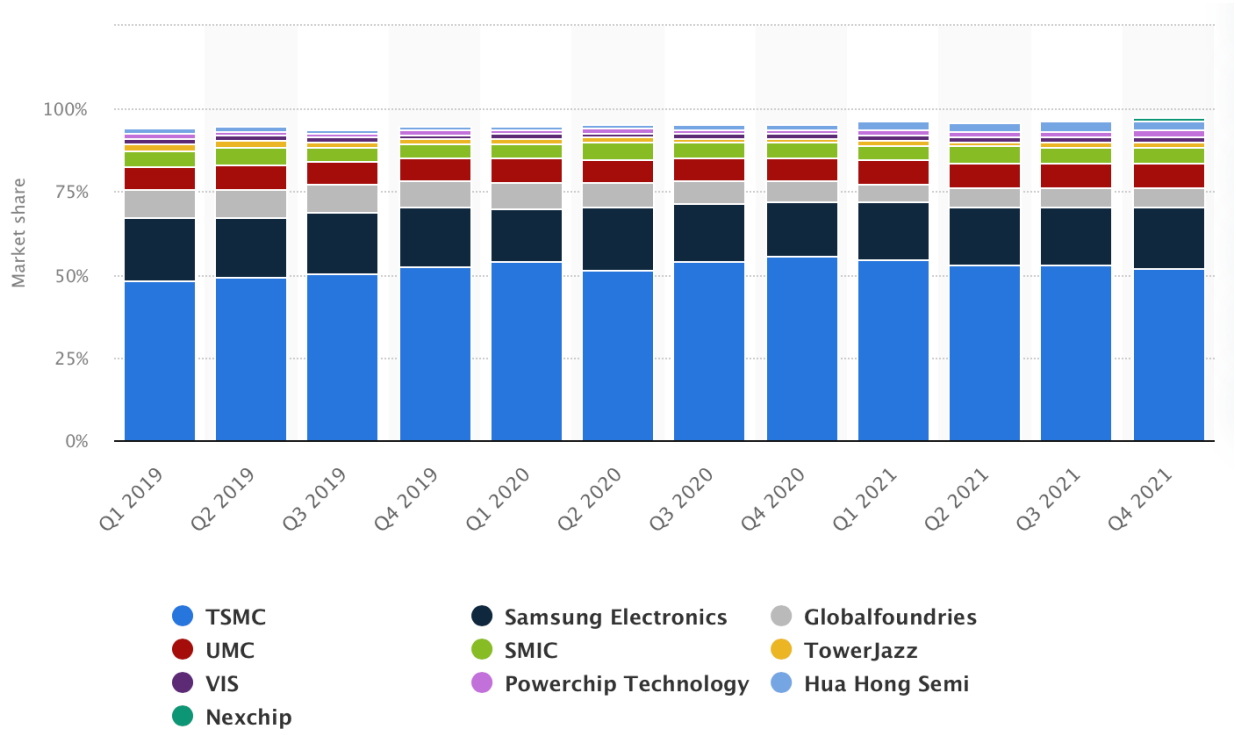


Fig. 8. Chips manufacturers by the market share. Source: (Alsop, 2022)

Lockdown has forced most of the employers to shift to work from home, what increased the demand for computers, servers and other digital appliances. Another big thing that increased the demand for chips even more is cryptocurrency. Crypto mining farms require big powers and a lot of chips.

The automotive industry on the other hand, predicted decrease in demand for personal vehicles, so, many big companies have cancelled orders for chips and now they are not in priority for companies like TSMC.

J.P. Morgan forecasts the beginning of the crisis ending in 2023 (J.P. Morgan, 2021)

Even though current situation with resources is generally unstable, the resources needed for production of electric vehicles are still available. They are growing in price but are proclaimed to be enough for the development of the EV's production for several decades.

2.2 Policies in Russia

Russian Federation is the biggest country in the world by territory (Statista, 2022). However, its territory is not homogeneous and development of the territories is at strikingly different

levels. Russia has both urban and rural areas. There are some technically advanced cities, as Moscow, being ranked as one of the most comfortable cities to live on the Earth (RUSSIA BEYOND, 2022) with a highly developed infrastructure and regions where people have no access to gas, road and mobile communications infrastructure.

That is the reasoning for the fact that there are less nationwide and more local policies implemented. Russian Federation consist of 85 territorial entities (cities, regions, provinces and districts) (Blinov, 2020) and today only 15 waived the transport tax for EVs. Those constituent units are as follows (Zhigulev, 2021); (e-cars.tech, 2020); (Sharonov, Esche v treh regionah Rossii dlya electromobiley otmenili transportniy nalog [In three more regions of Russia, the transport tax was abolished for electric vehicles], 2020); (Motor.ru, 2020):

- Republic of Bashkortostan
- Republic of Dagestan
- Kabardino-Balkarian Republic
- Zabaikalsky Krai
- Amur region
- Volgograd region
- Irkutsk region
- Kaliningrad region
- Kaluga region
- Kurgan region
- Leningrad Region
- Lipetsk region
- Moscow region
- Tyumen region
- Moscow
- Saint-Petersburg

On the figure 9 previously listed constituents are highlighted. As we can see, all territorial entity's municipalities, excluding highly developed cities like Moscow and Saint-Petersburg, that resort to measures, which persuade citizens to transit to EV, are located closer to the south and thus have better climate conditions for an EV.

Figure 9. Subjects of RF with no transport tax for EVs. Source: (Motor.ru, 2020)

Moscow is the most developed and digitalized constituent of Russian Federation with most developed measures and stimulus for EV market development. Its local policies also include free parking in the city and free charging on public stations (GKU "AMPP", 2018) (e-cars.tech, 2021). Being the most developed in the country, Moscow's policy measures, however, still leave much to be desired in comparison with some European countries, especially, Norway.

Norway is a leading country in terms of EV implementation. According to Reuters, in 2021 65% of all newly sold cars were fully electric. 176 276 units were sold by the end of December 2021 (Klesty, 2022). That is more than petrol, diesel and hybrid combined. Surely, that wouldn't be possible if not for Norway's great policies and incentives program.

The main aim of those policies is to reduce overall cost of EV ownership (sum of use and purchase costs). So, most of the incentives are cancelling or reducing taxes. Norway has so called 50% rule, which is applied to prices for ferries, toll roads and public charging stations. Counties and municipalities are not allowed to charge more than a half of the price from electric vehicles. Also, Norway has a lot of incentives aimed at reducing different taxes like VAT or import tax. Another important benefit of EV ownership is that you can access bus lanes which is reducing time spent in traffic. (elbil, n.d.)

Another key element for a quick transition is a public infrastructure. Having a lot of public charging stations is vitally important for the development of an EV sector. If we are to compare

number of public charging stations in Norway and Russia, we would see that Norway has way more developed infrastructure. In total Norway has more than 16000 charging stations, 3300 of which are superchargers (Visit Norway, 2021). Russia, on the other hand, has only 161 units (Avtostat, 2020). But since Norway and Russia have different demand for EVs, it would be a bit better to calculate number of charging stations per EV. As it was mentioned before, Moscow is a leader among Russian cities by EV implementation, so we are going to compare only Moscow to Norway.

Table 1. Amount of charging stations per EV

	Norway	Moscow
Number of public charging stations	16 000	100
Number of EVs	341 926	1 360
The coefficient of availability of electric charges	21,37	13,60

Source: (Avtostat, 2020)*;* (Statista, 2020)*;* (Sharonov, 35% vseh elecctrocarov v Rossii prihodyatsa na tri regiona [35% of all electric cars in Russia are in three regions], 2021)

As we can see, even Moscow itself has lower availability index that Norway. That is partly because Russia doesn't offer as many incentive programs as Norway. However, that is changing. Russian government is now thinking about implementation of a program that should stimulate "green" transition. According to this program government will give bonuses to those who want to buy an electric vehicle. It is discussed now that 25% of total cost (not more than 625 000 RUB) of the car would be covered by the government, when buying an EV. Although there is a clause stating that this program would be applicable only for an automobile that has been manufactured in Russia (Koshkin, 2021).

2.3 Transportation and crude oil demand

Transport is the major sector fueling oil consumption, influenced as well by technology and changes in transport behavior (Claes & Hveem, 2016). For more than two decades more than a half of global crude oil consumption is attributed to transport (Fig.10).

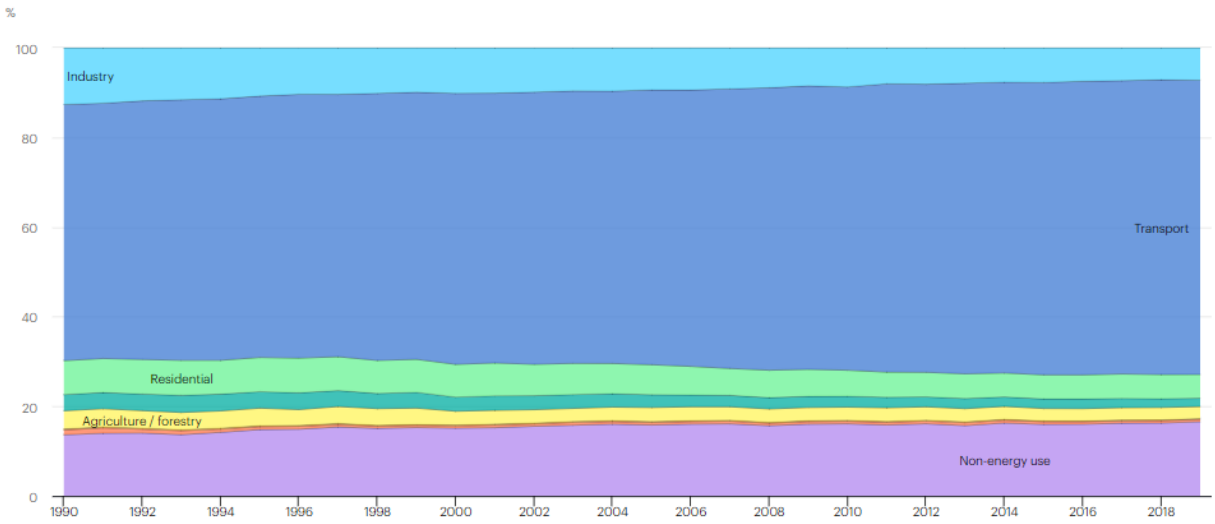


Figure 10. Oil products final consumption by sector. Source: (IEA, 2021)

Furthermore, out of the 42 gallons of crude oil about 45 gallons of petroleum products are made (because of the refinery process gain) and on average 20 gallons is gasoline – a major source of profit as it suites market demand and helps to maximize profitability (U.S. Energy Information Administration, 2022). Gasoline that enjoys huge and stable demand is mostly used by cars and light tracks (U.S. Energy Information Administration, 2021).

