



**The impact of COVID-19 on energy:
How the pandemic facilitated the transition to renewables and a
perspective on EVs**

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Introduction

During the first lockdown period at the beginning of 2020, billions of people from all over the world were forced to stay at home for more than two months consecutively. In this period most of them rediscovered the joy of little things and had more time to deepen the study of topics in which, otherwise, would be harder to find the time for. Personally, I was shocked by the constant news regarding the environment and how the air that we breathe was becoming always less polluted, due to many factory closings. Moreover, the oil-demand shock gave me the opportunity to think: is this the peak of the oil and coal era? Will the institutions and the companies exploit this momentum to put in action efforts to challenge the energy transition? These questions allowed me to analyze deeper this topic, being always more interested in finding a response.

For this reason, I decided to write this thesis to study if the measures implemented as a response to the pandemic recession really facilitated the transition to renewable energy, and to a more sustainable way of living. Doing so, this work is structured in three main chapters, characterized by a precise and logical order.

To begin, I evaluated how the lockdown measures affected the world economy, in particular, the energy industry. I investigated the effect of the closures on the oil demand, characterized by a devastating reduction caused by the lack of mobility. Then, the topic shifts to the energy demand and how the source of the electricity mix changed during the last year. And finally, I reported facts and data that demonstrate how CO₂ in the air really decreased in the atmosphere.

However, the real answer to the questions is found in the second chapter, and partly in the third. In fact, the main pillar of this work is the analysis of all the major policy response made by the most powerful governments in the world (EU, USA and China) and my local country, Italy. The reader will find so the investigation and the conditionalities of the “recovery plans” of the politics mentioned, namely the NextGenerationEU, the Italian PNRR, the American Jobs Plan and the Chinese 14th Five-Year Plan, all released in the last twelve months. Diverse billions of dollars were indeed planned to be invested to recover from one of the greatest recessions of the last 80 years, and this work wants to discover if they will allow us to become a net-zero planet in the next decades.

Finally, to achieve the target of decarbonisation is crucial to switch from internal engine combustion cars to vehicles that do not produce emissions, and the most advanced in this category,

are the EVs. For this reason, in the last chapter, is interesting to understand on one hand the consumers' behaviours that lead to a massive decrease in car sales, while EVs outperformed the traditional market, and on the other hand how the manufacturers are responding to this shock, examining their business strategies for the following years. In brief, the chapter will give an idea of how the recession influenced negatively the 2020's results of the car market, and how instead allowed EV's to gain market share continuing to advance their growth.

For this kind of work, capturing scientific data by myself was practically impossible, given that also institutions have some large discrepancies among them. So, the methodology for this work was to collect and interpret the most reliable information and reports released, analyzing deeply governments and institutional papers. The more peculiar data for the industries were found from the International Energy Agency, the US Energy Information Administration, the National Aeronautics and Space Administration and the European Automobile Manufacturers' Association. While for topics related to the policies and the national plans to fight the pandemic's downturn, I went directly to the sources, reporting information from the European Commission, the Italian Government, the White House, but also the OECD and IMF. Finally, it does not miss the opinion of expert journalists, especially from the Financial Times, the Economist, Il Sole 24 Ore and Bloomberg.

Chapter I: COVID-19 and energy demand in 2020

1.1 COVID-19 outbreak

While at the end of December 2019 and beginning of January 2020 we were thinking about good resolutions for the new year and were completely unaware of the health emergency that would be created, a new highly contagious virus and completely unknown to our immune system had begun to circulate in a remote location of the globe. We would never have thought, at the time, that this apparently distant virus could have spread and caused so many problems on an individual and collective level, for health and economic systems. But in just over two months the global scenario has changed radically, and we have had to adapt and meet the new needs.

Already in November 2019, the new coronavirus Sars-CoV-2 had begun to circulate, in China, in particular in Wuhan, a pivot for the trade and commercial exchanges. In the beginning, however, it was not known that it was a new virus: what is beginning to be registered is a certain number of anomalous pneumonia, with causes not attributable to other pathogens.

The first official date on which the story of the new coronavirus begins is December 31, in which the local health authorities had given news of these unusual cases. At the beginning of January 2020, the city had found dozens of cases and hundreds of people were under observation. In fact, from the first investigations, it had emerged that the infected were frequent patrons of the Huanan Seafood Wholesale Market in Wuhan, which has been closed since January 1, 2020, hence the hypothesis that the infection may have been caused by some product of animal origin sold in the market.

On January 9, the Chinese authorities had told local media that the responsible pathogen is a new strain of coronavirus, from the same family as the coronaviruses responsible for SARS and MERS, but different from these, new and stronger, in fact. World Health Organization disclosed the news on January 10, providing all the necessary instructions (avoid contact with people with symptoms) and declaring that no travel restrictions were recommended to and from China. All the cases, still very few, were concentrated in Wuhan and the contagiousness of this virus was not known (SARS and MERS, for example, were much more serious but much less contagious).

Meanwhile, Wuhan became an isolated city, and the Chinese New Year celebrations were cancelled there and in other Chinese cities, such as Beijing and Macau.

At the end of January, the risk of the epidemic spreading, moved from moderate to high and on January 27 the WHO wrote that it was "very high for China and high at the regional and global level". The risk was so high, that three days later the WHO declared the "public health emergency of international interest", and Italy blocked flights to and from China, the only one in Europe. But the situation in China was already improving: a few days later, on February 8, the WHO wrote that the infections in China were stabilizing or that the number of new cases per day seemed to be gradually decreasing.

Outside China, in February, the number of infected people is very high in Italy, Iran and South Korea, even if for WHO, COVID-19 is not yet a pandemic. However, between the end of February and the first days of March 2020, an increasing number of cases are detected also in other states (Europe and beyond).

While Italy is moving, first in Europe, with the applause of the WHO, to contain the infection, something is also happening globally. On 11 March 2020, Tedros Adhanom Ghebreyesus, WHO general director, announced in the briefing from Geneva on the coronavirus epidemic that COVID-19 "can be characterized as a pandemic situation", declaring *de facto* the pandemic, and appealing to all nations to counter the spread of COVID-19.

1.2 Global lockdowns

Due to the COVID-19 pandemic, curfews, quarantines, and similar restrictions have been implemented in numerous countries and territories around the world. These non-pharmaceutical interventions were established to prevent the further spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes COVID-19. By April 2020, about half of the world's population was under lockdown, with more than 3.9 billion people in more than 90 countries or territories having been asked or ordered to stay at home by their governments. Nations around the world have enforced lockdowns of varying degrees. Some include total movement control while others have enforced restrictions based on time. Mostly, only essential businesses were allowed to remain open.

Lockdown is a term that is in common use today and we all know, but before 2020 was used referring only to prisoners and their cells. Nowadays, given the situation, its meaning switched and comprehend:

- Stay-at-home orders and total movement control
- Closing of schools and kindergartens
- Closing of non-essential shops (shops and stores apart from food, doctors and drug stores)
- Closing of non-essential production
- Cancellation of recreational venues and closing of public places
- Curfews
- Border closures
- Social distancing measures and social movement restrictions
- Travel restrictions.
- Other non-pharmaceutical anti-pandemic measures like mandatory quarantines after travel, self-quarantine and social distancing measures¹.

China was the first country to enforce the quarantine and lockdown of cities and later the whole provinces at the end of January. On January 23, 2020, Beijing imposed the total isolation of Wuhan and other cities in Hubei in order to stem the spread of the infection. For the first time in modern history, a large metropolis with a total population of 11 million inhabitants was isolated. The measures implemented in Wuhan were then imitated in other cities. Within a few hours, quarantine and restrictions on movement were also imposed in the neighbouring cities of Huanggang and Ezhou and finally imposed on 15 other cities, a measure that finally affected 57 million inhabitants.

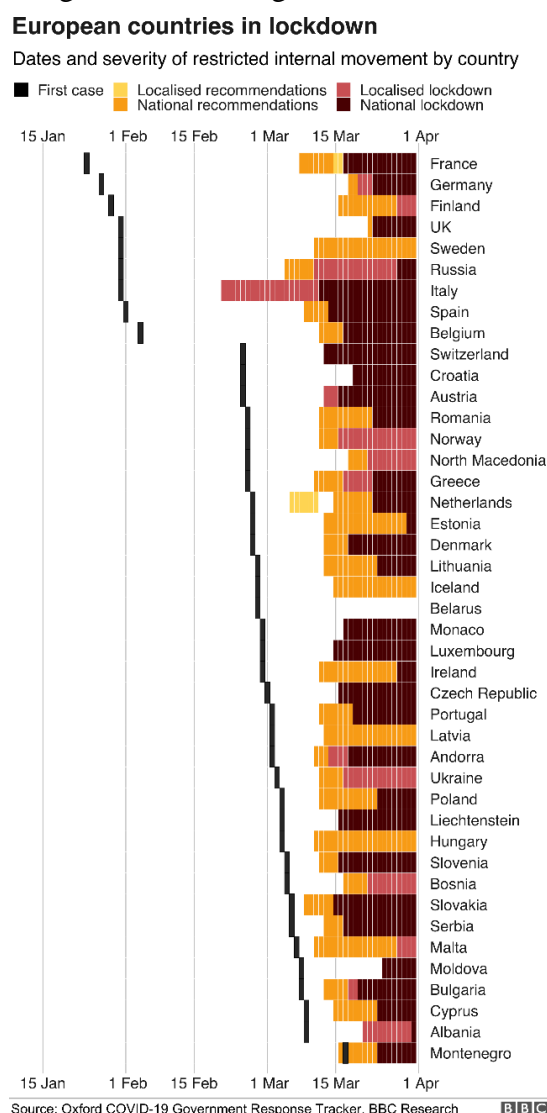
Meantime in Europe, Italy was the first country to go into a nationwide lockdown: "There will no longer be a red zone, there will no longer be zone one and zone two, but an Italy protected area. Movements will be avoided except for three reasons: proven work issues, cases of necessity and health reasons"². With this sentence, Prime Minister Giuseppe Conte announced, on March 9, 2020, the signing of a decree that would mark Italian history. From the following morning, in fact, the whole of Italy would have been in lockdown due to the COVID-19 pandemic. Curfews were introduced for the first time after the Second World War, it was

¹ Wikipedia, dictionary entry for the word: "Lockdown", https://en.wikipedia.org/wiki/COVID-19-19_lockdowns

² Italian Ministry of Health, "Nuovo coronavirus", <http://www.salute.gov.it/portale/nuovocoronavirus/dettaglioNotizieNuovoCoronavirus.jsp?lingua=italiano&menu=notizie&p=dalministero&id=4184>

prevented marrying or celebrating funerals. Gyms, swimming pools, cinemas, theatres were closed. Museums, cultural centres, wellness centres, discos and ski resorts, all sporting events cancelled, and license exams suspended. That 9th of March, in short, Conte's announcement made Italians touch the Coronavirus pandemic for the first time, giving way to a "new world" that we still live in daily today. Those two months, perhaps, were the most surreal. From that March 10, two armoured months passed, that have marked all forever, until the first ray of normality, that came only more than two months later, on May 18, when the shops reopened for the first time.

Following the Italian example, almost all the EU members were in lockdown by the end of March, starting from Spain and France to the northern countries (except Sweden, which kept much of his society open during the pandemic). However, the following chart is extremely helpful to understand the length and the strength of the various European zone lockdowns.³



³ Oxford COVID-19 Government Response Tracker, BBC Research, <https://www.bbc.com/news/world-52103747>

By March 26, 2020, 1.7 billion people worldwide were under some form of lockdown, which increased to 3.9 billion people (more than half of the world's population) by the first week of April with the join of the vast Indian population, following the orders deliberated by its government.

Finally, a different situation was faced in the US, with President Trump leaving to the federal states the power to hold for a lockdown or not. In fact, the restrictions were not adopted uniformly throughout the United States, given the wide discretion reserved for federal states. As of April 6, five states did not yet adopt restrictive measures to deal with the pandemic (North and South Dakota, Iowa, Nebraska and Arkansas). Four states (Oklahoma, Wyoming, Utah, and South Carolina)⁴ enacted restrictions limited to specific areas, while the remaining forty-one had urged all populations to stay at home, with about 9 out of 10 Americans subject to such restrictions, more or less strictly. However, this fragile management of the virus, rapidly made the US first for cases and deaths caused by the virus, reaching more than 30 million positives and 550,500 deaths⁵, at the time of writing⁶.