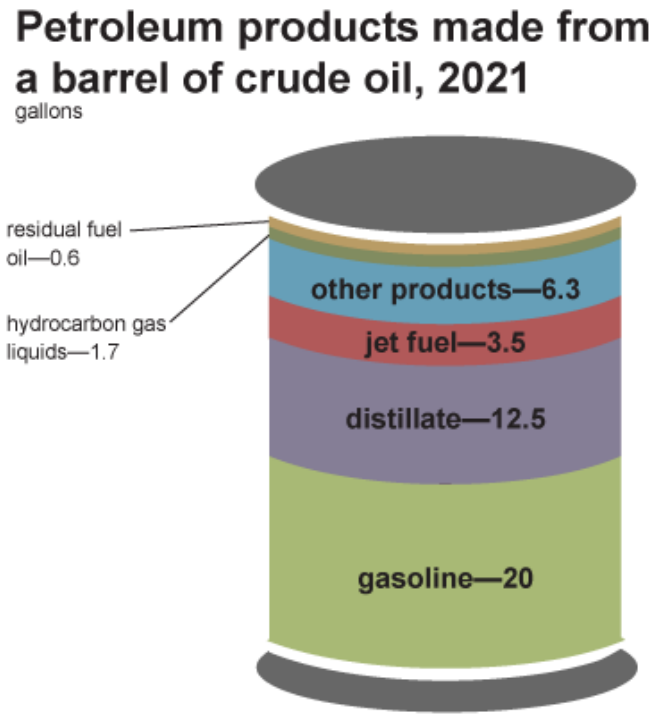


Figure 11. Petroleum products made from a barrel of crude oil. Source: (IEA, 2021)

Even though CIS region accounts for the smallest proportion of oil consumed (Fig.12), Russia itself holds the fifth place in rank of countries consuming oil (World Population Review, n.d.).

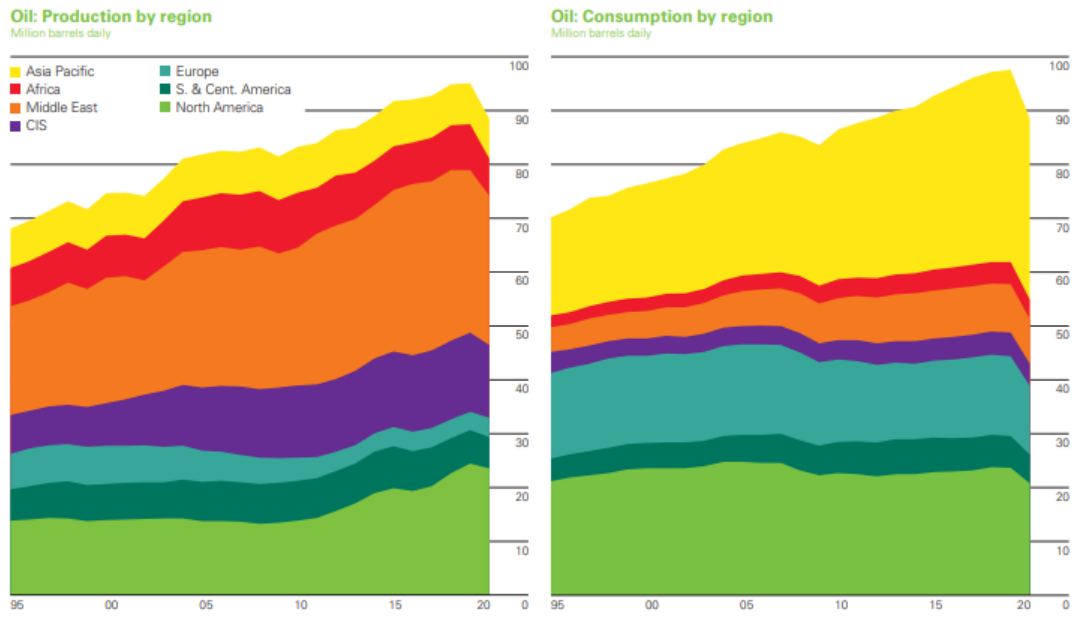


Figure 12. Oil production and consumption by regions. (World Population Review, n.d.)

Even though after the covid-19 pandemic the forecast of oil demand was significantly revised downwards, it is still considered to be growing (Figure 13).

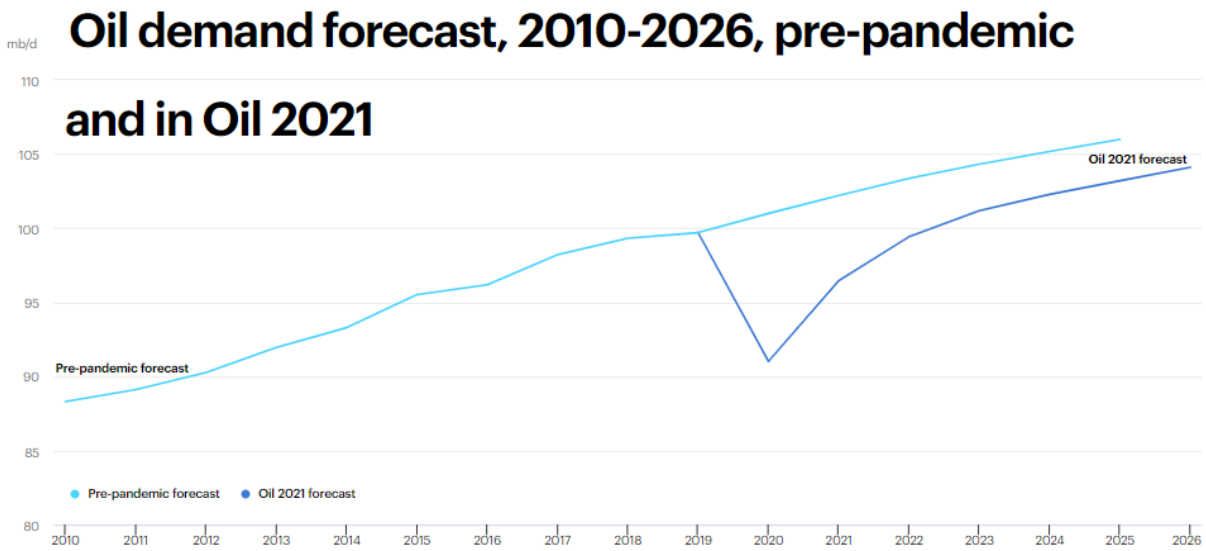


Figure 13. Oil demand forecast 2010-2016. Source: (IEA, 2022)

As for the influence of EV's on oil demand, electric vehicle can impact the crude oil demand only by fuel consumption changes in the way that the fuel consumption and electric vehicle has reverse relationship; the more electric car the less fuel consumption (Hasan, 2017)

As for Russian car market most cars there are so old (Automotive Statistics, 2022) that they no longer stick to any ecological rules and produce more CO2 than acceptable. Moreover, the oil product consumption for such cars is excessive. That means that replacement of such car by eclectic one is even more effective and considerably contributes to the environmental stability.

Furthermore, the majority of cars in Russia are used ones, so that even if a used electric vehicle enters Russian market, it offers double benefit for the environment as its predecessor consumed oil products and polluted air by far too much in comparison with modern cars. That means, that in Russian case transition from ICE cars to EVs is more beneficial than European and has more influence on the crude oil demand as the effect of such replacement is considerable.

Chapter 3. Theoretical framework

This chapter outlines relevant theoretical framework that is used for analyses, highlight both strengths and weaknesses of the scenario analyses, providing explanation why it is relevant for the research.

3.1. Transportation demand

Demand as a fundamental concept of the economic analyses plays an important role in every market analysis. Having no single definition in the academic world, here the demand will be referred to as an abstract idea that trace out individuals that would like to consume under different scenarios (Button K. , 2010).

Key attributes to the concept are D – the quantity of the goods in question, P- The price of goods, T- tastes, Y- income level, so that the neoclassical demand curve is D= F (P, P1, P2,…., Pn, T, Y) (KENTON, 2021). However, for the calculation purposes the formula that is more widely used is LnQm= A+ B1LNPm+B2lnY+B3lnPn (KENTON, 2021), providing understanding that the higher the price is attributed to the lower quantity of goods. That forms the curve, while all other factors are to move this curve in one or another direction, as it is shown on the figure 14.

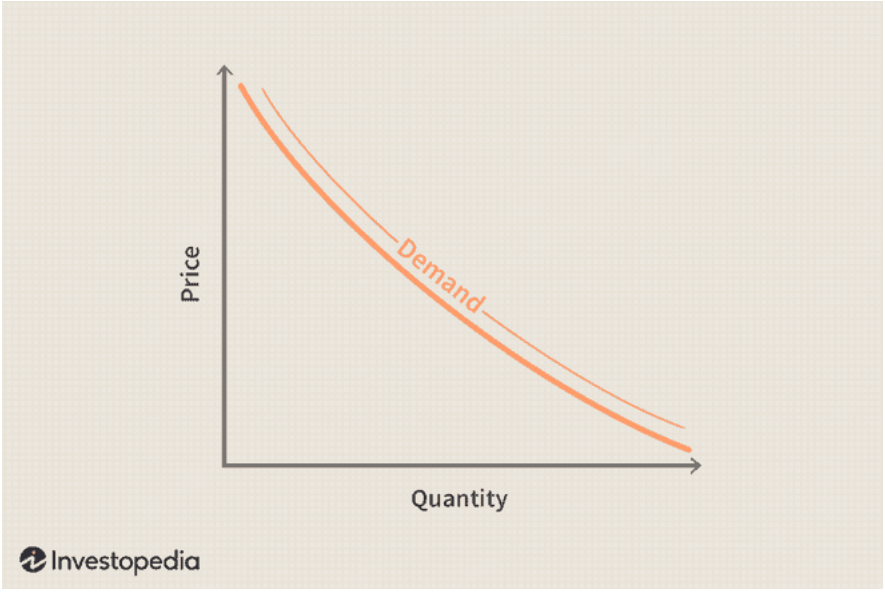


Figure 14. Demand curve. Source: (KENTON, 2021)

All the factors used in the model are multicomponent and include various complex terms and cannot be taken in isolation both from each other and from the environment.

As for the transport specifics, the grounds for further discussion is the book "Transport Economics" written by Kenneth Button (Button K. , 2010). According to him, the demand has a derived nature. Described as a fluctuating over time, the demand for transport is widely connected with the demand for the final services that it made accessible and varies within not only the period but also the area examined.

When it comes to price of the transport services, it's a complex term that implies not only a fare paid, but all costs accrued while obtaining the transport services. For example, a private car travel is affected by two different price effects –one on vehicle ownership and another on its use. Users themselves often underestimate the cost of transport and rarely take into consideration the environmental effects and cost of congestion. In some cases, the price fluctuations within a certain limit have almost no effect on quantity of travel demanded. Moreover, business travels are less sensitive to price change than other forms of travel.

Transport as third major expenditure position of the households (after housing and food) is highly dependent on their income. With the income raise the number of both car-ownership decisions and trips in total go way up, as well as the average distance travelled increases. The rate of disposable income to be spent on car travel appears to be resilient no matter the level of income. Furthermore, in some countries the percentage of the disposable income spent on travelling has been growing for more than four decades (Neil, et al., 2006).

Tastes are considered to be the least clarified concept, that in the case of transport demand includes numerous factors and is so called 'catch-all' variable as it is usually used in the equations to cover all aspects not mentioned before. The tastes are changing dramatically with the time passed. As for nowadays, the most outstanding feature is the change of priorities from price to other attributes of transport services, so that people prefer more comfort and freedom using private transport no matter of costs and income considerations (Button K. , 2010). Even the demand for car use in the city is rigid to tickets price change the for both buses and trains. Sustainability is one of the major trends arising that is becoming a priority at the moment of decision making.

Other important elements included in variable taste are asymmetry and inertia. That means that people do not like spending too much time looking for details and prefer to stick to the option ones chosen even if costs rise until a significant change happens. Moreover, the reaction to the price and cost decrease is not the same as to the rise so called ratchet effect is seen in the transport as well.

Going into more detail of the car ownership mentioned above, it has significantly increased since the beginning of the 20th century all over the world as a result of two trends car availability and long-term income rise. Road infrastructure and substandard public transport infrastructure are also fueling the demand for car ownership as well as the tendency looking for bigger homesite at a distance from the city center. Even though on average women still have less transport mobility than man (Button K. , 2010), in the last decades the travel patterns are shaped by rising car and driving license ownership, growing income and falling real car ownership cost (Neil, et al., 2006), causing the reduce of the need for public transport in some areas.

Another important aspect for consideration is the period observed while talking about the market.

As for the timeline, within the ultra-short run the elasticity of the transport demand might be extremely high, but short-lived and almost impossible to predict. This period with its outstanding volatility is usually omitted by scientists but widely discussed by politicians.

More informative for the analyses period is short run, however in short run all the resources and factors to influence bot demand and supply are fixed. All the factors constant means almost no place for change in terms of the car market.

The most common period taken for the analyses of the industrial markets and car market itself is business cycle period or in other words Juglar cycle (Legrand & Hagemann, 2007). In this almost 7-year period most factors and costs are variable, the predictable change is to take place.

As for the long and ultralong period of analyses, it is usually considered at the level of at least national economy, being informative even at a global scale. However, another problem of the analyses raises: all the factors and costs are variable, there is no longer an opportunity to rely

on the current stage of the technological development, level of live or any other factors. Each and every factor is to be under consideration.

According to all mentioned about the time line, we believe the period of 5-10 years to be optimal for our study as we are to deal with car market that is industrial, and it takes time to introduce changes.

Another argument for this period of time to be chosen is that political bodies have time to implement new measures and laws, but do not have opportunity to change the legislation drastically.

Sticking to the wide-spread approach of setting goals to achieve by a year with round numbers we decided to go with 2030 as the date of the scenarios for our study.

3.2 Scenarios analysis

Before applying scenarios, we have to understand the concept of scenario analysis and the way it works. According to Rami Ali, scenario analysis a is a process with the help of which a researcher could logically and structurally forecast the future to a certain degree (Ali, 2020). The key feature of the scenario approach is that instead of having only one prediction it uses several models that are developed in the way that they cover most possible options of the development.

The mechanics of this strategy are quite transparent. Scenario framework has several components:

- Condition

This part is a given data, something that has already happened and that requires further steps to be done. By using this method, a researcher is trying to find possible outcomes of every step and decide what outcomes are the best ones.

- Assumptions

It is the factors that are impossible to predict, but for the sake of the purity of the experiment are considered to be true. Assumptions may include the absence of force majeures and cataclysms.

- Uncertainties

This part is devoted to the situations that may happen and which should be taken into consideration. Uncertainties are the most important factors that might affect the purity of the experiment.

- Scenarios

This part can be divided into separate parts or kept as one part. It should include all relevant data and calculations for the scenarios. After combining all the data, calculating relevant aspects and parameters, every scenario is analyzed.

That's the basic idea of scenarios approach. It also has several types and models, but we are going to use 3 scenarios model. This model implies that there would be 3 possible outcomes (green, yellow and red).

We have to know advantages and disadvantages of this type of analysis in order to understand how reliable it could be. Below we draw up some advantages and disadvantages as well as strengths and weaknesses of this approach.

3.2.1 Advantages and strengths of scenarios analysis

Scenario analysis has many advantages in different aspects. One of the most important advantages of this method is that it takes into consideration several possible future outcomes (Lestan & Kabiraj, 2022). This feature is very beneficial as it provides an opportunity to take actions faster because all the consequences are already thought over. Nowadays the world is changing rapidly, and such approach helps to form a plan of actions for several variants of future.

Another valuable advantage was described by Rami Ali and David Luther in their article for brainyard. This method gives an ability to respond much quicker (Luther & Ali, 2020). It also helps to cover wider specter of possible challenges and questions.

Moreover, this method maybe used several times in different variants. This situation may occur in unexpected situations like pandemic or military conflict. Those situations are hard to predict, but their outcomes could be quickly combated if proper scenario had been made before.

3.2.2 Disadvantages and weaknesses of scenarios analysis

Scenario method, despite having such strong advantages, has several weaknesses and disadvantages. First of all, it is very time and energy consuming. It requires collecting and processing a lot of data. Since a researcher has to produce several predictions about possible future outcome, they will need to use much wider specter of ground data in order to produce viable scenarios.

Another strong weakness of this method was described by Kirti Solanki in scenario planning article (Solanki, 2021). It is described as scenario planning nature being theoretical and lacking calculations needed to be more scientific. Scenario planning method primarily is an assumption based on analysis of available data. However, this data may be not sufficient, or it may not be enough to give true conclusion.

To sum up, scenario framework is the one to contribute to our scientific goal achievement. While having its minor shortcomings, it provides us with the opportunity to make a valuable contribution to the clarification of EV market future. Furthermore, it allows to work out the concept of transport Market transition to electric vehicles for any period of time left at our choice. As mentioned and explained above, in the subchapter 3.1, we opt for the medium term and use the scenario framework to build up scenarios for the year 2030.

Chapter 4. Methods

This chapter depicts the philosophical positioning of the research, the data and methods used to proceed with the analyses. Moreover, the chapter includes the validity and reliability of the research. The main idea of this chapter is to prove that the way we deal with the data given in the second chapter within the theoretical framework mentioned in the third chapter is accurate, suitable and reliable

4.1 Research philosophy and ethics

Research philosophy consist of four different types (Dudovskiy, Research Philosophy, n.d.):

- Pragmatism

It is a research philosophy that implies a variety of understandings of the world. It insists on broadening of the "view" in order to "see the full picture" (Dudovskiy, Pragmatism Research Philosophy, n.d.).

- Positivism

It's a philosophy which states that only observed, measured or collected knowledge can be trusted. This type depends on quantitive data that has been collected (Dudovskiy, Positivism Research Philosophy, n.d.).

- Realism

This type implies independence of reality from people's minds. This method can be divided into 2 groups (Dudovskiy, Realism Research Philosophy, n.d.):

  - Direct realism. It can be understood as personal knowledge, obtained through senses, always have a true value. In other words, the world is like we sense it.

- ♦ Critical realism. It can be understood as personal knowledge, obtained through senses, might not have true value. In other words, the world is deceptive and it is not as we sense it.

- Interpretivism

This type would require the researcher to interpret the study, so the idea of interpretivism can be formulated as: “The access to reality may be achieved only via socialization (Dudovskiy, Interpretivism (interpretivist) Research Philosophy, n.d.).

Saiful Hasan outlined in his work three reasons for research philosophy's usefulness (Hasan, 2017). Those reasons are:

1. The design of the research may be clarified with the help of research philosophy

2. It indicates the designs that could work

3. The design that is created will not be based on the experience of the author and thus may be completely different from it.

As for our study we consider positivism to be most suitable in our case because it provides explanations for correlation between cause and effect. The exact measurable effect is the one our work looks for when considering the proportion of ICE cars and EV’s on the market. Moreover, the positivism is relevant while talking about car market because it provides a chance for exact estimations an opportunity to measure all the factors needed.

4.2 Document analysis and data collection

Document analysis is a type of qualitative analysis. It is used to get understanding for further implementations of obtained information. Usually, there are three main variations of documents that are reviewed during scientific research (Indeed Editorial Team, 2021):

- ♦ Public records. This category includes materials provided by government agencies, varies institutions and different organizations

- Personal documents. This category includes personal accounts like diaries, emails and blogs

- Physical evidence. This Category includes banners, flyers and various handouts

As for our research NO personal documents, personal data or any other type of personal data was used. No raw data procedures were carried out. That means no necessity to carry out any private data protection procedures or require special anonymization policy.

Only publicly available and trustworthy sources of data were used. All the material is easy to recollect and possible to reconstruct the result of the research.

Data collection is a way of obtaining and sorting information for later use. Data collection consist of two types and two subtypes (NDUKWU, 2020). Here you can see types:

1. Primary data collection

2. Secondary data collection

And subtypes:

1. Qualitative data collection

2. Quantitive data collection

There are seven methods of collecting data (NDUKWU, 2020). The table of pros and cons of each method is provided below:

Table 2. Pros and cons of data collection methods

Name of the method	Pros	Cons
Close ended question surveys	• It's cheap • It can be made anonymous	• Low response rate • Inability to ask for explanation

	• With the help of special software, the data obtained can be easily analysed	• Low complete rate
Open-ended surveys	• More informative • Customer answers may be used later to increase trust in marketing campaigns • Shows wider angle of the problems	• Hard to analyse • Inability to ask for explanation • Hard to structure the answers
Interviews	• More informative • Allow to deep into the topic by asking more questions on the go • Give interviewee better understanding of the question • More accurate due to ability for asking the explanations	• Get more expensive if the scale is increased • Time consuming, because interviews have to be set at the times when both sides are free • Time consuming
Online analytics tools	• Gives an understanding of how people are using online source • You can make tests to improve results	• Inability to interact with people • Limitations on data
Observational data collection	• High application rate • Easy to set up • Widely accepted	• Hard to keep objective • Limited in observations
Focus groups	• Reliable information • Less expensive than interviews • Ability to gather quantitative information	• More expensive than other 5 methods • Groupthinks may occur • Hard to set up due to different schedules of participants • Moderators required

Research or reported data collection	• Quick • Access to multiple sources of data	• Rely on the quality of the third party • Hard to get data that directly answers the question

Source: (NDUKWU, 2020)

As for our study, only secondary data is taken into consideration. We decided to go with the results of the researches carried out by various private and governmental statistical buddies. Furthermore, the use of the results of scientific research that are publicly available research and data reported by international agencies provided us with the ability to rely on quality of the third party, gather information from different sources and spent less time on the gathering of the data. To sum up we use the best suiting our study aim method – usage of publicly available information provided by the sources with excellent reputation, so it fits best our study purpose and methods and limitations.