1.3 Effect of lockdowns on oil demand

Oil demand, in general, is sufficiently resilient to financial and economic shocks, as this source is mainly used to move people and goods. About 50% of it is used for road transport, a value that exceeds 60% if it includes air and sea transport. However, in the historical moment described before, in order to limit the spread of Covid-19, more than 65 countries have chosen to implement a complete lockdown by imposing the closure of all activities deemed non-essential, requiring where possible to work from home and allowing travel only if strictly necessary. Besides, another 100 countries have adopted less severe measures but still impacting the oil demand, as they provide for restrictions on travel and commercial activities.

The shock, therefore, has the peculiarity of directly hitting the main source of oil consumption: *transport*. The peak of losses in global consumption was recorded in April 2020, with a decline

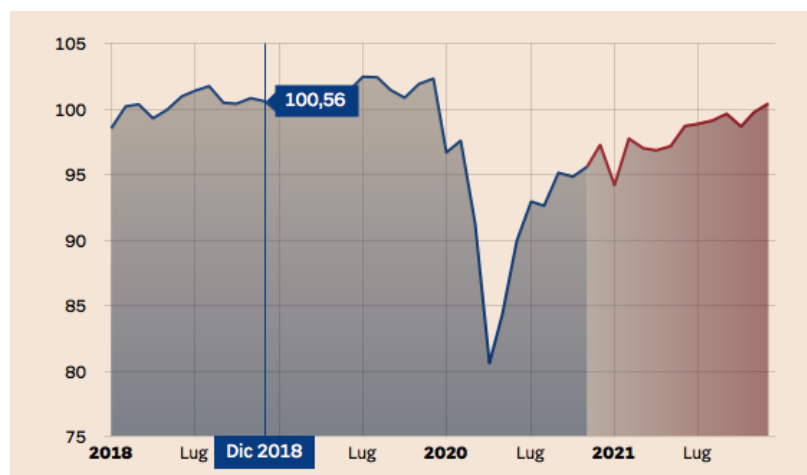
⁴ R. Barlaam, "Coronavirus, tutti gli errori degli Stati Uniti che dobbiamo evitare di rifare in Europa", Il Sole 24 Ore, <https://www.ilsole24ore.com/art/coronavirus-tutti-errori-stati-uniti-che-possiamo-evitare-rifare-europa-ADZKrlc>

⁵ "Coronavirus in the U.S: Latest map and case count", The New York Times, <https://www.nytimes.com/interactive/2020/us/coronavirus-us-cases.html>

⁶ 31/03/2021

of more than 20 million barrels per day, mainly attributable to the decision of the world's largest consumers (Europe, India, China, and the United States) to implement drastic restrictive measures.

Compared to the classic oil crises that periodically afflict the market, that of 2020 has a strong peculiarity. It is a demand-driven crisis, in which the factors of production and distribution, such as Opec+ decisions, have not played a central role. Historically, in fact, the worst shocks in the oil market have come from sudden supply restrictions following monetary or political events (such as the 1973 and 1979 crises) or the heavy growth in production (as happened in 1986 and more recently in 2014). In 2020, it was the demand that dictated the price trend, and with a certain delay, the production.



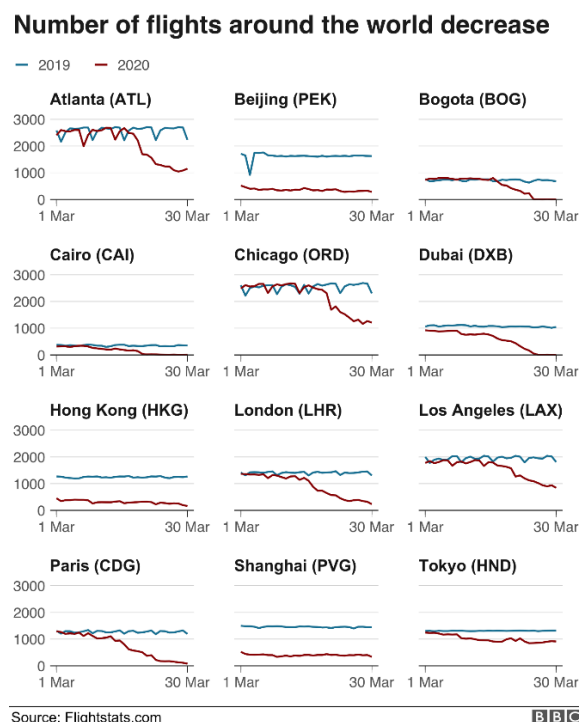
As reflected in the figure⁷, in January 2020, world demand was stable at the maximum values of 100-102 million barrels per day (ordinate axis). In February, the first sudden drop of 5-6 percentage points was noted due to the explosion of the pandemic crisis in China, with a temporary block of manufacturing activity for a few weeks. The demand situation seems to stabilize around the end of the month with the improvement of sanitary conditions in China and the consequent industrial recovery, but this is just an illusion. In March, in fact, the gradual blockade of Western economies imposes an unprecedented reduction in demand. In the span of 30 days, more than 20% of world daily consumption is missing, mainly connected to the transport sector of industrialized economies. With the first reopening in May, an immediate rebound in consumption takes place during the summer period, which however does not completely reach the previous levels due to the displacement of the pandemic crisis in other geographical areas (Brazil and India) in which the adoption of restrictive measures continues

⁷ M. Minenna, "Il grande crash della domanda di petrolio del 2020", Il Sole 24 Ore, <https://www.ilsole24ore.com/art/il-grande-crash-domanda-petrolio-2020-radiografia-AD9QdQAB>

on a large scale. The autumnal flashback of coronavirus infections in western economies and the new cycle of regional lockdowns definitively slow down the recovery in oil demand. And the Energy Information Administration does not expect significant growth in consumption before the third quarter of 2021 and definitely, a full recovery would not occur until the end of 2021.

During the Great Lockdown in 2020, not only the demand fell, but also oil's price on the stock market collapsed. The demand was the major factor for this fell, with storage capacity reaching its maximum threshold, those companies with the capacity to store oil (such as refineries and airlines) were no longer buying it. The contracts for future crude deliveries dropped below zero for the first time in history on April 21, 2020. Stocks for US oil exchanges (WTI) for delivery in May reached a negative peak of -37.63 dollars a barrel with a decline of more than 305%. There was a little recovery for contracts from June onwards, ranging from losses of 11% in June to a more contained 3.96% in September, finally reaching a stabilization to before-covid prices at the beginning of 2021.

One of the many industries affected negatively by the COVID-19 pandemic is the airline industry, which engines are fueled completely by oil (for the moment). According to the International Air Transport Association (IATA), there has been a drop in global passenger traffic of 65.9% compared to 2019, with -75.6% for international flights and -48.8% for domestic ones, as shown more in details in the figure⁸, that analyze data from major hubs worldwide.

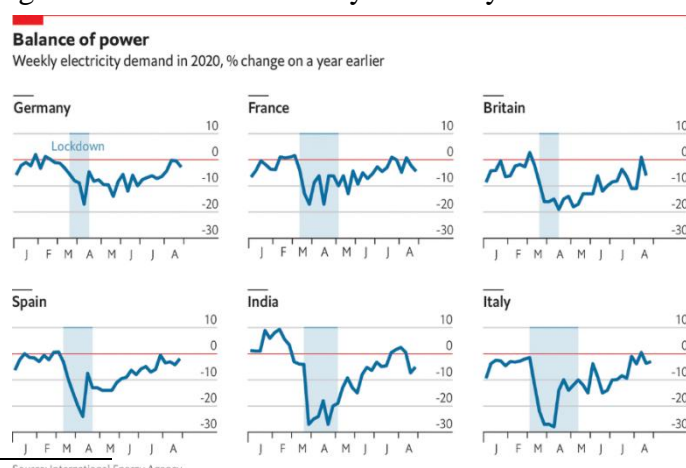


⁸ BBC, "The world in lockdown in maps and chart", <https://www.bbc.com/news/world-52103747>

The continent that saw the greatest reduction of flights was Asia, with -80.3% compared to 2019, due to generalized lockdowns and travel bans towards China, while air traffic in Europe fell by 73.7%, compared to the previous year⁹. To make matters worse, is the fact that there is still no light at the end of the tunnel: IATA predicts in fact that 2021 will be another disastrous year for airlines, as showed in January, when bookings dropped by 70% compared to the same month of 2019, and with passengers around the world facing a series of uncoordinated and rapidly changing restrictions. However, the most optimistic forecasts for 2021 assume a return to about half of pre-pandemic air traffic levels, with 2019 traffic levels not being reached until 2024.

1.4 Effect of lockdowns on energy demand

Having seen the effects of the pandemic on the oil market, it is now time to analyze the energy sector as a whole, given the enormous disruption in it, the largest in modern history, caused by the COVID-19 pandemic. During the various lockdowns, due to the strong reductions in services and the closure of production plants, the electricity demand has fallen to low levels, not fully collapsed because of the downside of the lockdown itself, which forced millions of families to stay at home. In fact, the entire system and lifestyle have been redefined, accelerating the growth of digitalization and household's energy consumption. From the following graph¹⁰ from the International Energy Agency, it is easily understandable how lockdowns in spring 2020 affected the weekly electricity demand.



⁹ OECD, “COVID-19 and the aviation industry: impact and policy responses”, <http://www.oecd.org/coronavirus/policy-responses/covid-19-and-the-aviation-industry-impact-and-policy-responses-26d521c1/>

¹⁰ The Economist, “Energy’s covid recovery”, <https://www.economist.com/graphic-detail/2020/10/15/energys-covid-recovery>

On average, demand has fallen by 6% compared to 2019, starting from 10% in the first half of 2020, then reaching the levels of the previous year in November. In the epicentre of the virus, China, electricity consumption dropped by 11% in February 2020, but soon after the ending of the restrictions in April, it quickly stabilized to pre-covid levels, even reaching +6 % in August, confirming that when strengthening measures are indicted, they negatively impact the electricity demand.

The main point this paragraph wants to focus on, is the sources of the electricity consumed in 2020, and how they changed relative to the year before. In fact, catalyzing the structural fall in the electricity demand, COVID-19 heavily affected the downward coal use for power generation. This reduction in coal demand is strictly connected to the various examples of closures and suspensions of the production in different power plants from many countries, confirming that the fuel has reached its peak after more than 200 years of absolute domination. It is also important to remember that the industry was in trouble even before the pandemic, due to the various campaigns of climate activists and the rise of green alternatives, increasingly cheaper due to “substantial innovations, impressive policy frameworks, and technologies cost downturn”¹¹.

However, during April and May 2020, there were days, and even months, in which countries were not burning a single gram of coal. As in the case of the UK, where the national grid did not operate for 35 days, the longest period since the start of the industrial revolution more than 230 years ago. This period was long almost two months in Portugal, while in Sweden it was closed the last coal-fired plant, two years before planned, confirming the choice of becoming a net-zero emission country before 2045.