Reviewed documents

In this work we have looked at different data sources. In order to make a proper analysis, we had to analyze huge data bases. The sources where numerical data were taken from be:

- Rosstat
- Autostat
- Moscow statistical reviews
- Statista
- International Energy Agency web-site
- United nations web-site

In terms of laws, incentives and other programs, valid sources are taken from the Russian or Moscow government web-sites. There are special web-site libraries, like:

- Consultant Plus
- The state Dumas' web-site
- Moscow's mayor web-site
- Russian government web-site

As for the literature used the full list can be found in the section Sources. Scientific books, articles, master theses, market outlooks, web-pages and some other sources that are publicly available, have been used.

4.3 Reliability and validity

Reliability

The term reliability may be referred as "consistency of the measure". There are three types of consistency (Price, Jhangiani, & Chiang, 2015):

- Test-retest Reliability

This means that the measured factor, which should be the same over time, will give the same result in the future. Test-retest reliability may be assessed by measuring the same group over a course of period of time and then checking the results for correlation.

- Internal consistency

That is consistency of people's responses to all elements of a measurement consisting of several elements. In general, it is assumed that all the points of such indicators reflect the same basic construction, so people's estimates on these points should be correlated with each other. Internal consistency can also be assessed by obtaining data over time.

- Interrater Reliability

That is how consistent various observers in their verdicts.

As for our study, all information used in our research is considered to be reliable, since the information is publicly available and it has been taken from trustworthy sources. In addition, no private, secret or undocumented data has been used while formulating this paper. Furthermore, the result of our analyses can be easily replicated, as the data used for the bases of the study is publicly available.

Validity

The concept of validity shows how close to the truth obtained results are. There are three main types of validity with several subtypes (Trochim, Types of Measurement Validity, n.d.):

- Construct validity

It is the truth (as close as it can be) of the inference that your precise spelling out how a concept will be measured (operationalization) is accurately reflects its design.

- Translation validity

In this pert, you focus on whether the operationalization is a good reflection of the design

- Face validity
- Content validity

- Criterion-related validity

Here you check whether the operationalization behaves as it should.

- Predictive validity
- Concurrent validity
- Convergent validity

- Discriminant validity

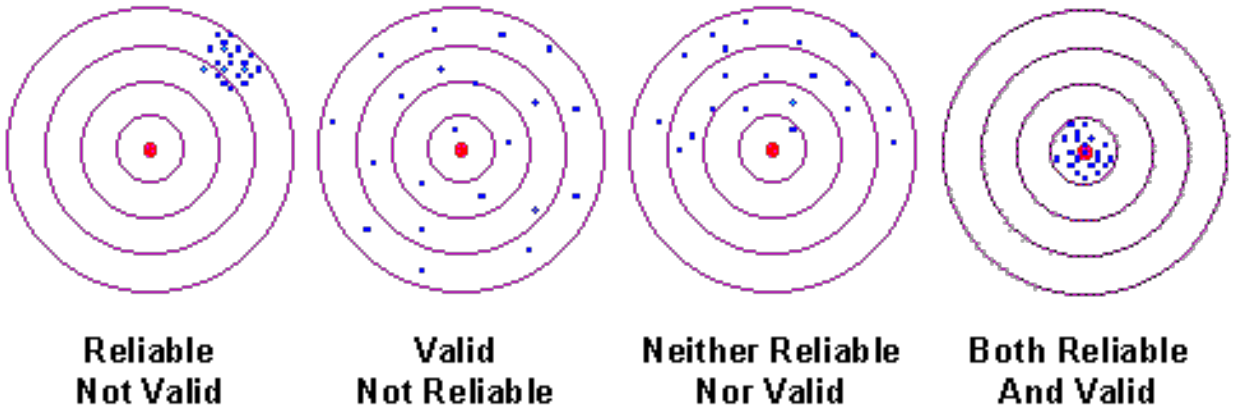


Figure 15. Possible situations in target metaphor. Source: (Trochim, Reliability & Validity, n.d.)

On the figure 15 you can see situations with different validity-reliability correlations in the target metaphors. In this concept the canter of the target is the measured concept

As for our research, all data and information that has been used in this research is up to date and it has been taken from valid sources. However, the data obtained from statistical agencies that use various statistical methodologies and units and systems of measures are not perfectly congruent, however, are highly correlated and consistent, representing same trends. Moreover, statistical agencies have not conducted a survey being in full correspondence with the topic of our research. The data may vary by a fraction, depending on the agency source.

Chapter 5. Scenario building

In this chapter based on all the trends given in the second chapter with the help of theoretical framework and methodology we provide the basis: assumptions and uncertainties taken for scenario building. Moreover, the ground for both assumptions and uncertainties are outlined. All the factors mentioned are combines into two complex variables – consumers attitude towards EV and Governmental EV stimulations, that are used as the basis for scenarios

5.1 Assumptions

As mentioned before, assumptions are the factors taken from the analyses of the objective reality which we consider staying the same for the duration of scenario. That means as stated previously by the year 2030 and for some time further the trends described below will continue to exist and influence on individuals, political bodies and companies and countries and world economy in general. Furthermore, representing worldwide trends these assumptions are applicable to Russia and its car and oil market in particular. We found no data to contradict these assumptions fixed in Moscow or published in available sources.

5.1.1 Desire for innovations

Based on the data mentioned in the chapter one and two that humanity in general and people of 21st century in particular are looking for innovations, that can not only provide them with the tool to treat global problems but increase the level of life of each individual. Curios by nature, humans managed to perform hundreds of scientific discoveries, the outstanding ones that are applicable to our topic are mentioned in subchapter 2.1 electric vehicle overview (history). Furthermore, as a part of the variable “tastes” that describes demand on the market that as a concept was depicted in the subchapter 3.1 Transportation demand it is stated that people prefer comfort and quality that in many cases can be provided only with the help of the enhanced technology and innovations. Today, when people are getting more and more comfort oriented and looking for the quality and high-speed services innovations play a huge role in business and civilization development in general.

Moreover, as mentioned before in the subchapter 2.1 Electric vehicle overview the pace of innovation is constantly increasing which shows that modern people are getting more and more innovation oriented. All that allows us to claim that for next decade to come innovations are to be highly appreciated by society and be desired by overwhelming majority of business as it

helps to improve efficiency and gain competitive advantages. That are the grounds for desire for innovations to be an assumption for our scenarios.

5.1.2 Technological and energy development

While talking about car market, technological and energy development is partly connected with the desire for innovations but to our minds current technological and energy development shows the desire for innovations that previous generations had. According to the data given in the chapter one and two the world has been changing the way the technology and energy are used and is still developing both practical and theoretical implications of advancements in technology. As for technologic and energy advance, examples that are applicable to our topic are mentioned in subchapter 2.1 electric vehicle overview (history).

Moreover, as mentioned before in the subchapter 2.1 Electric vehicle overview the enhancement of energy storage and usage technology has significantly improved efficiency of cars and is still providing people with the room for further development. All that allows us to claim that for next decade to come technological and energy development is an indivertible process that is world-wide spread and Russia is not an exception. That are the grounds for Technological and energy development to be an assumption for our scenarios.

5.1.3 Demand for vehicles

As it is described in the subchapter 3.1. Transportation demand with the rise of income and affordability of cars the demand for them is growing, as well as with the time passing needs of the population grow. As given in the chapter one, the population is increasing, so the more people are there on the planet the more transport they need, and as today the major trend is for private car ownership the demand for cars increases. Furthermore, taking into account the information provided in the chapters one and two, average distance modern people are covering is increasing that also fuels the demand for vehicles. All in all, we can state that demand for vehicles is strong and it will increase in the future, so this particular assumption is relevant.

5.1.4 Resource sufficiency

Even though the population is growing and global problems such as the lack of the drinking water has not been tackled in this particular assumption, we are talking about the development opportunities for the car industry and especially EV's. Based on the data mentioned in the chapter one and two there are enough resources for EV production. Furthermore, according to the programs mentioned in the subchapter 2.2. the ability of authorities to provide stimulus for the EV marked development is also considered stable. Moreover, as stated in the subchapter 3.1 transport expenses form a considerable part of household spendings, this means the market of transport services is huge and growing and there is a share of market to compete for. Based on all mentioned above, if no drastic changes are to take place, there can be found a resource sufficiency for the EV market at least for a decade. That are the grounds for resource sufficiency to be an assumption for our scenarios.

5.2 Uncertainties

5.2.1 Total Primary Energy Supply and Demand (TPES&TPED)

As the civilization thrives, technological progress advances and population is growing, world needs more energy every year. So, people build more power stations, develop new, more efficient ways to produce electricity for sustainability of the humanity.

On the figure 16 we can see how primary energy consumption changed over time. It can be seen that energy consumption is constantly growing and only in 2020 the consumption has decreased due to lockdowns and business activities of many companies being halted for a period of time.

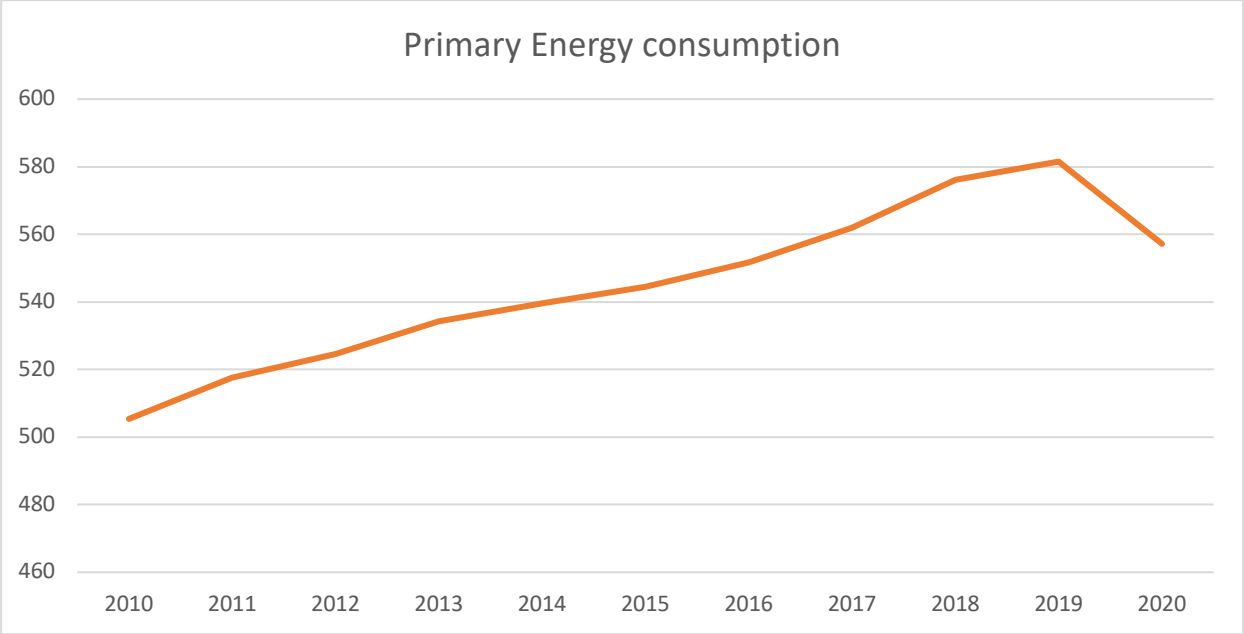


Figure 16. Primary Energy consumption by years. Source: (BP, 2021)

Despite having such constant increase, it is hard to estimate future energy demand. Nowadays, "green" trends are at priority for companies and governors, we are implementing more sustainable and environmentally friendly approaches to our lives.

Figure 17 shows what sources are used in the world to produce energy. We can notice, that oil share is decreasing, while shares of renewables are increasing. As mentioned before in the subchapter 1.1people nowadays are much more aware of climate change problems, so that are taking many actions to combat this threat.

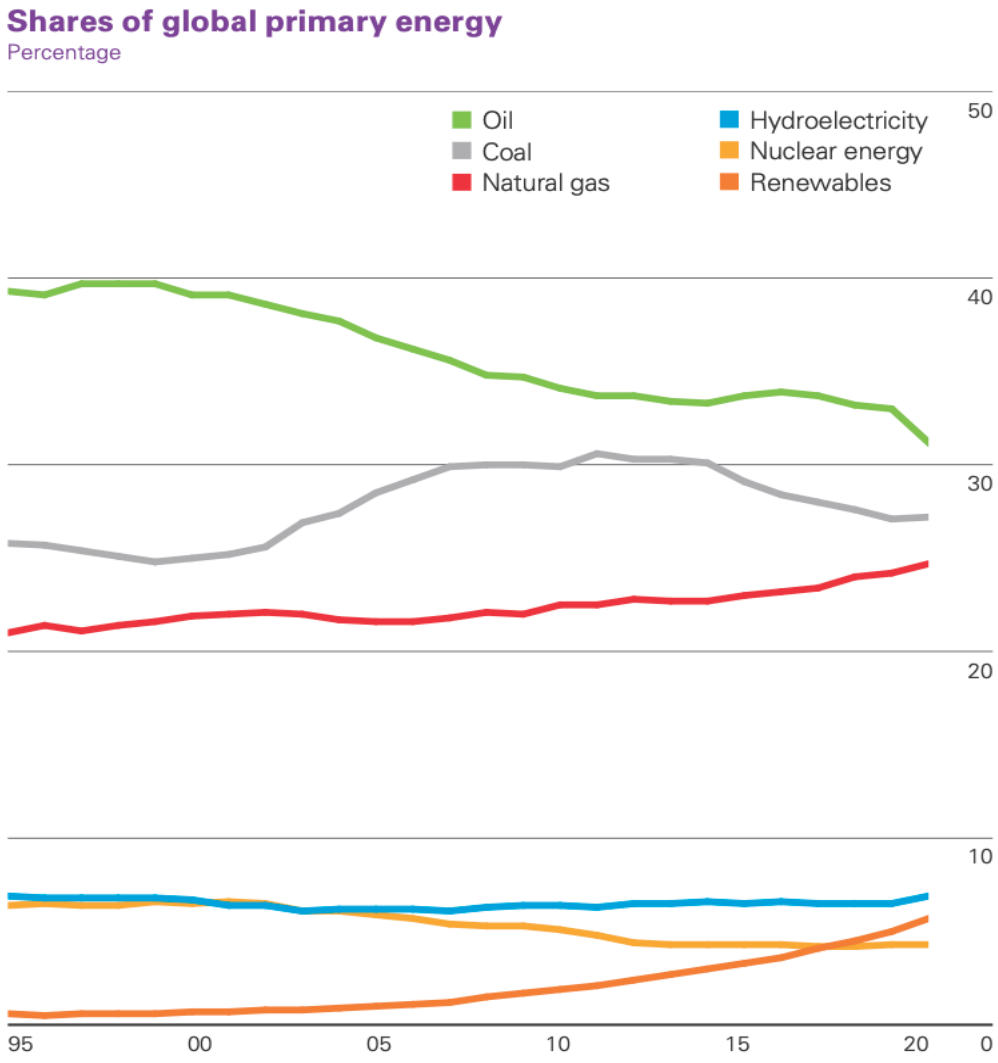


Figure 17. Shares of global primary energy. Source: (BP, 2021)

5.2.2 Fossil Fuels Production, Supply and Demand

If we look closer at the fossil fuel side of this topic, we would find that it is the main source of energy today (fig. 18). In 2020 fossil fuels were used to produce approximately 83% of electricity.

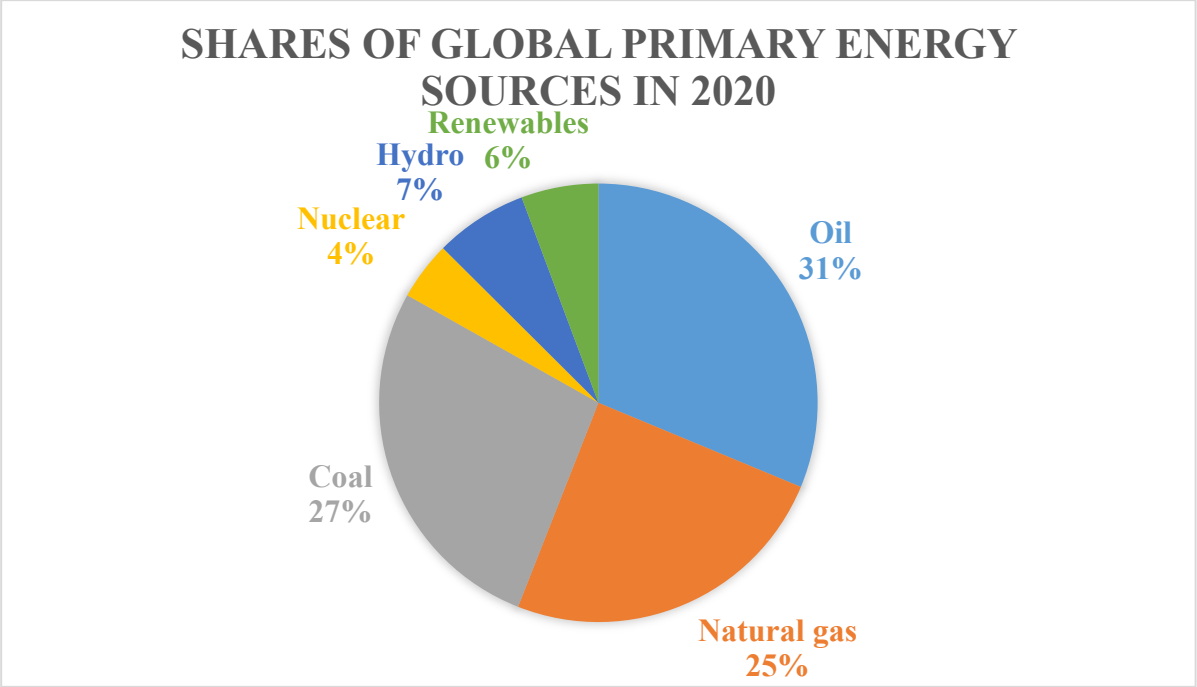


Figure 18. Shares of global primary energy sources in 2020. Source: (BP, 2021)

However, the situation is changing. As we can see from the figure 19 in all three positions a decline can be noticed since 2019 to 2020. This environmentally positive trend was achieved partly with the help of green laws and people's awareness.

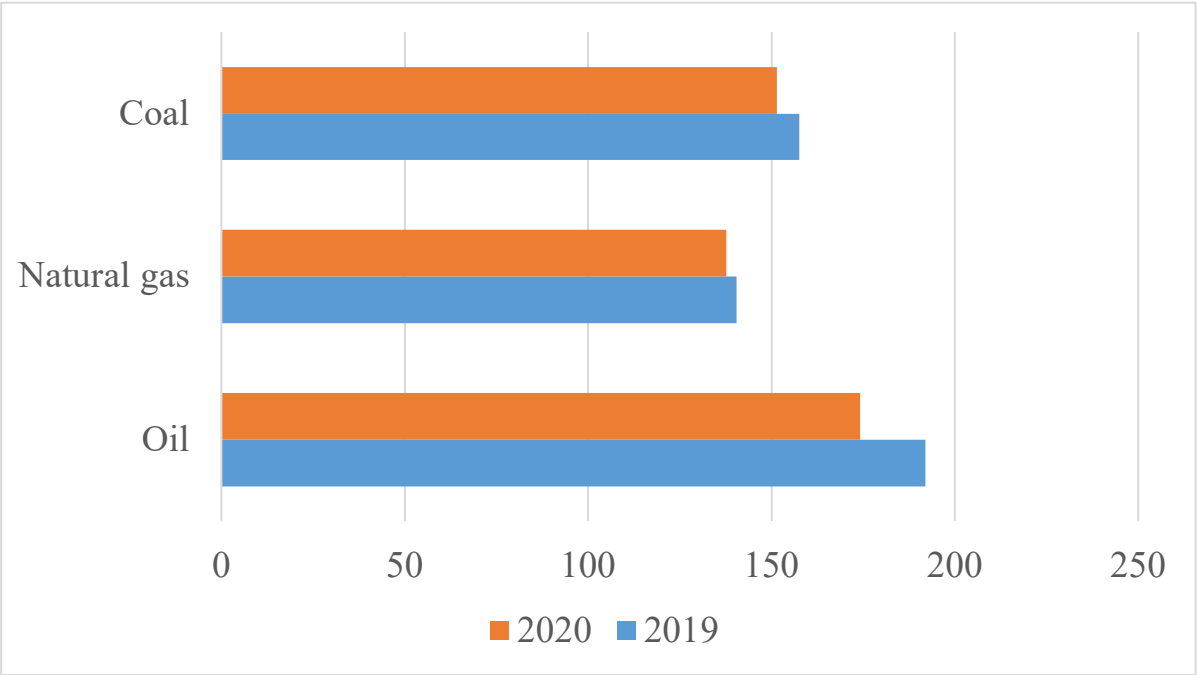


Figure 19. Primary energy: Consumption by fuel. Source: (BP, 2021)

5.2.3 Green Energy Production, Supply and Demand

Green energy production is one of the most important agendas in 2022. Many countries are trying to exclude fossils from their energy production equation. The leader in this trend is undoubtedly Norway. According to Norway's ministry of petroleum and energy back in 2016 98% of their electricity was produced by renewables (Ministry of Petroleum and Energy, 2016). However, by 2020 all of Norway's electricity was produced by renewables. Figure 20 bellow shows what sources and by what share are used in Norway to produce electricity.