Finally, if in the EU and the US there were strong declines in coal usage (-19% and - 14%, respectively)¹², we face a different situation in Asia, where are placed the first two biggest coal consumers, China and India. In the continent, by contrast, coal-fired power generation increased by 1.2% annually. In the case of China, this was in line with the electricity demand, which rapidly rebounded after the strong lockdown, while India faced an unusual decline, due

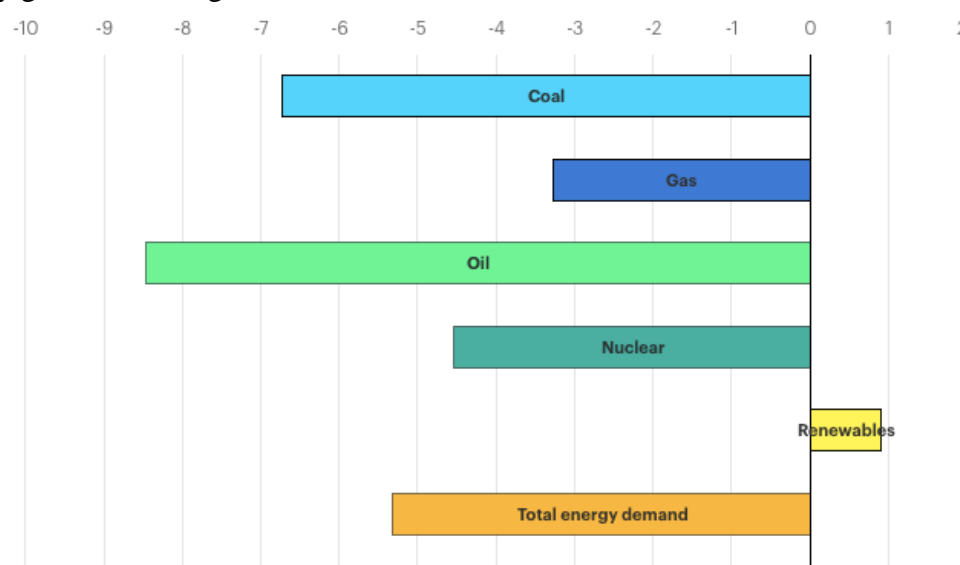
¹¹ S.E. Hosseini, “An outlook on the global development of renewable and sustainable energy at the time of COVID-19”, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7262507/>

¹² P. Jang, “Impacts of COVID-19 on energy demand and consumption: Challenges, lessons and emerging opportunities”, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7834155/#b0120>

to the decisions set by the government, prioritizing solar energy and leading the country in a first YoY fall in carbon emissions in four decades.

Ted Nace, Global Energy Monitor's founder and director, believes the balance has now shifted forever: "Coal is definitely on the downturn and this pandemic is going to accelerate that. Demand should come back to some degree next year. But there is a very strong argument that it is not going to just bounce back."¹³ In fact, if it is certain that coal demand had a contraction in 2020, for the IEA there will be a rebound in 2021, in line with the boost of electricity demand and the growth of global GDP (based on the IMF World Economic Outlook), main drivers of coal demand.

As we said, electricity demand has fallen in 2020, and many utilities have cut back on coal first because it is more expensive than gas, wind and photovoltaic. Also reminding the reduction of oil demand analyzed in the paragraph before is now understandable how the renewables seem to accelerate the trend of replacing fossils. The only sources of energy exploited in 2020 that had a growth (even if smaller than 1%), are exactly the green ones, reaching the 20% share on the total global energy mix, and reaching a record 29% in the share of the EU electricity generation in 2020, four percentage points higher than in 2019. Indeed, many countries across the EU during lockdowns have seen new highs in the share of variable renewables in the electricity mix. This share depends on many factors, first of all, the total demand, and the interesting fact here is that the renewables remained high as lockdown measures were softened, allowing the positive growth in the demand for them, even if the global energy growth was negative.



¹³J. Watts, "Coal industry will never recover after coronavirus pandemic, say experts", The Guardian, <https://www.theguardian.com/environment/2020/may/17/coal-industry-will-never-recover-after-coronavirus-pandemic-say-experts>

The graph above, taken from the World Energy Outlook released in October 2020 by the International Energy Agency, shows the change rates of the different types of energy during the last year. Oil and coal, as described before, had the most significant declines, while the renewables were the fewest affected, towed the most by wind and photovoltaic (which supply chain is somewhat centralized, with 70% of it generated in China).

Although it is still early to understand if the pandemic will lead to more sustainable and renewable energy systems, there is no doubt that COVID-19 has facilitated the use of renewable energy and provided new opportunities for it. As in the European Union, where the decrease in electricity demand and higher renewable production has driven non-renewable generation down. In the first semester of 2020, weekly renewable production has been higher than fossil fuel, then reversed in July because of lower wind production. In fact, coal production was lower from January to August 2020, when started increasing to match 2019 levels, in line with the rise of the global demand described before.

Last year, the US produced more electricity from renewables than from coal for the first time in their history, as stated in the Short-Term Energy Outlook published in May 2020 by the US Energy Information Administration: “Reduced economic activity related to the COVID-19 pandemic has caused significant changes in energy supply and demand patterns. Crude oil prices, in particular, have fallen significantly since the beginning of 2020, largely driven by reduced oil demand because of COVID-19 mitigation efforts. [...] EIA forecasts that total U.S. electric power sector generation will decline by 5% in 2020. Most of the expected decline in electricity supply is reflected in lower fossil fuel generation, especially at coal-fired power plants. EIA expects that coal generation will fall by 25% in 2020. Forecast natural gas generation is relatively flat this year, reflecting favourable fuel costs and the addition of new generating capacity. Renewable energy sources account for the largest portion of new generating capacity in 2020, driving EIA’s forecast of 11% growth in renewable generation by the electric power sector”¹⁴. In the end, natural gas remained the leading source of electricity, and the coal-fired power plants were outpaced by the renewables as the demand decreased following the first closing measures. Finally, in line with the rebound of the demand, and with the EU performance, coal generation grew during summer 2020, thanks also to the hydro and wind decline typical of the season.

¹⁴ US Energy Information Administration, “Short-Term Energy Outlook May 2020”, <https://www.eia.gov/outlooks/steo/archives/May20.pdf>

To conclude, in China, the decline of the demand for electricity during the lockdown impacted negatively on coal-fired power generation. Renewables held a high share in the mix of energy, even in April, when the coal slightly recovered, picking up high again by the end of the year, and accounting for the double of the renewables in the Chinese electricity mix¹⁵.

1.5 Effect of lockdowns on air pollution

Starting from the first lockdown, nature has begun to take back its spaces. All over the world, images of animals in urban centers and of vegetation that has started to grow again among the street have been observed. At the same time, the parameters of environmental well-being have undergone very positive changes. This trend was confirmed, among others, by satellite images processed by NASA's Earth Data Covid-19 project, which shows that a few weeks of lockdown were enough for air pollution to decrease by a third and water and air quality to improve by over 40%¹⁶. In fact, one of the most extraordinary short-term and indirect effects has been the reduction of greenhouse gas emissions globally. Only in 2020, as far as Europe is concerned, a reduction in greenhouse gas emissions of 7.6% was recorded. The reasons are directly linked to a major change in work and life habits: with smart working, the reduction of business and tourist travel, the entire transport industry has seen a decline in use, and consequently, a collapse in emissions.

However, the most positive environmental aspect has been the improvement in air quality: the collapse of transport has in fact lowered the concentrations of NO₂ and PM₁₀, the most harmful elements that worsen the purity of the air. The EEA's Air quality and COVID-19 report shows how this particle (mainly caused by road transports) fell in many countries under lockdown, and particularly in most polluted cities, such as Milan and Madrid, where this reduction has even reached 70%. Another research, 2020 World Air Quality Report published by IQAir, confirm the major trend, sustaining that 65% of cities worldwide experienced better air quality, in relation to the previous year. "The connection between Covid-19 and air pollution has shone new light on the latter, especially as many locations have observed visibly cleaner air [...] revealing that air quality improvements are possible with urgent, collective

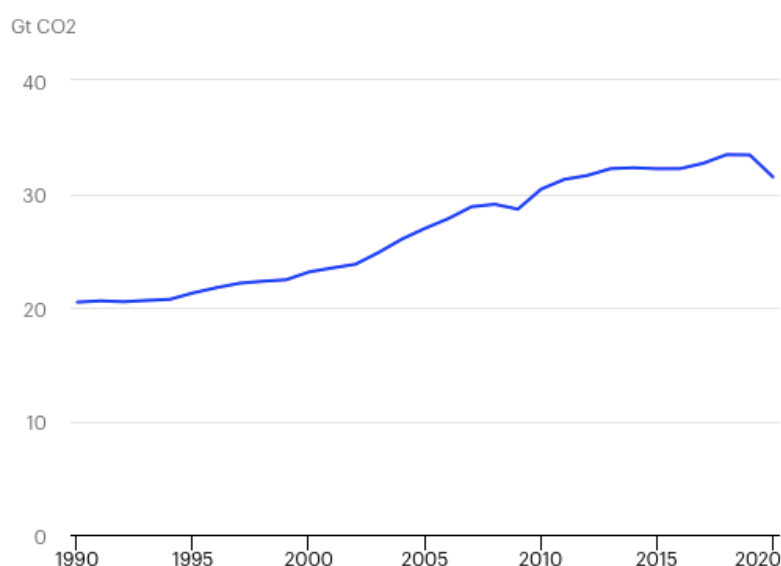
¹⁵ International Energy Agency, "Covid-19 impact on electricity", <https://www.iea.org/reports/covid-19-impact-on-electricity>

¹⁶ National Aeronautics and Space Administration, Earthdata, <https://earthdata.nasa.gov/covid19/>

action,"¹⁷ report says. As of March, the northeastern region of the US has experienced 30% reductions in nitrogen dioxide (NO₂) and carbon dioxide (CO₂) emissions in most major metropolitan areas, including New York City. While when Chinese authorities suspended travel and closed operations at the end of January 2020, Beijing's nitrogen dioxide levels dropped dramatically. In February 2020, concentrations fell by almost 30% compared to the previous five-year average, according to NASA, because of the closures of several industrial facilities and power plants.

When it comes to CO₂ emissions from the last year, we have seen how the pandemic restrictions accelerated the drops in the oil and coal demand, major sources of CO₂, and causing a global fell in the global carbon footprint by 5.8% for the IEA (shown also by the following graph)¹⁸ and by 7% according to Global Carbon Project, in both cases the largest annual decline since WWII. The US outperformed, reducing their emissions by more than 10% annually, with peaks of -18% during Q1, facilitated also by the strong coal-to-gas shift caused by the historic low prices of the latter. A similar decrease in emissions was registered in the EU (-10%), where restrictive measures were the strongest and the longest. A different situation was faced in the world's largest CO₂ emitter, China, that had a steep fell in the first quarter of 2020, but rapidly rebounded from April on, with even positive changes during the final months of the year, reaching a final overall emission of +0.8%, compared to 2019.

Global energy-related CO₂ emissions, 1990-2020



¹⁷ IQAir, "World air quality report 2020", <https://www.iqair.com/world-air-quality-report>

¹⁸ International Energy Agency, "Global Energy Review: CO₂ emissions in 2020" <https://www.iea.org/articles/global-energy-review-co2-emissions-in-2020>

Given that it is taken from granted that the reader will understand how air pollution affects our lives and causes chronic disease (such as asthma, COPD, lung cancer, heart disease and diabetes)¹⁹, this situation is an encouraging signal in the short term.

Then, to keep in line with the 2050 net-zero emissions goal, the world emissions must be reduced by 40% by 2030, renewables sources need to provide nearly 75% of global electricity generation by the same year (more than the double of today), and more than half of cars sold in ten years has to be electric²⁰.

And finally, both the facts should lead to the increase and to facilitate the growth of the use of renewable energy more than ever, with the help of global politics ensuring a transition to clean energy for the whole world, in order to restart with a sustainable approach, as we will see in the next chapter.

¹⁹ European Parliament, “Air pollution and COVID-19”, [https://www.europarl.europa.eu/RegData/etudes/STUD/2021/658216/IPOL_STU\(2021\)658216_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2021/658216/IPOL_STU(2021)658216_EN.pdf)

²⁰ International Energy Agency, “World energy outlook 2020”, <https://www.iea.org/reports/world-energy-outlook-2020>

Chapter II: New Green Policies and Investments

2.1 EU's response to the pandemic

As it should be clear now, the EU objective is to become a net-zero emission continent before 2050, in line with the Paris Agreement goals. In December 2020, during the Euro Summit, EU's leaders decided to accelerate the transition and the decarbonization, raising the intermediate targets and approving a cut in emissions of 55% by 2030, compared to 1990 levels, instead of a previous 40%. To achieve this climate neutrality goal many actions will be required from all sectors of our economy, such as “investing in environmentally friendly technologies, support industry in innovation, introduce cleaner, cheaper and healthier forms of private and public transport, decarbonise the energy sector, ensure greater energy efficiency of buildings and collaborate with international partners to improve global environmental standards”²¹. In the conclusion of the meeting held on the 10th and 11th of December, the Council composed by the 27 EU leaders stated: “We will increase our climate ambition to stimulate sustainable economic growth, create jobs, deliver health and environmental benefits for EU citizens and contribute to the long-term global competitiveness of the economy EU by promoting innovation in green technologies.[...] The European Council recognizes the need to ensure interconnections, energy security for all Member States and affordable energy for households and businesses, and to respect the right of Member States to decide on their respective energy mixes and to choose the most appropriate technologies to collectively achieve the 2030 climate goal, including transition technologies such as gas. Public funding and private capital need to be mobilized to address the significant investment needs arising from this increased ambition. The economic response to the coronavirus crisis offers the opportunity to accelerate the sustainable transformation and modernization of our economies as well as gain a competitive advantage”²².