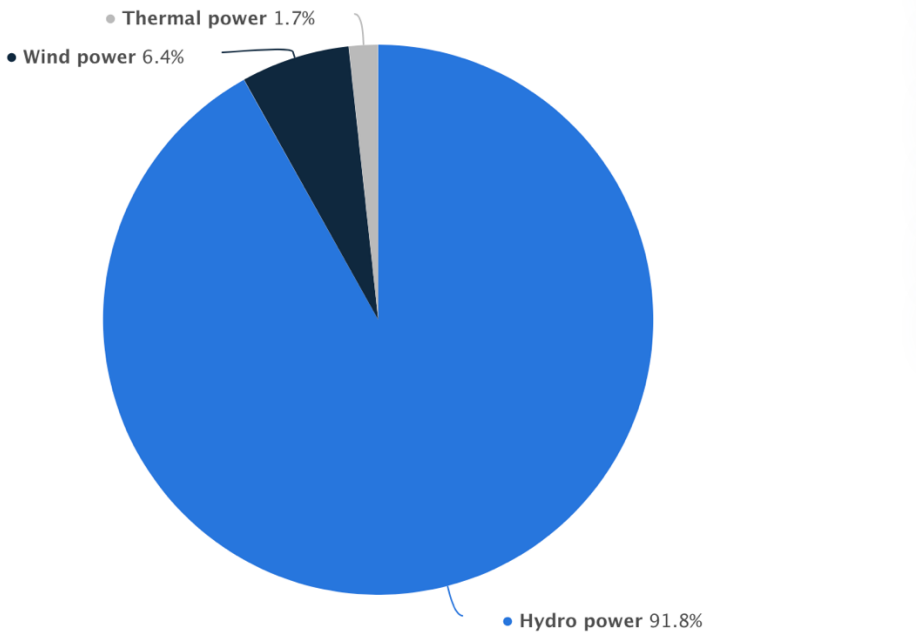


Figure 20. Distribution of electricity production in Norway in 2020, by source. Source: (Alves, 2022)

World also is trying to keep up with green trends. In the figure 21 we can see that power generated by the renewables has significantly increased and in ten years the increase was by approximately 340%.

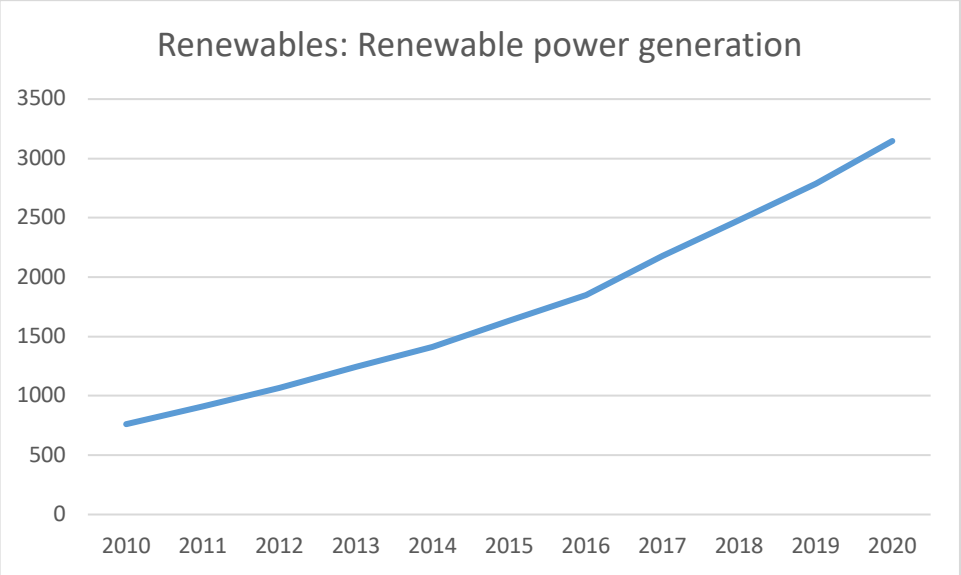


Figure 21. Renewable power generation. Source: (BP, 2021)

5.2.4 CO2 Emissions and decarbonization

By going to EVs, we cut down CO2 emissions. Some might argue that EVs require electricity that is produced by burning fossils, but as Elon Musk stated in his TED interview in 2013 "… If you burn that in modern General Electric natural gas turbine, you'll get about 60 percent efficiency. If you put that same fuel in an internal combustion engine car, you'll get about 20 percent efficiency. And the reason is in the stationary power plant you can afford to have something that weighs a lot more, is voluminous and you can take the waste heat and run a steam turbine and generate a secondary power source…" (Musk, 2014)

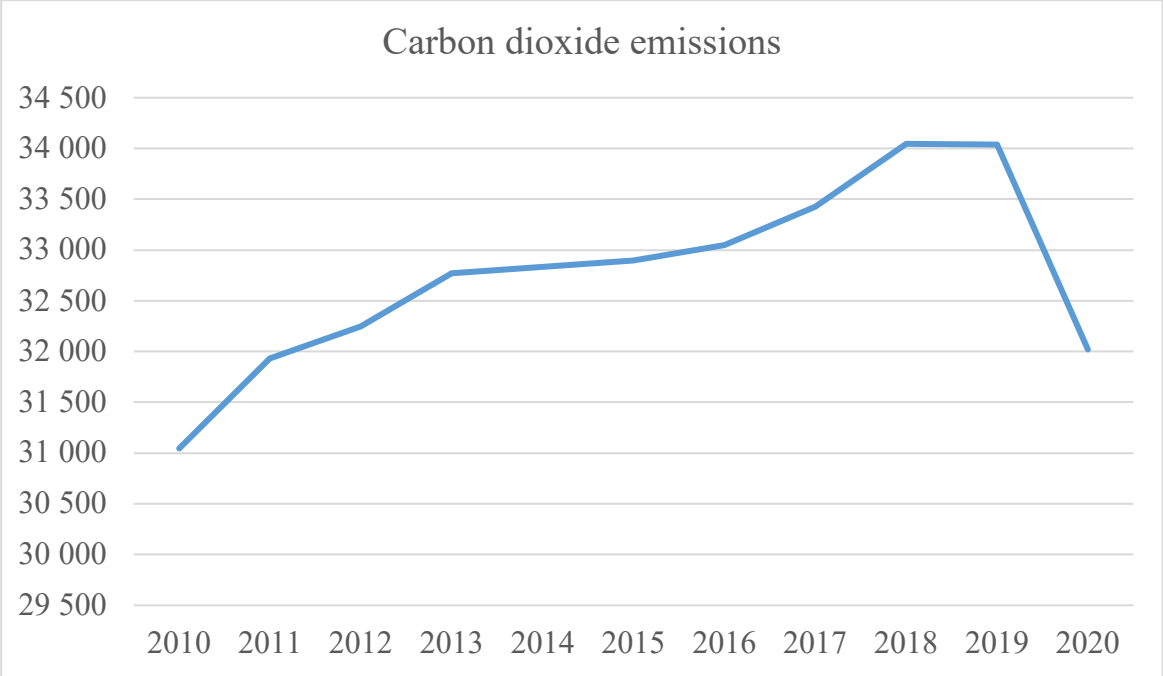


Figure 22. Carbon dioxide emissions by years. Source: (BP, 2021)

Global warming and CO2 emissions are a big threat to the society which should be eliminated in the nearest future. CO2 emissions may lead to irreversible consequences and it is important for us to reduce the pollution in all aspects of our lives. Physicists, chemists and engineers all over the world are trying to find the best solution to reduce the amount of this hazardous gas in the air.

From the figure 22 we can see that CO2 emissions, unlike other previously mentioned ones, is growing unevenly and by much smaller proportion. The amount of carbon dioxide emitted from 2018 to 2019 barely changed.

These all are good signs, but it is impossible to predict future pollution levels and how big will the changes be.

Chapter 6. Scenarios

In this chapter all the information provided before is used for the sake of our study. Taking the problems mentioned in the chapter one in a vide contest given in the chapter two with all the data mentioned there within the framework provided in the chapter 3 and using the methodology of chapter 4 relying on assumptions and uncertainties proved in the chapter 5 here in chapter 6 the scenarios for the year 2030 are build. Moreover, the difference between the scenarios is explained. Furthermore, the effect of the scenario to happen on oil demand is provided.

Before getting to explore the scenarios directly, we agreed on two variables that depict two different spheres of any market work and car market in particular. As mentioned before in the chapter 3.1 demand can be influenced by enormous number of factors. In order to clarify our scenario building process, we decided to divide all the possible factors into two big groups – customer group and governmental one. The first group is represented by a complex variable named Consumers attitude towards EV. It reflects all the mentioned above and functions according to the assumptions mentioned above. The other group is called government stimulations in the EV's market. These two variables and their proportion are to determine our scenarios. Mentioning that these two variables can take any value, for the clarity of the explanation all the are classified either to low or high level.

Important factor in these scenario analyses is that at the moment Russia doesn't produce any EV's on its own, so either the cars themselves or the technology have to be imported from other countries, so in our analyses we believe the political situation to be stable enough for other countries wishing to supply Russia with EVs.

If no cars are to cross the border of Russia that our research is no longer applicable.

This part is devoted to a scenario building and explanation of those scenarios. For better visualization we should include special graph to understand the differences between scenarios.

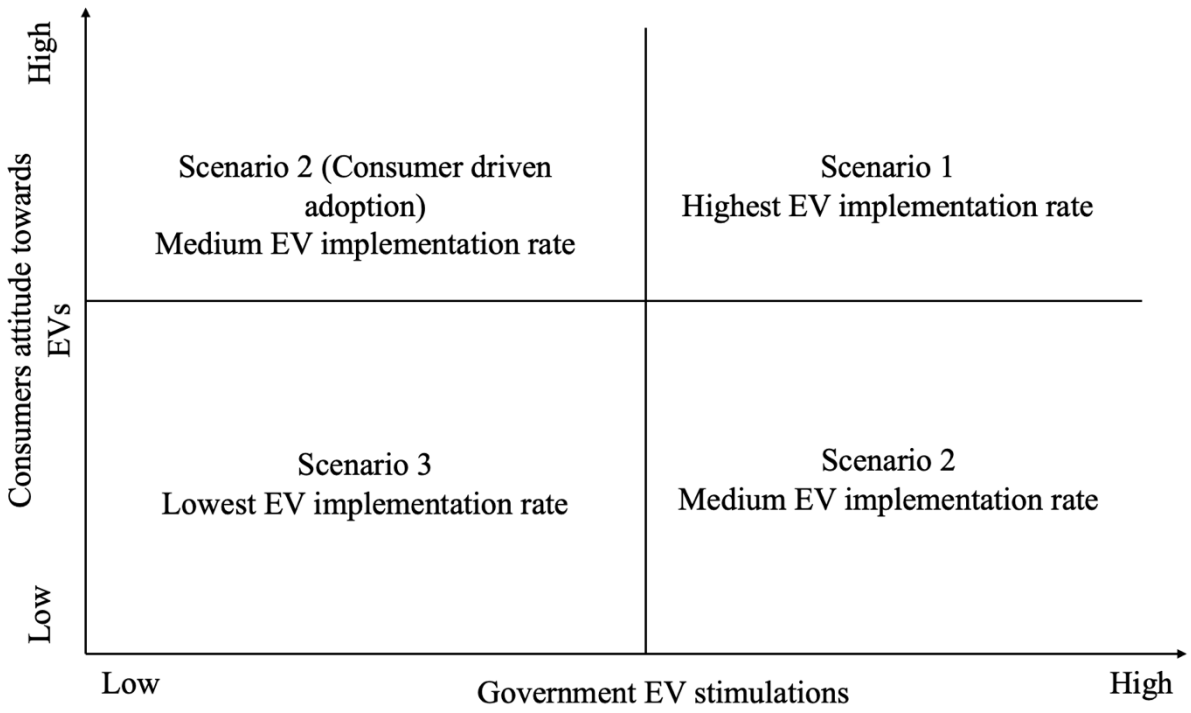


Figure 23. Scenario matrix.

On the figure 23 we can see how each scenario is related to others. Consumer driven adoption model is a unique, but possible path. Since we are going to look at Russian market, this model is not very realistic and it is very unlikely to happen. Therefore, mostly we are going to focus on the other model in scenario building 2.

Each scenario has several key points and characteristics that will be affected by different factors including, but not limited to:

- Government EV stimulations
- Consumer attitude towards EVs

6.1 Scenario 1 (Green scenario)

Scenario 1 is a possible future, where the rate of transition to EVs is high. This may be achieved by various factor combinations, but in this method we will be absolute. In this scenario, EVs would have the highest effect on oil demand.

Consumer attitude towards EVs in this scenario is at high level. This situation is partly formed by high government EV stimulations. So, we know that we are in the second quadrant of our matrix (Fig.23).

If we apply Norway's approach, by 2027 about half of newly sold car should be either BEV or PHEV. According to our calculations, electrification of newly sold vehicles should look like the graph presented on fig.24

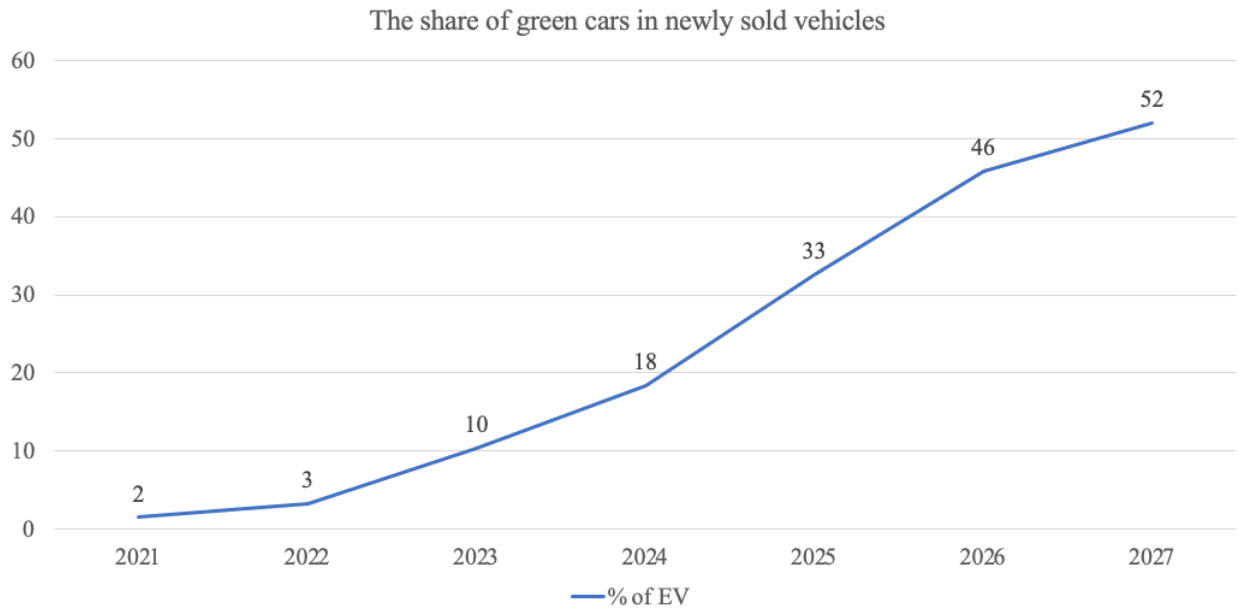


Figure 24. The share of green cars in newly sold vehicles for scenario 1. Source: (Rosstat, 2022) (Ivanov, 2021) (e-cars.tech, 2021) (Delovoy Profil, 2021).

Our forecast for scenario 1 states that by 2027 5,7 million cars on the Russian roads would be EVs. Keeping that in mind, we can calculate approximate impact of such transition.

As for the influence on crude oil demand, that has a reverse correlation with the number of EV's on the market it is estimated to decrease.

6.2 Scenario 2 (Yellow scenario)

Second scenario is less “green”. It implies far slower rates of conversions and it can be named as “what happened if nothing changes”. As we mentioned before, there are two possible ways of interpreting scenario 2. Customer-driven and policy-driven. Here we are going to focus only on policy-driven way.

In this situation, Russian public attitude to EV’s is neutral and no strong desire to by an EV can be found. The problem of warming up social appetite for EV in this scenario can be attributed to both laziness of the society (mentioned in the chapter 3/1) and low personal desire for greener world (the uncertainty 5.2.3. is here seen as the one with negative effect. At the same time, Russian government wants to follow green trends that are conquering the world and therefore it is trying to support EV transition by creating better infrastructure and implementing EV oriented policies.

In Yellow case the consumer attitude towards EVs in this scenario is at **low** level even though the government EV stimulations are at **high** levels. Thus, we can find that we are in the fourth quadrant of our matrix (Fig.23).

On the graph bellow (Fig. 25) we have presented the pace of the change in transition to green cars is not very steep.

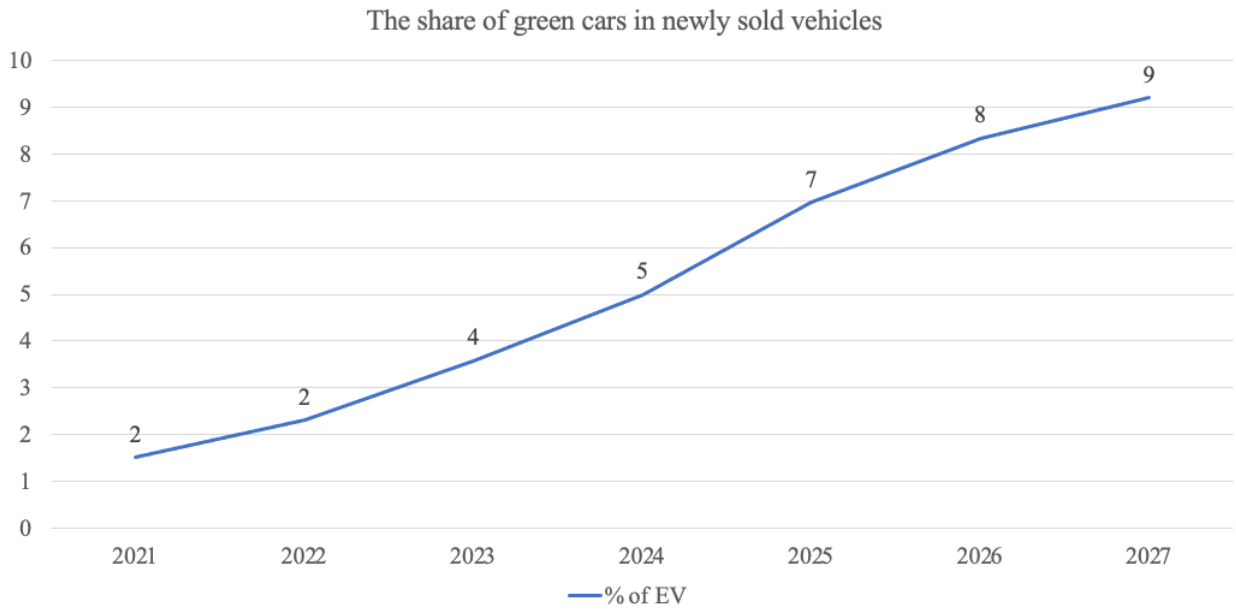


Figure 25. The share of green cars in newly sold vehicles for scenario 2

According to our findings, by the end of 2027 total number of registered EVs in Russia is expected to be 0,78 mil.

As for the influence on crude oil demand, that has a reverse correlation with the number of EV's on the market it is estimated to decrease slowly.

6.3 Scenario 3 (Red scenario)

Last scenario can be attributed to less developing countries, which do not invest into changing the world and their approach towards sustainability. One of the main things that can enforce for this scenario to happen are low prices for oil. In the rush for a profit, country would try to sell as much oil as it can to cover lower prices, while customers enjoy low prices of petrol and see no sense in choosing EV.

As a result, government EV stimulations are not at priority and therefore they are at **low** levels. This situation is followed by **low** consumer attitude towards EVs. This scenario is located in the third quadrant of our matrix (Fig.23).

Oil price forecast

Oil prices here would be at lowest possible levels, totally neglecting the economy from using EVs in terms of petrol. Figure 26 has previously mentioned forecast and from this graph we can understand how it may look like.

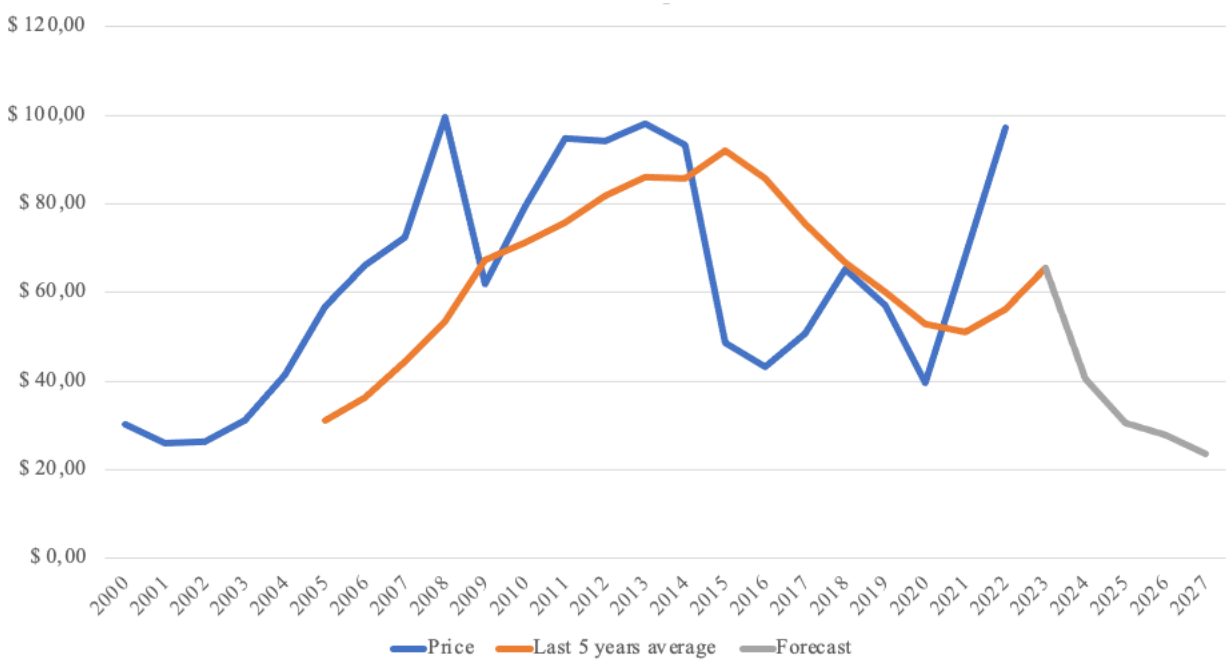


Figure 26. Oil prices by years with forecast for scenario 3

Table 3 contains forecasts of the oil price for the next 5 years for this scenario. Such small prices undoubtedly affect petroleum prices.