The estimates offered by the European Commission in the European Economic Forecast, released in autumn 2020, show a clear contraction of the Euro Area GDP curve between 2019 and 2020 (from + 1.3% to -7.8%), offset by the stabilization of positive values for the following two years

²¹ European Council, “European Council meeting (10 and 11 December 2020) – Conclusions”, <https://www.consilium.europa.eu/media/47296/1011-12-20-euco-conclusions-en.pdf>

²² Id.

(+4, 2% in 2021 and + 3.0% in 2022)²³. Furthermore, although during the third quarter of 2020 the recovery in economic activity was more vigorous than expected and the large-scale vaccine distribution campaign is encouraging, the far-reaching economic prospects still remain uncertain.

To recover from this massive economic contraction caused by the pandemic, at the end of May 2020, the European Commission presented the "Next Generation EU" (NGEU) plan, a package of emergency recovery tools and strategic investments that will mobilize over 750 billion euros to lay solid foundations for the benefit of future European generations. Next Generation EU is an ambitious plan aimed at harnessing the potential of the EU budget to mobilize investment and focus financial support in the crucial first years for recovery from the effects of the Covid-19 pandemic. More specifically, the NGEU supports the Multiannual Financial Framework for the seven years 2021-2027, making available to the Member States additional resources equal to 750 billion euros, integrating the package of ad hoc tools already introduced to tackle the pandemic such as the ESM, the PEPP, the SURE and the EIB measures.

This massive package of stimulus measures is the largest ever funded by the EU and is aimed at rebuilding and restarting the economy of the 27 states, facilitating the ecological and digital transition. As said before, the instrument is incorporated in a seven-year budget 2021-2027 worth approximately 1,800 billion euros (750 from Next Generation plus over 1,000 billion in the budget). The provision is also known as the “recovery fund” and it comprehends the Recovery and resiliency facility, the European device for recovery and resilience, cornerstone of Next Generation EU, with its endowment of 672.5 billion euros, divided between 360 billion in loans and 312.5 billion in grants. The remaining 75.5 billion, out of the final package of 750, are distributed between React Eu (47.5 billion), the EU Agricultural Fund for Rural Development (7.5 billion), the Just Transition Fund (10.5 billion), Horizon Europe (5 billion), the InvestEU Fund (5.6 billion) and RescEu (1.5 billion). But, while the latter three are in charge of the European Commission, the firsts four are managed directly by the Member States. The most disruptive news is that the entire sum will be raised on the markets with the issuance of common debt, jointly and severally guaranteed by all EU countries. However, the heart of Next Generation EU, the Recovery and resiliency facility, is based on the dual objective of stimulating investments for recovery from aggregate demand (recovery) and reforms that increase the sustainability of individual European

²³ European Commission, “European economic forecast: Autumn 2020”, https://ec.europa.eu/info/sites/default/files/economy-finance/ip136_en_2.pdf

economies, making them more "resilient" to the changes that are looming in years of recovery from the Covid crisis (resiliency). The interesting point here is that, given the large investments and their potential to create jobs, the individual national plans must comply with predefined criteria, concentrating investment and spending projects on 7 flagship areas: clean and renewable energy, the energy efficiency of buildings, sustainable transport, broadband deployment, digitalization of the public administration, cloud development and sustainable processors, education and training for so-called digital skills. More in particular:

1. *Power up* – The frontloading of future-proof clean technologies and acceleration of the development and use of renewables.
2. *Renovate* – The improvement of energy efficiency of public and private buildings.
3. *Recharge and Refuel* – The promotion of future-proof clean technologies to accelerate the use of sustainable, accessible and smart transport, charging and refuelling stations and extension of public transport.
4. *Connect* – The fast rollout of rapid broadband services to all regions and households, including fiber and 5G networks.
5. *Modernise* – The digitalisation of public administration and services, including judicial and healthcare systems.
6. *Scale-up* – The increase in European industrial data cloud capacities and the development of the most powerful, cutting edge, and sustainable processors..
7. *Reskill and upskill* – The adaptation of education systems to support digital skills and educational and vocational training for all ages²⁴.

It is so extremely clear how the Commission gives absolute priority to an ecological and a digital transition, recipients of a minimum spending ceiling in national plans. In fact, each state must direct at least 37% of spending to climate issues and at least 20% to enhance the digital transition. As stated the last December, more than 50% of the sum will support the modernization of these areas through research and innovation. “Under this new recovery instrument, NextGenerationEU, we will support investments and reforms that are essential for a sustainable recovery. With this package, we also commit to ‘do no harm with regard to our climate ambitions. What we do should help us fulfil these ambitions and should not go in the other direction. This economic crisis has

²⁴ European Commission, “NextGenerationEU: next steps for RRF”,
https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1658

raised an existential question. ‘Do we rebuild what we had before? Or do we seize the opportunity to restructure and create different and new jobs that can serve us for decades to come?’²⁵. With these words from the press conference on a Green and Just Recovery, the European Commission vice-president, Frans Timmermans, underlined how a package of such huge resources to reform EU countries will perhaps never arise again, and that the main objective to reach is to transform the whole system and make the EU become the first net-zero emissions continent before 2050.

A crucial character for the recovery of the economy from the pandemic is the European Investment Bank. As stated on the last published roadmap, the institute will remain at “the forefront of efforts to enable and accelerate the energy transition”²⁶ stimulating the alignment of the international public and private finance flows into a sustainable pathway. Moreover, the EIB plans to increase its share of finance for climate action to 50% in the next 4 years, “aiming to support green investments worldwide worth over 1 trillion euros over the decade 2021-2030”²⁷, confirming that the EU bank, and its wide spectrum of financial products, is a strong catalyst for the green transition. Since 2012 the bank has supported over 670 billion euros in investments of projects aimed to reduce greenhouses emissions and to protect the environment, while only in 2020, the EIB, spent 37% of its financing to fight climate change, with an amount of more than 24 billion euros of investments²⁸.

The European strategy towards climate action and environmental sustainability is not new, as it was already described in the Green Deal, introduced just before the COVID-19 outbreak, in December 2019. The European Green Deal is a series of measures to make energy production and the lifestyle of European citizens more sustainable and less harmful to the environment. In the intentions of the European Commission, the Green Deal "will transform the European Union into a just and prosperous society, with a modern market economy and where greenhouse gas emissions will be zero, and growth will be decoupled from the use of natural resources."²⁹ In concrete terms, the

²⁵ European Commission, “Opening remarks by executive Vice-president Frans Timmermans”, https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_20_964

²⁶ European Investment Bank, “EIB Group climate bank roadmap 2021-2025”, https://www.eib.org/attachments/thematic/eib_group_climate_bank_roadmap_en.pdf

²⁷ Id.

²⁸ European Investment Bank, “Climate and Environmental Sustainability”, <https://www.eib.org/en/about/priorities/climate-action/index.htm>

²⁹ European Commission, “The European Green Deal”, <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52019DC0640&from=EN>

European Green Deal will be a series of measures of a different nature, including new laws and investments, that will be implemented over the next thirty years. Both the Commission, the Parliament and the Council, will work on the Deal. For the Commission, the Green Deal will be managed by Frans Timmermans, Vice-President of the Commission and one of the most respected politicians in Brussels, and also the main supporter for a massive “green” share as a conditionality of the NGEU.

In practice, the Green Deal will be financed with a large amount of public and private money. In the first ten years, the goal will be to mobilize around 1 trillion euros to finance it, more or less 100 billion per year. The European Green Deal Investment Plan (EGDIP), also referred to as the Sustainable Europe Investment Plan (SEIP), is the investment pillar of the Green Deal. The objectives of the plan are 3. Firstly, to increase funding for the transition and to support sustainable investments over the next decade through the EU budget and associated instruments, in particular InvestEU. Then, to create a framework that allows individuals and the public sector to make sustainable investments easily. And thirdly, to provide support to public administrations and project promoters for the purpose of identifying, structuring and executing sustainable projects.

A part of the Green Deal budget is destined to the Just Transition Mechanism, which aims to ensure a fair and just green transition mobilizing at least € 100 billion of investments over the period 2021-2027, to support workers and citizens in the regions most affected by the transition, and to alleviate the socio-economic impact of it. In essence, the tool will protect from the transition itself the part of the society tied to the actual energy system, and will facilitate their “employment in the newborn sectors, offering re-skilling opportunities, investing in the creation of new SME and startups and supporting the transition to low-carbon technologies based on climate-resilient investments and jobs”³⁰. Finally, it is important to remember that the Just Transition Mechanism is not just about funding, but the Commission will also provide technical assistance to Member States, regions and investors, and will ensure that affected communities, local authorities, social partners and organizations are involved. The instrument will so enable multilateral exchanges of experiences and best practices in all relevant sectors, while the Commission will facilitate investment in the transition by ensuring that the regulatory framework provides the right incentives.

³⁰ European Commission, “The Just Transition Mechanism”, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/just-transition-mechanism_it

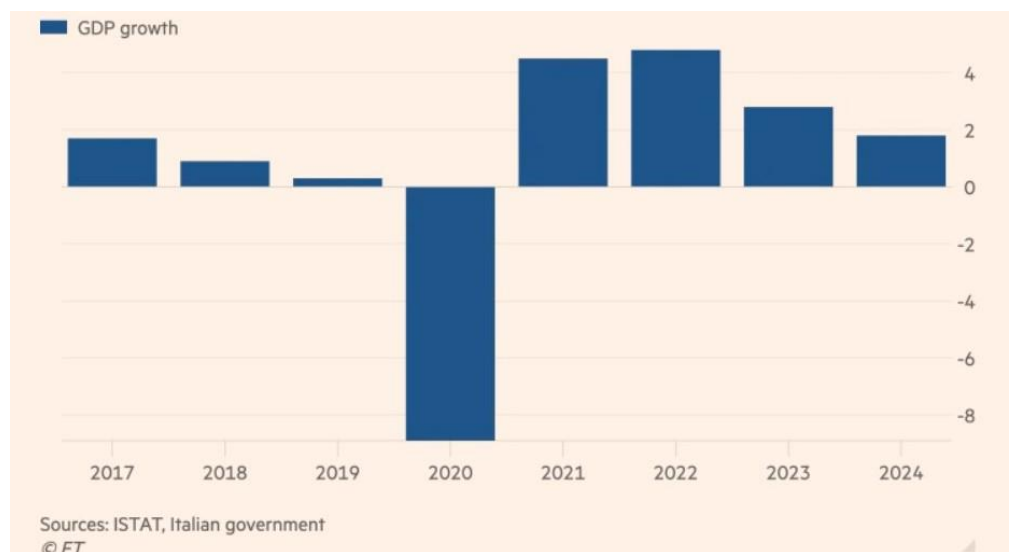
“In the recovery period of COVID-19, it is important to front load investment in offshore renewable energy where possible, as this is likely to boost enduring jobs and economic activity and thereby contributing to the green recovery and long-term sustainable, inclusive growth”³¹. This is the reason why, in November, the Commission has published “*An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future*”, establishing how much these infrastructures are a key cornerstone to reach the objective of becoming the first climate-neutral continent and looking forward to supporting the long-term sustainable development of this sector. In fact, as explained in the document, these sources (wind, wave and tidal) are completely natural and clean, and are becoming increasingly cheaper compared to the traditional fossil-fuel ones, allowing their increasing role in the energy mix. However, with the expansion of the offshore wind industry, the Commission estimates that 3% of the European maritime space will be required. Fortunately, EU seas are many and situated in different parts of the continent, sometimes also at thousands of kilometres away, as for the North and Baltic seas, the Black sea, the Mediterranean, the Atlantic and the 9 EU outermost regions in the Caribbean and the Indian Ocean. The choice is not a coincidence, in fact the EU is a leader in the industry, representing 42% of the global market. Moreover, European companies were able to produce and install 93% of the total continental capacity in 2019 and they hold more than half of the patents related to wave and tidal innovations, allowing them to exploit 70% of the global ocean energy capacity. From the 672.5 billion of the recovery and resilience plan, the 37% will be used to finance the green transition and, given the advanced state of the EU offshore renewables, it is thinkable that good part of it will be invested in the sector, also modernizing port infrastructure and grid connections.

2.2 Italy’s response to the pandemic

The recession induced by the pandemic is the most severe in contemporary Italian history in times of peace. In the first half of 2020, GDP was 12 per cent lower than the same period in 2019. In April, industrial production was more than 40 per cent below the level at the beginning of the year. In this context, the Italian government has launched very extensive interventions in support of the economy (including the *superbonus* and the *ecobonus*, which will be discussed later). The violent drop in economic activity in the spring of 2020, was followed by a strong, although partial, recovery in the summer months. In the third quarter, the return to growth was

³¹ European Commission, “EU strategy on offshore renewable energy”, https://ec.europa.eu/energy/topics/renewable-energy/eu-strategy-offshore-renewable-energy_en

more robust than expected and driven by the significant recovery of the industry, which in August returned to pre-pandemic levels of activity. The employment has also suffered the effects of the crisis, despite the measures to support businesses and workers. The pandemic hit an economy that had not yet recovered from the aftermath of the double recession connected with the global financial crisis of 2008 and the 2011 euro area debt crisis, in fact, in 2019, Italy's GDP was still almost 4 percentage points lower than it was in 2007. For more than two decades, the Italian economy has been systematically growing less than that of other developed countries. The Italian GDP per capita, which at purchasing power parity in 1995 was 9 points higher than the euro area average, in 2019 was 10 points lower. However, the pandemic is driving public debt to levels never reached in modern times, which has risen from 134.6% of GDP in 2019 to 157.5% in 2020, according to the IMF³². From a strictly economic point of view, Italy recorded a drop in GDP of 8.9%³³, double the average for world GDP, which suffered a decline of 4.4%. To deal with a phase of reallocation of consumption and production, a strong economy is needed, led by a state that invests and innovates, facilitating companies and their products to adapt to what will be demanded in the post-Covid world.



For instance, it has been decided to allocate other funds for the so-called *ecobonus*, a measure promoted by the Italian Ministry of Economic Development, which offers contributions for the purchase of low-emission vehicles. The measure is not a support measure for the automotive

³² International Monetary Fund, "Italy", <https://www.imf.org/en/Countries/ITA>

³³ V. Pop, "Draghi under high pressure as spotlight falls on Rome", Financial Times, <https://www.ft.com/content/28c32921-d458-4c23-9992-121b67b08ed7>

industry, but has an environmental purpose, integrating the current European legislation on air quality and the environment. The government has in fact confirmed its decision to focus on cars with a lower environmental impact, such as electric vehicles and rechargeable hybrids, but also to diesel, gasoline and LPG Euro 6 cars. More specifically, in August 2020, the government introduced incentives for the purchase of private vehicles with reduced CO₂ emissions to replace the existing car fleet. The total amount made available is 500 million and is divided into 410 million for incentives for the purchase of low-emission models, and 90 million directed to the installation of infrastructures for the recharging stations of electric cars. As previously said, the discount on the purchase price applies not only to electric cars, but also to vehicles with CO₂ emissions between 61 and 110 g/km belonging to the Euro 6 environmental category fueled by gasoline, diesel, LPG, with or without scrapping. In fact, if the car to be purchased belongs to a range with an emission level of 0-60 g/km of CO₂, the buyer will be able to benefit from a state contribution of 2000 euros (provided that the list price of the vehicle is lower to 50.000 euros). If, on the other hand, emissions are higher, in the 61-135 g/km CO₂ range, the state contribution drops to 1,500 euros (with a list price that must be within 40.000 euros). More in detail, of the total 410 million available, 120 million euros are reserved for contributions for the purchase of cars in the 0-60 g/km CO₂ range and 250 million euros for the purchase of vehicles in the 61-135 g/km CO₂. Furthermore, although up to a total of 20 million (then raised to 50 in May 2021), an extra bonus has been introduced just for electric cars. It is a contribution of 40% of the total costs for the purchase, by the end of 2021, of an electric vehicle with power up to 150 kW, but only to people with a determined financial situation. This contribution should not be confused with the ecobonus which has no conditionality regarding the wealth, and that provides incentives not based on the engine, but on the level of CO₂ emissions.

Another measure introduced for the first time in May 2020, is the *Superbonus 110%*³⁴, which serves to boost the Italian economy while at the same time fighting climate change. The Superbonus 110% allows all citizens to make their homes more efficient and safer for free, in an unprecedented collaboration between public and private, between the state and companies, between citizens and public administration. This benefit brings to 110% the deduction rate for expenses incurred from 1 July 2020 to 31 December 2021 (for the moment) for energy efficiency and photovoltaic systems installation. The Superbonus is due in case of thermal insulation interventions on the envelopes, replacement of the winter air conditioning systems on the common

³⁴ “Ecobonus”, Il Sole 24 Ore, <https://argomenti.ilsole24ore.com/storie/ecobonus-2020-guide-e-novita-detrazioni-110percento.html>

parts, replacement of winter air conditioning systems on single-family buildings or multi-family buildings and anti-seismic interventions. More specifically, the interventions are:

1. The thermal coat, or the interventions of thermal insulation of surfaces that affect the envelope of buildings with an incidence equal to or greater than 25%;
2. Interventions to replace existing winter air conditioning systems with centralized systems for heating, cooling or the supply of domestic hot water on the common parts of the buildings, or with condensing systems, with efficiency at least equal to class A;
3. photovoltaic systems and solar panels;
4. integrated storage systems for photovoltaic systems;
5. charging stations for electric vehicles in buildings.

While the planned spending limits are: € 48,000 for the installation of photovoltaic systems connected to the electricity grid; 1,000 euros for each kWh of capacity of the storage system for the simultaneous or subsequent installation of storage systems integrated with photovoltaic systems; and 3,000 euros for the installation of infrastructure for recharging electric vehicles. In order to benefit from 110%, the aforementioned efficiency interventions must comply with the original expenditure ceilings provided by the bonus, so 100,000 euros for energy requalification interventions of existing buildings and 60,000 euros for the installation of solar panels or screens. The beneficiary may decide to exercise the invoice discount option, and the company that carried out the work apply a discount of up to 100% of the invoice value and the citizen thus carries out the work without any monetary outlay. The company will thus be granted a tax credit equal to 110% of the amount of the discount applied. This measure creates a virtuous market mechanism that offers benefits to all parties involved: the citizen can renovate his home for free, reduce the cost of bills and enhance the value of his real estate assets; the company can increase its turnover thanks to the increased volume of work; the State can make homes more efficient and safer and support the increase in employment and income. Finally, it is estimated that investments of approximately 18 billion euros are needed, which will allow the renovation of about 50,000 buildings each year, for a total annual surface area of 20 million square meters. Of this 18.51 billion, Italian Prime Minister Mario Draghi stated that 10.26 billion will come from the Recovery Fund (NGEU) and the remaining 8.25 from the Italian Complementary Fund.

Going back to the EU response to the pandemic, we have seen what instruments the Commission has made available, but not all 27 member states requested 100 per cent of the funds at their disposal from the Recovery and Resilience Facility. Italy did it and requested a total of 191.5

billion, split between loans and grants³⁵. There are also differences among member states in how they choose to allocate funds. In fact, if the European guidelines, on the macro-headings, as we have seen, were twofold (at least 37% must go to the environment, and 20% to digital transition), Germany and France have gone even further, concentrating the budget in certain sectors. For example, Germany has focused its investments on renewable energies and sustainable mobility (also because of bonuses and subsidies to its automotive sector), and on the digitalization of public administration. France, on the other hand, plans to invest more than others in the efficiency of buildings.

However, Italy is the first beneficiary of the two main instruments of the Next Generation EU, the Recovery and Resilience Facility and the Recovery Assistance for Cohesion and the Territories of Europe (REACT-EU). The first instrument guarantees resources for 191.5 billion euros (of which 68.9 billion are non-repayable grants), while the second allows Italy to use 13.5 billion, both in the period 2021-2026. These funds are crucial for the recovery of the national economy, as stated by Prime Minister Mario Draghi: "For Italy, the NGEU represents an unmissable opportunity for development, investment and reform, and this epochal intervention is intended to repair the economic and social damage of the pandemic crisis, help resolve the structural weaknesses of the Italian economy, and accompany the country on a path of ecological and environmental transition"³⁶. Furthermore: "The economic policy response to climate change and the pandemic will have to be a combination of structural policies that facilitate innovation, financial policies that facilitate the access of companies capable of growing to capital and credit, and expansionary monetary and fiscal policies that facilitate investment and create demand for the new sustainable activities that have been created"³⁷. This was the introduction of the former ECB president to the Italian plan, that defines the cornerstones of Italian industrial policy for the coming years, confirming the desire to strengthen the production of energy from renewable sources, high speed rail, electric mobility, production and distribution of hydrogen. Specifically, the Italian national plan for investing NGEU money, is the National Recovery and Resilience Plan (Piano Nazionale di Ripresa e Resilienza, PNRR), released the last week of April 2021, and divided into 6 missions:

1. Digitization, innovation, competitiveness and culture;

³⁵ Presidenza del Consiglio dei Ministri, "Trasmissione del PNRR al Parlamento", <https://www.governo.it/it/articolo/pnrr/16718>

³⁶ M. Draghi, "Piano Nazionale di Ripresa e Resilienza", https://www.governo.it/sites/governo.it/files/PNRR_PremessaPresidenteDraghi.pdf

³⁷ Id.

2. Green revolution and ecological transition;
3. Infrastructure for sustainable mobility;
4. Education and research;
5. Inclusion and social;
6. Health.³⁸

As previously mentioned, the Italian plan provides investments of 191.5 billion euros financed through the Recovery and Resilience Facility, the key instrument of the NGEU, and a further 30.6 billion, which are part of a complementary fund, financed through the national multi-year budget variance, for a total of a total planned investment of 222.1 billion euros. One of Draghi's first moves, when he became Prime Minister in January, was to set up the Ministry of Ecological Transition, which will take charge of competencies related to the green economy and calls for proposals inherent to the second mission, "Green Revolution and Ecological Transition", which allocates a total of 68.6 billion, of which 59.3 billion from the Recovery and Resilience Facility and 9.3 billion from the national fund. Its objectives, among others, are to improve the sustainability of the economic system and to ensure a fair and inclusive environmental transition.

The Plan provides investments and reforms for the circular economy and waste management (to reach ambitious targets such as 65% recycling of plastic waste), allocates resources for the renewal of local public transport (with the purchase of low-emission buses and the renewal of part of the fleet of trains for regional transport with alternative propulsion means). Then, there are substantial tax incentives to increase the energy efficiency of private and public buildings (including the Superbonus 110%) and major investments in energy production from renewable sources, simplifying authorization procedures in the sector. Finally, the second mission of PNRR supports also the hydrogen supply chain, and in particular research in its production and local use in industry and transport with the creation of the so-called hydrogen valleys: industrial areas with an economy partly based on hydrogen. Regarding this chemical element, the aim of the project is to develop a real hydrogen network, to test different technologies and operational strategies, as well as to provide research and development services for all industrial players. Specifically, the line of intervention provides for the development in the production of green hydrogen and the development of technologies for storage, transport and transformation into other derivatives and green fuels.

³⁸ "Piano Nazionale di Ripresa e Resilienza", https://www.governo.it/sites/governo.it/files/PNRR_3.pdf

The component of the second mission to receive most of the budget the is the “Energy Transition and Sustainable Mobility”, to which 23.78 billion is allocated with the aim of increasing the share of energy produced from renewable energy sources in the system and to promote renewables in energy communities through their self-consumption. Other objectives are to develop more sustainable local transport and to develop international leadership in research and development in the main sectors of the transition. For this last point, research will be carried out at an industrial level to develop the fields of renewable energy and batteries, hydrogen (as mentioned before), electric buses, as well as establishing a fund (the Green Transition Fund) that will support start-ups, incubators and venture capital active in the ecological transition with 250 million available. Finally, a part of the funds is also intended for sustainable mobility, in particular for sustainable local transport, the construction and maintenance of bicycle networks, school buses and sharing mobility, trying to give an increasingly green footprint to the Italian cities.