Table 3. Oil prices by years with forecast for scenario 3

	2023	2024	2025	2026	2027
Last 5 years average	$65,46				
Forecast	$65,46	$40,39	$30,60	$27,89	$23,60

As a result, people don't see reasonable financial cause to exchange petrol cars for more expensive EVs. Figure 27 illustrates how the share of EVs would change over time in the scenario 3.

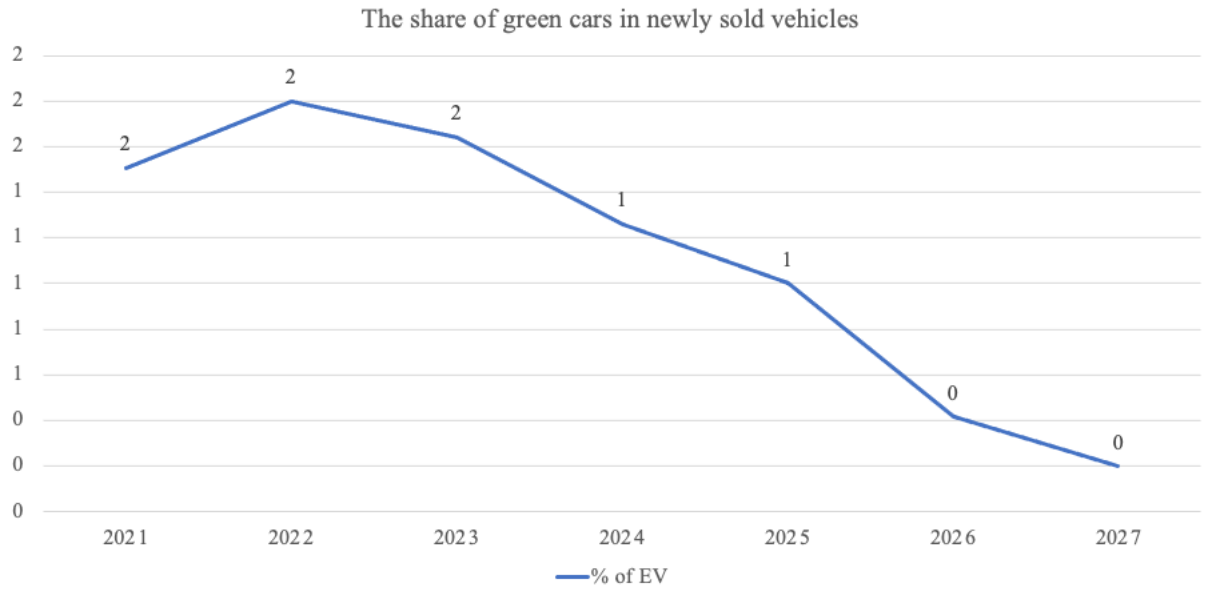


Figure 27. The share of green cars in newly sold vehicles for scenario 3

As we can see on figure 27, the demand for EVs is proportionally smaller the the demand for vehicles in general, so, even though the total number of EVs on the roads is increasing, the share of them is decreasing.

As for the effect of red scenario on the oil demand it is as follows. As the population is growing, the number of cars and need for transport is growing, the demand for oil products is growing at a high speed.

6.4 Black Swans

Black swans are the situations which happen unpredictably. The name of the term comes directly from the fact that in Europe it was believed that swans were only white, however, everything changed when black swans were seen in Australia (PA Knowledge, 2022).

The most famous black swans of 21st century were (SWEDROE, 2021):

- The attack of September 11, 2001
- Global financial crisis, 2007-2008
- COVID, 2019-today

All of those three events happened unpredictably and they have changed the way people live now. The after effects of the first two disasters can be seen and evaluated now, but the results

of the COVID are still emerging. Figure 28 shows major black swans that happened since 1973 and it gives short information about them.

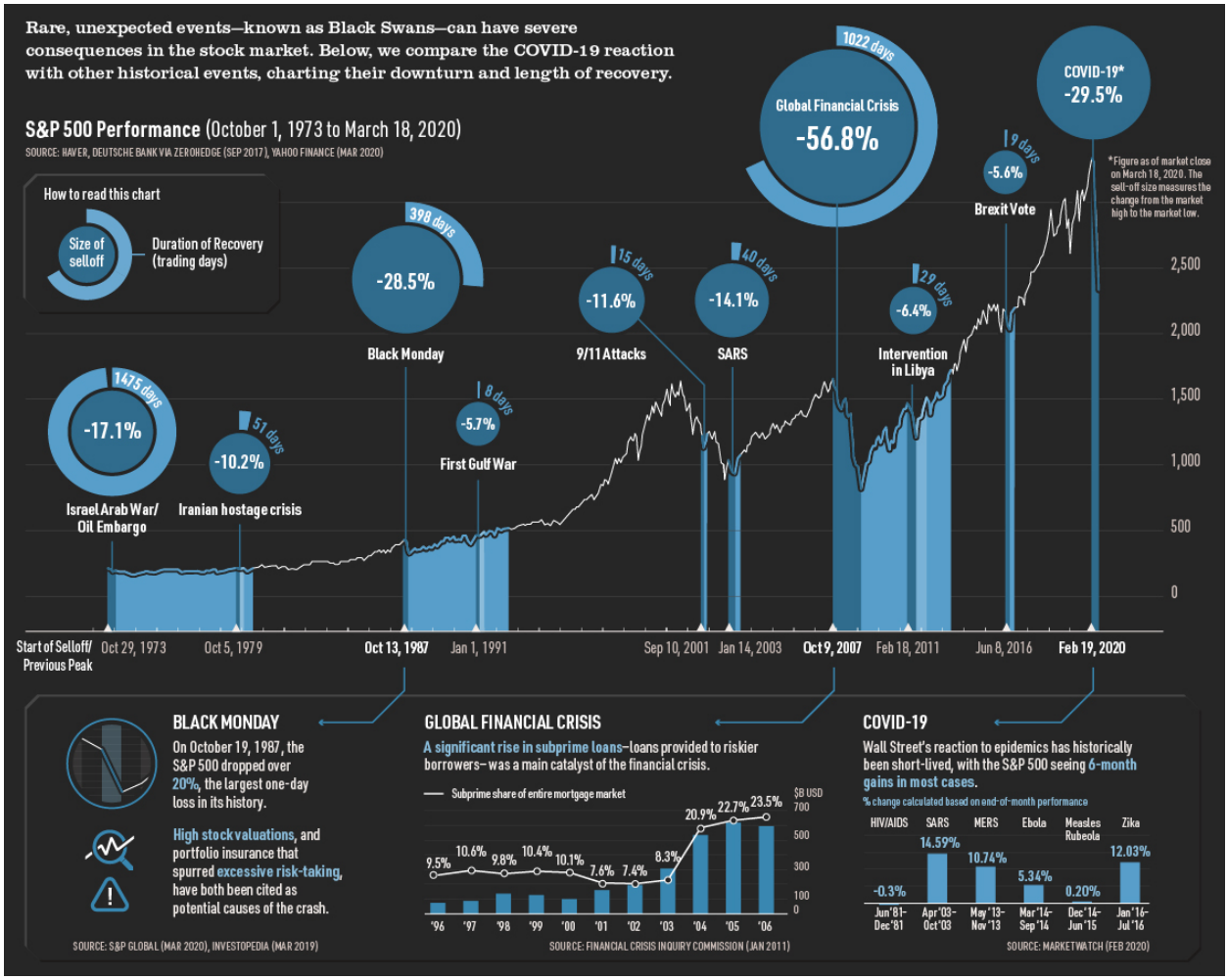


Figure 28. Major black swans since 1973. Source: (Ross, 2020)

Sometimes, the result of one black swan can be another one. Today's chip crisis is a result of lockdowns, that happened due to virus spread, and technological advancement that happens in the world.

Chapter 7. Conclusion

This chapter starts with the summary of the thesis. As well, it includes the implications and concludes with the recommendation of future research scopes.

7.1 Summary

Russia accounts for around 5 % of word crude oil consumption. Major part of it is consumed by cars. Most of cars on Russian market are so old that they no longer respond to any ecological requirements and consume excessive volumes of oil products. Replacing even one such car by electric vehicle is beneficial for the environment.

In our study we worked out scenarios that show with enough political will and customers opting for EVs the impact of the replacement is more than several countries could afford to perform even if they fully stop consuming oil products. Green case scenario describes the growing share of EVs on the market and reduction of oil demand while, the red one is the one with the lowest share of the market and highest oil consumption.

7.2 Implications

The findings by this study are of interest to EV policy makers from any countries, EV manufacturers and oil industry. Even though most of the discussion and analysis are based on Russian and Norwegian EV market, the findings can be helpful for other countries as well as to understand what policy measures require lots of attention and are to influence the future of the globe. We believe that drawing public attention to the fact that Russia itself is responsible for almost 5% of all oil word consumption that is more than half attributed to transport and Russian policy measures that stimulates the increasing number of EV's can decrease the volume of oil consumed in the way that all the globe will fill it, is of major importance. Furthermore, this study shows that consumers and their attitude are of vital importance as their actions are to determine the future not only of an industry but humanity. But best effect is seen when both consumers and government are interested in transition from ICE cars to EV's.

Sufficient EV stimulations from the government play key role in the EV conversion. Generally, EVs are more expensive than ICE, but in many aspects, they are still behind ICEs. So, in order to persuade citizens to substitute their petrol car by EVs governments should introduce such programs, that would give EV owners more benefits over petrol car owners.

Nevertheless, sufficient EV stimulations would also affect climate change as well. Since better incentive programs persuade more people to buy EV, that result not only in reduced greenhouse gases emissions, but also in reduced oil consumption, and therefore reduced oil extraction (meaning less air pollution from oil companies' activities). However, it is important to make electricity production process greener as well.

7.3 Future research scope

Further research can be conducted to analyze the crude oil demand changes due to EVs including all other types of vehicles except for passenger cars that were examined in thus study, e.g., buses, trucks, bikes, airplanes etc.

This research was mostly about Russia and its possible future within options for increasing of their EV market share by adopting effective EV policy measures and their impact on crude oil demand, but further research can consider deriving evidence from other countries where car population is high and their market can influence their global scenarios, e.g. China, India and USA.

Moreover, our research was conducted taking into consideration that EV have to be imported to Russia, research for national producer of EVs can potentially become even more fruitful as establishing of the car production is likely to influence the economy of the whole country, because the multiplicator of the funds invested to building will help to raise the level of people's life.

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