2.3 USA’s response to the pandemic

One of the countries most affected under the health point of view is the United States, a country in which a handover between presidents took place during the winter of 2020-21. In fact, Republican Trump had to leave the keys of the White House to Joe Biden, former vice president during Obama's Administration. The Democratic candidate had based much of his campaign on the fact that, once he became president, he would make key decisions to cut emissions through a clean-energy plan that would create millions of jobs in all federal states, thus making sure to restart the national economy in a sustainable way. During the campaign that led him to be the 46th President of the United States in January 2021, Joe Biden stated: “We can lead America to become the world’s clean energy superpower. We can export our clean-energy technology across the globe and create high-quality, middle-class jobs here at home. Getting to a 100% clean energy economy is not only an obligation, it’s an opportunity”³⁹. The goal is to reach climate neutrality no later than 2050, directing large investments in clean energy and climate research and innovation, incentivizing the “rapid deployment of clean energy innovations across the economy, especially in communities most impacted by climate change”⁴⁰. Some points of Biden's Green New Deal to reach the target just described are described in this list:

³⁹ “The Biden plan for a clean energy revolution and environmental justice”, <https://joebiden.com/climate-plan/>

⁴⁰ Id.

- zero net energy buildings at zero net cost;
- using renewables to produce carbon-free hydrogen at the same cost as that from shale gas;
- decarbonizing industrial heat needed to make steel, concrete, and chemicals and reimagining carbon-neutral construction materials;
- decarbonizing the food and agriculture sector, and leveraging agriculture to remove carbon dioxide from the air and store it in the ground;
- capturing carbon dioxide from power plant exhausts followed by sequestering it deep underground or using it make alternative products;
- refrigeration and air conditioning using refrigerants with no global warming potential.⁴¹

Moreover, given that airline emissions account for approximately 2% of global greenhouse gas emissions, Biden stated that he wants to incentivize the research for the creation of new fuels and engines for aviation, changing the whole aircraft technology. Biden looked also very active on another means of transport, EVs. In fact, even if in the US there are one million of EV, Biden's direction was to prioritize the deployment of more than 500.000 charging stations in the next 10 years and to introduce a tax credit to incentivize the number of units sold. Finally, during his electoral campaign, Biden, did not accept contributions from oil, gas and coal corporations or executives, demonstrating how he is committed to this topic.

On the first day in the office, January 27th, 2021, it took a short time to keep the promises made during the election campaign. In fact, President Biden immediately rejoined the Paris Agreement, because of the previous Trump's administration exit, defining climate change as an "existential threat to humanity" and promising a 2000 billion dollars stimulus package to reboot the economy and to achieve the US climate goal of tackling the emissions. Moreover, he established many teams related to the topic such as the White House Office of Domestic Climate Policy, led by the first-ever National Climate Advisor and Deputy National Climate Advisor, and the National Climate Task Force, which comprehends executives across 21 federal agencies.

The first stimulus plan introduced by the new president was the American Rescue Plan, a maxi aid plan for the economy worth 1,900 billion dollars, which aims to accelerate the recovery and to heal wounds and social inequalities aggravated by a long pandemic crisis. Of the nearly two trillion total, about 800 billion are earmarked for payments to American families. First of all, one-off checks of 1,400 dollars per person, for a total of 410 billion, which will reach those with individual incomes up to 75 thousand dollars and couples up to 150 thousand dollars. Biden and Congress

⁴¹ "The Biden plan for a clean energy revolution and environmental justice", <https://joebiden.com/climate-plan/>

have also allocated about 360 billion in aid to state and local budgets struggling with the impact of the virus. The education system will receive 176 billion, mostly to safely reopen schools. while 59 billion is earmarked for small businesses, 56 for transportation, 105 for health care.

But, if these investments are meant to jumpstart the economy in the short term, Biden lived up to his promises with the introduction of the American Jobs Plan on March 31, 2021, even larger than the previous plan, and with a scope of \$2.3 trillion. These billions will be invested over the next 8 years not only to revive the labour market (the unemployment rate that has reached 14.8% in April 2020⁴²) and the various U.S. infrastructures, but also to finance the ecological transition. The largest part of the investment (1.3 trillion) goes precisely to infrastructure, which however should not be understood only as bridges and highways, but also to build, together with the private sector, a network of 500,000 EV chargers by 2030. In fact, for the EV market, 174 billion are available not only for the columns, but also for the replacement of 50,000 diesel vehicles and to make electric the vast fleet of American school buses, at least for 20%. Then, the plan aims to modernize the electric grid with 100 billion dollars (which is not among the most recent as demonstrated in Texas during February 2020), aiming to move cleaner and cheaper energy, and phasing out from fossil fuels. On the clean energy point, the president wanted to lead by example, claiming that federal buildings will be powered by 100 per cent clean energy and establishing the Energy Efficiency and Clean Electricity Standard (EECES) aimed at “cutting electricity bills and electricity pollution, increasing competition in the market, incentivizing more efficient use of existing infrastructure, and continuing to leverage the carbon pollution-free energy provided by existing sources like nuclear and hydropower”.⁴³ Finally, the plan gives also much importance to technological research in the field of clean energy and to make the U.S. a leader in climate science. In fact, it will be invested \$35 billion in the full range of solutions needed to “achieve technology breakthroughs that address the climate crisis and position America as the global leader in clean energy technology and clean energy jobs”⁴⁴, while other \$15 billion will be invested in R&D climate projects such as “priority utility-scale energy storage, carbon capture and storage, hydrogen, advanced nuclear, rare earth element separations, floating offshore wind and biofuel/bioproducts.”⁴⁵

⁴² Statista, “Monthly unemployment rate in the United States from April 2020 to April 2021”, <https://www.statista.com/statistics/273909/seasonally-adjusted-monthly-unemployment-rate-in-the-us/>

⁴³ The White House, “FACT SHEET: The American Jobs Plan”, <https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/>

⁴⁴ Id.

⁴⁵ Id.

The aim of the plan is definitely to increase the number of Americans employed, but the president has also tied renewables development to this creation of new jobs. In fact, with the plan, the Administration believe that would create 44,000 jobs in offshore wind and other 33,000 in support sectors by 2030. Finally, offshore wind turbines are crucial also for the US' decarbonization goals, as demonstrated by the announcement in May 2021 of the creation of the first large scale offshore wind project in Massachusetts' island Martha's Vineyard, with 84 turbines that will help the President to achieve his goal of increasing the US renewable production, fighting climate change and offering good paying jobs.

2.4 China's response to the pandemic

China accounts for about a third of global warming-related carbon dioxide emissions. It derives approximately 60% of its electricity from coal, is the world's second largest producer of oil, and releases approximately 28% of global carbon dioxide. These factors contributed to President Xi Jinping's announcement that China would reduce carbon dioxide emissions to zero by 2060, in a surprising announcement made during the virtual United Nations General Assembly in September 2020. He stated at the UN meeting that China intended to achieve carbon neutrality by 2060, adding that the coronavirus pandemic demonstrated the world required a "revolution" to accelerate "green growth" signalling a firm expectation that the nation will assume the mantle of leading the world into the renewable energy age. In fact, the President, while addressing the UN assembly, said that all countries should pursue a green recovery of the world economy in the post-COVID era.

On March 5th China unveiled its 14th five-year strategy for the period 2021-2025. For the first time in the country's history of drafting five-year plans, China's strategy does not have a clear GDP growth objective, but instead emphasizes targets for other factors such as unemployment rate, electricity use, and carbon dioxide emissions, in line with the mission to boost people's livelihoods and standard of production. In terms of economic objectives, the Communist party emphasized the shift from rapid growth to high-quality development, with a focus on the medium-term goal of transforming the economic system for improved productivity and performance. The strategy includes twenty key indicators across a broad spectrum of fields, as well as eight mandatory objectives, seven of which are focused on ecological conservation and development. However major themes of the Plan include:

- “Prioritizing the quality of growth rather than the quantity of growth;
- Building China into a self-reliant technological and manufacturing powerhouse;
- Accelerating the drive towards a low-carbon economy to help achieve the 2030/2060 climate goals;
- Achieving “common prosperity” through new rural revitalization and urbanization strategies;
- Moving ahead with gradual liberalization of the business environment;
- Elevating China’s leadership role in regional and global economic governance;
- Managing great-power rivalry with the United States”⁴⁶.

The Five-Year Plans are extremely influential in the Chinese context, and the fact that up to ten of the 47 chapters address the environment is critical for recognizing the country's potential course of action. Additionally, China promises to prioritize "green development," to maintain Xi Jinping's "30-60" pledge for China to attempt to peak carbon emissions before 2030 and achieve carbon neutrality by 2060, and to serve as a global role model for climate governance. Even though, in the absence of GDP goals, assessing the plan's effect on China's carbon emissions trajectory over the next five years is challenging. More precisely, the FYP proposed to "accelerate China's shift to a green growth model"⁴⁷ decreasing its carbon pollution intensity (the amount of carbon dioxide emitted by one unit of GDP) by 18 per cent in five years, its energy intensity (the amount of energy used by one unit of GDP) by 13.5 per cent, and to increase the share of renewable energy in its energy mix to 20% from the current 15%. However, examining these declarations demonstrates that new standards of commitment can be seen as a starting point, as existing targets risk weakening global climate goals. If China meets its goal of minus 18% emission intensity reduction, China's CO₂ emissions could rise by up to 10% by 2025, relative to 2020, assuming annual GDP growth of 6% over the next few years (China actually hopes to reach more than 6 per cent in 2021). To put that in perspective, with China's estimated CO₂ emissions of well over 10 billion tons a year, an additional 10% will match the total CO₂ emissions of the UK, South Africa, and Egypt together. Assuming annual GDP growth of 5.5 per cent over the timeframe, CO₂ emissions could increase by 1.1 per cent between 2020 and 2025 while also meeting all of the goals announced. This will represent a modest slowdown in comparison to previous years.

⁴⁶ B. Cooper, “China’s 14th Five-Year Plan (2021-2025) Report”, Hill+Knowlton Strategies, <https://www.hkstrategies.com/en/chinas-14th-five-year-plan-2021-2025-report/>

⁴⁷ L. Hongqiao, “Q&A: What does China’s 14th five year plan mean for climate change?”, CarbonBrief, <https://www.carbonbrief.org/qa-what-does-chinas-14th-five-year-plan-mean-for-climate-change>

Under a 5% growth assumption, Chinese CO₂ emissions will peak about 2027, three years ahead of existing ambitions to peak before 2030. This example will lead to a 5% increase in CO₂ pollution above current levels.

While if we predict a 6% growth forecast, Chinese CO₂ emissions will peak in 2031, one year later than the existing goal of peaking before 2030, and China will increase pollution by up to 15% by 2020.

GDP growth, 2022-2025, per year	5%	5.5%	6.0%
Energy intensity reduction 2020-2025	-13.5%	-13.5%	-13.5%
Total energy consumption growth, 2021-2025, per year	2.3%	2.7%	3.1%
CO ₂ intensity reduction 2020-20	-18.9%	-18.9%	-18.9%
Coal consumption growth, 2021-2025, per year	0.1%	0.5%	0.9%
Oil consumption growth, 2021-2025, per year	2.7%	3.1%	3.5%
Gas consumption growth, 2021-2025, per year	5.2%	5.6%	6.0%
Non-fossil energy production growth, 2021-2025, per year	7.1%	7.5%	7.9%
CO ₂ emissions growth, 2021-2025, per year	1.0%	1.4%	1.7%

In the short term, the strategy is focusing on gradual changes, such as reducing the intensity of emissions, while still investing in research into technology such as hydrogen and battery storage, which it hopes would allow the country to increase efforts to reach its 2060 target in the future.

Although Beijing would accelerate the transition to renewable energy, it will still continue to encourage "safe and productive coal usage". This was frustrating for many climate campaigners looking for a move away from coal, as was the lack of a target for reducing total energy consumption in the 14th FYP or an overall ceiling on carbon emissions, even though they would be included in future sectoral plans, similar to how the 13th FYP for Energy Development set a coal output cap of 4.1 billion tonnes. Indeed, the China Coal Association proposed capping coal

⁴⁸ L. Myllyvirta, "China's five-years plan: baby steps towards carbon neutrality", Centre for Research on Energy and Clean Air, <https://energyandcleanair.org/china-14th-five-year-plan-carbon-neutrality/>

usage at 4.2 billion tonnes in 2025⁴⁹, a goal that may be included in the energy sector programme. In fact, more climate goals are likely to be announced later this year, with the government expected to issue a separate five-year energy plan in addition to the action plan for reaching peak emissions by the end of the decade. Indeed, similar to the 12FYPs and 13FYPs, experts anticipate that National Development and Reform Commission (NDRC) and National Energy Administration (NEA) will reveal more comprehensive goals for the energy sectors in the coming year, including coal consumption and production and clean energy generation and use.

Finally, according to the China Coal Association, innovation in the sector would also be improved. Green and intelligent coal mining would be studied, as well as mining protection, accident and catastrophe management, and the efficient and productive usage of coal. Technological innovation can be strengthened in critical areas such as secure and intelligent extraction, reliable coal usage, and strategic energy conservation. Moreover, China is the global leader in investments and production of clean energy power, and in order to achieve carbon neutrality by 2060, more than 90% of energy must come from renewable sources⁵⁰, which means China's renewable transformation must be significantly accelerated. In the short term, one of the most pressing issues is to provide a functional power market that enables rapid growth of renewable energy penetration while containing renewable curtailments. This will necessitate not only hardware such as a smart grid and distribution capabilities, but also legislative mechanisms for business reform.

⁴⁹ L. Zhihua, "China caps coal output goal at 4.1b tons", China Daily, <https://www.chinadaily.com.cn/a/202103/04/WS60401b45a31024ad0baac8f6.html>

⁵⁰ Y. Rylander, "How ambitious is China's five-year plan on climate targets", Stockholm Environment Institute, <https://www.sei.org/featured/how-ambitious-is-chinas-five-year-plan-on-climate-targets/>

Chapter III: EV's results and perspective

3.1 Car industry in 2020

As the Covid-19 epidemic emerged in early 2020 and nations throughout the globe adopted lockdowns, worldwide automobile sales fell to an all-time low, with almost all major automakers suspending production lines for different periods of time. Despite a slight rebound throughout the year, the European Automobile Manufacturers' Association (ACEA) market data⁵¹ indicates that worldwide car sales declined by an estimated 14% YoY, from 74.9 million units in 2019 to 63.4 million in 2020. While, according to Moody's, the 2020's decline was 16 per cent in worldwide light vehicle sales, around 14.5 million units. However, the decline in worldwide automobile sales in 2020 was substantially greater than the decline experienced during the global crisis of 2008.

In general, global car sales in the first four months of 2020, the period most affected by demand shocks, fell by around a third compared to the same time in 2019. According to the IEA, China's automobile sales fell by 80% in February, the biggest year-on-year loss in a month that is generally associated with a reduction in auto sales due to the Lunar New Year. In April, automobile sales in the United States fell by half, while Germany had a 60% decline. These results seem nothing in comparison to France, where automobile sales fell by 90%, the UK and Italy, which had declines of 98%.

When it comes to regional final results in 2020, the European passenger car market had a severe fall, owing mostly to the COVID-19 spread in the spring of 2020. Indeed, the region's performance was impacted by significant losses in the EU (-23%) and the United Kingdom (-29%). The pandemic had a limited influence on Eastern Europe, indeed Russia (-8%) and Ukraine (-5%) had more mild declines. North America's automobile demand improved slightly in the last quarter of 2020, even though full-year total sales of 13.2 million vehicles remain 18 per cent lower than in 2019. The US performance was consistent with the region's, declining 16 per cent to 11.2 million vehicles sold in 2020. China's whole automobile market was less affected by the pandemic than other areas. Indeed, total new vehicle registrations fell by around 9%. Finally, South America was one of the areas most hit by the spread of COVID-19, and the region's passenger car demand

⁵¹ ACEA, Economic and Market Report: EU automotive industry full-year 2020", https://www.acea.be/uploads/statistic_documents/Economic_and_Market_Report_full-year_2020.pdf

contracted by 29 per cent to 2.5 million units in 2020, due to the severity of the lockdowns. Brazil's market (the largest in Latin America) suffered comparable declines, losing 28 per cent year on year.

Diesel and petrol automobile sales both fell significantly not only during the initial spread of the pandemic but also in the last months of 2020. Diesel cars registrations in the EU decreased by 23 per cent to 730,000 units⁵² between October and December. Therefore, diesel's percentage of the automobile market fell from 30.5 per cent in the last quarter of 2019 to 25.4 per cent in Q4 of 2020, lowering diesel's full-year market share to 28%. Demand for gasoline-powered vehicles declined even more dramatically, from nearly 1.7 million units in 2019 to 1.2 million in the last quarter of 2020. This led to a total of 40 per cent in the EU's market share, down from 56 per cent in the fourth quarter of 2019. Overall, petrol continued to account for nearly half (47%) of total EU passenger car sales in 2020.

When it comes to 2021, diesel's market share has now decreased to 23 per cent from 30 per cent in the first quarter of 2020. The majority of EU markets had large reductions in this area, including three of the four biggest: Germany (-29%), France (-11%), and Spain (-28%). Additionally, demand for gasoline-powered vehicles remains low, with sales falling 17 per cent, from 1.3 million in Q1 2020 to 1.1 million so far this year. As a consequence, petrol's market share in the EU market fell from 52 per cent in the first quarter of 2020 to 42 per cent at the end of this year's Q1.

In terms of production, the full-year statistics continue to reflect the effects on the economy of the COVID-19. Following the spring shutdowns and a delayed restart in the third quarter, output was accelerated by the end of 2020 due to increased demand and the need to restore inventory. Production slowly began in Europe in 2020 and came to a halt by mid-March as a result of industrial closures caused by supply chain failures and health precautions implemented in response to the pandemic. From September, new orders had grown and plant line rates had increased. But finally, in 2020, European commercial vehicle and bus production declined by 17.7 per cent to around 3 million units.

Last year, North American production fell by 20 per cent to 9.7 million units, mostly owing to pandemic-related closures between March and June 2020. In South America, passenger

⁵² ACEA, "New passenger car registrations by fuel type in the European Union: Quarter 4 2020", https://www.acea.be/uploads/press_releases_files/20210204_PRPC_fuel_Q4_2020_FINAL.pdf

automobile manufacturing reached its lowest level since 2003 in 2020, falling 34 per cent to 1.8 million vehicles for the whole year.

Finally, as previously said, China's economy improved in the fourth quarter of 2020, resulting in a comeback in passenger vehicle production. In the end, it produced more than 19 million automobiles last year, accounting for 31.5 per cent of global automobile output. However, although percentage growth remained negative compared to 2019, the overall year decreased only by 6.4 per cent, with decrease peaks reaching -19 per cent in January-September 2020.

After a year that witnessed the biggest decline in EU auto sales in history, ACEA anticipates that 2021 will signal the start of a rebound, with sales increasing by around 10% over 2020 levels. Indeed, we have analyzed how the COVID-19 impact continued into the first quarter of 2021, but the auto market is expected to rebound in the second part of the year as vaccination programs advance. ACEA's President, Oliver Zipse, stated: "Now more than ever it is crucial that we work hand in hand with EU policymakers to strengthen the competitiveness of Europe's auto industry on the global stage"⁵³. In fact, the issue for governments today is to develop an effective legislative response that enables workers to find employment while simultaneously establishing the electric vehicles market as a critical contributor to economic recovery. Previous experience has been inconsistent, cash-for-clunkers programs can be useful if they are tailored to encourage the adoption of more efficient (for example, hybrid and electric vehicles). However, in previous stimulus packages, such concerns were not always handled sufficiently, and sales of SUVs and diesel automobiles were increased, driving global oil demand and air pollution to increase. Support for the auto industry should also be linked to aggressive fuel economy laws, which have historically sparked innovation and accelerated the growth of important segments of today's electric vehicle sector.

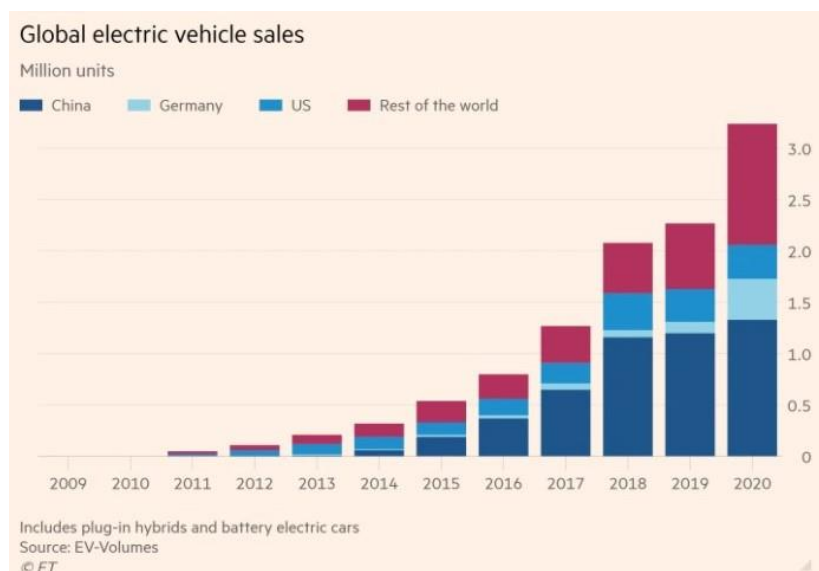
3.2 EV's market in 2020

After their entrance into markets in the early part of the decade, electric vehicle sales have surged, increasing by an average of 60% per year. In 2010, just approximately 17 thousands electric vehicles were on the world's roads. By 2019, that figure had risen to 7.2 million, with 47 per cent of them being in China. Nine nations had over 100,000 electric vehicles on the road, while

⁵³ ACEA, "EU car sales: COVID recovery expected to start in 2021, auto industry says", <https://www.acea.be/press-releases/article/eu-car-sales-covid-recovery-expected-to-start-in-2021-auto-industry-says>

at least twenty nations reported annual market shares greater than 1%. Additionally, electric cars in operation worldwide prevented the consumption of about 600,000 thousands barrels of petroleum products each day in 2019.

According to the IEA, worldwide EV sales continued their upward trajectory in 2020, exceeding the total for 2019, growing by 41% and establishing a record proportion of the global automobile market of more than 4.5%⁵⁴. This increase in global sales goes from the 2.1 million electric vehicles purchased in 2019 to around 3 million cars sold in the last year, with consumers spending 120 billion US dollars for them. As a consequence, there are now over 10 million electric vehicles on the road worldwide. Indeed, in the majority of nations, BEVs (Battery Electric Vehicles) and PHEVs (Plug-in Hybrid Electric Vehicles) were more resistant to the current crisis than traditional automobile markets. According to EV Volumes⁵⁵, global BEVs and PHEVs sales grew by 43% YoY, while the global light vehicle market analyzed in the previous paragraph fell by 14%.



The major surge in Europe began in summer and peaked in December with approximately 285 000 purchases for that month⁵⁶. Electrically charged vehicles accounted for 10.5 per cent (with peaks of 75% in Norway and 50% in Iceland) of all new registrations in the EU last year, resulting in over 1.4 million units of hybrid electric and electrically charged vehicles purchased in the region.

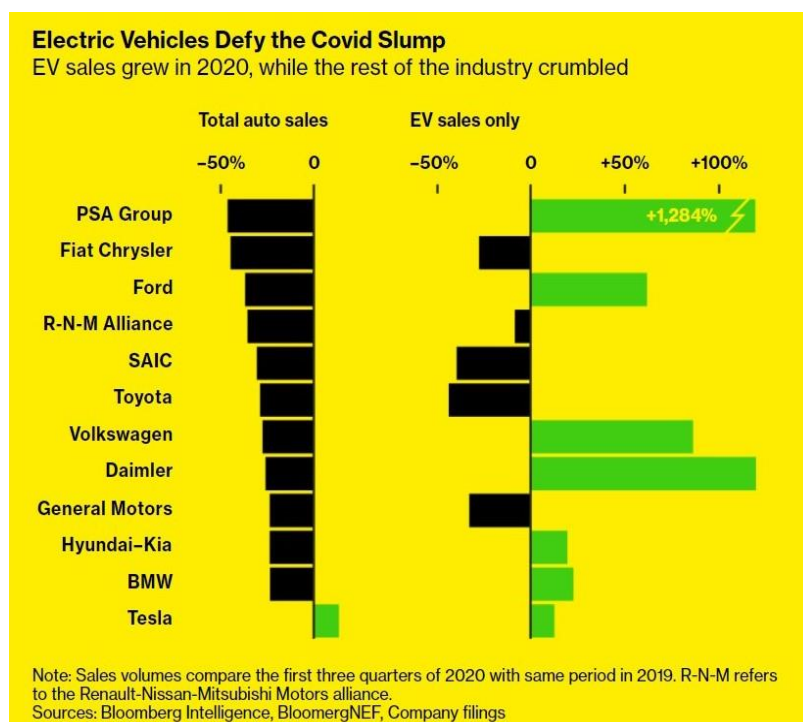
⁵⁴ International Energy Agency, “Global EV Outlook 2021”, <https://www.iea.org/reports/global-ev-outlook-2021?mode=overview>

⁵⁵ R. Irle, “Global plug-in vehicle sales reached over 3.2 million in 2020”, EV-volumes.com, <https://www.ev-volumes.com/country/total-world-plug-in-vehicle-volumes/>

⁵⁶ ACEA, “Car CO2 targets can only be as ambitious as the infrastructure deployed on the ground in Europe”, <https://www.acea.be/news/article/car-co2-targets-can-only-be-as-ambitious-as-the-infrastructure-deployed-on>

Furthermore, in China, EVs sales improved in the second half, with an average rise of 80% YoY from July to December, and increasing their proportion in the market share from 4.8% to 5.7%. Finally, EVs sales in the United States outperformed the internal combustion engine market with a positive 4.4% growth, owing largely to the debut of Tesla's Model Y (a company which expanded its sector dominance, accounting for 79% of all BEVs sales).

It should be clear now that electric vehicles have thrived despite the decline in regular automobile sales. In fact, analyzing deeper the individual results, PSA Group, Volkswagen, Ford and Daimler had double-digit growth in their electric vehicle operations, despite a record-low overall sales (as represented on the Bloomberg NEF table).



To fully comprehend the market outcomes for electric vehicles, it is necessary to place them within the framework of overall automobile market trends. We have seen how global auto sales fell to an all-time low in the first four months of 2020, as lockdown measures paralyzed production facilities, supply chains and consumer demand. However, electric vehicle sales in European nations defied the broader automotive industry trend for a variety of reasons. In fact, 2020 was the planned year for the EU's CO2 emissions guidelines, which set a cap on new car sales CO2 emissions per kilometre. Indeed, when looking at the largest auto markets, Germany, France and Italy all saw significant gains, driven by remarkable growth in battery-electric and plug-in hybrid vehicle sales towards the end of the year.

According to ACEA forecasts⁵⁷, the trend continued in the first quarter of 2021 as well. In the EU, hybrid cars accounted for 18.4 per cent of total passenger vehicle sales, almost double of their 2019's market share. Demand for electrically chargeable vehicles also surged over the first three months: battery electric vehicles accounted for 5.5% of all new vehicle registrations in the EU, while plug-in hybrids represented 8%. In fact, battery electric vehicles registrations in the European Union climbed by 59% in the first quarter of the year to 146,000 vehicles, with demand continuing to benefit from government incentives for zero-emission cars. This expansion was fueled by significant increases in important European countries, most notably Germany and Italy. In the latter, over 16 thousand plug-in vehicles were registered in the first quarter, a 445 per cent rise year over year. But in general, hybrid electric vehicles (HEVs) remained the most popular type of alternatively powered passenger vehicles in the EU during the first quarter of 2021, with almost 500,000 units registered.

Moreover, other forms of transport in addition to automobiles are also becoming electric. Since their inception in 2017, electric micro-mobility alternatives have grown fast, with shared e-scooters, electric-assist bicycles and electric mopeds now accessible in more than 600 cities among 50 countries⁵⁸. 350 million electric two-wheelers, most of which are in China, account for 25% of all two-wheelers traffic globally, due to limitations on two-wheelers with combustion engines in many Chinese cities. Furthermore, there are around 400,000 light commercial EVs in circulation on the planet (mostly part of delivery companies' fleet).

Many are the causes of the missed impact of the pandemic on the market: first, continued battery cost declines; second, the upgraded original equipment manufacturer offerings in terms of model selection and performance; third, fleet operators facilitated their technology transition; and finally, the interest of electric car buyers, who are frequently wealthy households less affected by the recession. In fact, in order to understand how the market remained unaffected by the downturn, it's necessary to examine the typical electric vehicle consumer, who, in many countries, is richer than the ordinary consumer and hence may have been less impacted by the global recession. Moreover, over the previous year, approximately 100 new electric vehicle models became available, and major technological advancements and a broader selection of models have expanded potential customers' choices. Additionally, manufacturers have declared plans to produce another 200 new

⁵⁷ ACEA, "New passenger car registrations by fuel type in the European Union: Quarter 1 2021", https://www.acea.be/uploads/press_releases_files/20210423_PRPC_fuel_Q1_2021_FINAL.pdf

⁵⁸ International Energy Agency, "Global EV Outlook 2020", <https://www.iea.org/reports/global-ev-outlook-2020>

electric vehicle models over the next five years, many of which will compete in the popular sport utility vehicle class, and buyers may delay their purchasing to await the newest models.

Furthermore, electric vehicles are increasingly becoming cost-competitive in several nations in terms of the total cost of ownership (fuel and purchase), even though the recent collapse in oil price has slightly reduced that advantage. However, electric vehicle upfront investment, remain on average higher than those of conventional vehicles and so, the electric vehicle industry, continues to rely on government subsidies. In fact, today, electric vehicles are subject to several incentives and regulatory attempts in a variety of regions, and the majority of worldwide electric vehicle sales are facilitated by government incentives, which often take the form of tax reductions or direct acquisition subsidies.

The reason lays in the fact that electric cars are a significant technology for reducing air pollution in densely populated regions and a plausible choice for achieving greenhouse gas reduction goals that most countries have set. They have many advantages over internal combustion engine cars, including zero tailpipe emissions, superior efficiency, and a substantial opportunity for reducing greenhouse gas emissions if linked with a low-carbon energy market. These goals are significant motivating factors for nations to invest in the development and implementation of the electric vehicle. To date, 17 nations have committed to achieving zero-emission automobiles by 2050 or to phase out conventional cars entirely. In fact, the regulatory intervention has been a significant driver of early EV adoption, guiding both consumer demand and corporate R&D efforts. In several markets in 2020, robust policy assistance was in place, especially in the form of purchasing incentives and legal frameworks. To offset the effects of the Covid-19 recession, numerous governments reaffirmed their focused support for low and zero-emission cars in order to boost the automotive industry's short-term recovery, and these stimulus reforms introduced worldwide offered an additional push via financial incentives to encourage the acquisition of electric cars.

These governmental initiatives aimed at stimulating the automobile industry in response to the Covid-19 epidemic are significantly different from some of the responses to the 2008–2009 financial crisis. To begin, there is a stronger emphasis on increasing the adoption of electric and hybrid automobiles. Second, many nations are taking a more integrated approach to the transportation industry, including charging infrastructure and support for public transportation or other mobility solutions. This fits within the larger framework of promises to clean energy transitions made before the Covid-19 pandemic, such as the EU Green Deal, and may be seen as

complementing other 2020 pledges to reach net-zero emissions by 2050. These measures must be adapted to the Covid-19 crisis reaction in order to promote the automobile industry following long-term transportation decarbonization goals. But near-term efforts should be focused on sustaining strong support for electric car competitiveness while progressively eliminating purchase incentives as sales grow.

The EU's CO₂ emissions rule for vehicles and vans, which includes milestone objectives for 2025 and 2030, could help continue the pace. In 2020, the emissions goal was applied to 95%⁵⁹ of each manufacturer's new automobiles with lower emissions. In fact, from 2021, the emissions of a manufacturer's newly registered vehicles must be less than 95 g CO₂/km. To speed up the adoption of sustainable mobility, the European Commission is also modifying the "CO₂ emissions regulation for cars and vans", the "Alternative Fuels Infrastructure Directive", the "Batteries Directive" and the "EURO pollutants emissions standard" objectives for the five years 2025-2030.

Meanwhile, China will continue phasing down its New Energy Vehicle subsidy program and gradually tightening its NEV credit mechanism and objectives. A key sign of how China will combine stimulus to the overall automotive industry with an emphasis on electric vehicle sales will be the city-level license plate permit limits, which have been momentarily eased to encourage demand. But, to maintain the trend in China's electric vehicle sales, favourable access and circulation policies for NEV must be quickly re-implemented in specified cities.

In the US, the new administration's stimulus measures and long-term ambitions will serve as crucial guidelines for electric car markets. However, the resilience of electric vehicle sales in 2020 despite the Covid-19 downturn, the planned introduction of new electric vehicle models in 2021 and the increased state support for electric vehicles, already boost optimistic projections in the coming years. In fact, we have seen in Chapter II how there are early signs that the Biden's Administration will promote fuel efficiency regulations, encourage the deployment of charging points, grant tax benefits, and assist manufacturers producing conventional cars in restructuring to produce EVs.

There are also indications that recovery efforts to address the Covid-19 situation will remain concentrated on vehicle economy and electrification in particular. Indeed, the infrastructure for charging electric vehicles continues to increase. There were around 7.3 million points of charge globally in 2019, of which around 6.5 million private, located in residences and offices.

⁵⁹ European Commission, "CO₂ emission performance standards for cars and vans", https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en

Accessibility, cost-effectiveness, and a range of support measures are the primary reasons for private charging's popularity, a number which grew by 60% in the last year. When it comes to public chargers, China continues to lead the world in the deployment of them, which are well-suited to the country's crowded metropolitan regions, where private ones are limited.

To boost the EVs sales is crucial to invest in charging infrastructures, this is the reason why automobile manufacturers, environmentalists, but also consumers, are asking the EU to establish aggressive objectives for the deployment of electric car charging stations. In fact, in a joint letter, the ACEA, Transport & Environment (T&E), and the European Consumer Organization (BEUC) urged EU Commission to exploit this year's revision of the Alternative Fuels Infrastructure law to implement 1 million public charging stations in the next three years, and 3 million by 2029. ACEA's president and BMW's CEO, Oliver Zipse wrote: "European automakers are driving the transition to e-mobility and are literally outperforming each other in launching new electric vehicles. But the success of this huge effort is seriously threatened by the delayed installation of charging infrastructure in the EU. The EU Commission quickly needs to take action and set binding targets for the ramp-up of charging infrastructure in the member states. Otherwise, even the current reduction targets in fighting climate change are at risk. In addition to public charging infrastructure, we also need to put a stronger focus on workplace and home charging"⁶⁰.

Finally, according to Bloomberg NEF's Electric Vehicle Outlook 2020⁶¹, electric vehicles will be more affordable to manufacture than internal combustion engines ones in every light vehicle class throughout Europe by 2027. According to the study, electric cars and vans could account for the totality of new vehicle sales by 2035, including in southern and eastern Europe, assuming politicians enhance vehicle CO2 goals and accelerate other market-stimulating measures such as the rapid roll-out of charging stations analyzed before. However, if left to market forces alone, electric vehicles would attain just an 85 per cent market share in the EU by 2035, falling to reach Europe's aim of decarbonization by 2050. While Deloitte forecasts that worldwide electric car sales will expand at a 29% annual pace over the next decade. According to the report⁶², total electric car sales would climb to 31 million by 2030, from 3 million in 2020 and 11.2 million in

⁶⁰ ACEA, "EU should target 1 million EV public chargers by 2024, say carmakers, environmentalist and consumer groups", <https://www.acea.be/press-releases/article/eu-should-target-1m-ev-public-chargers-by-2024-say-carmakers-environmentali>

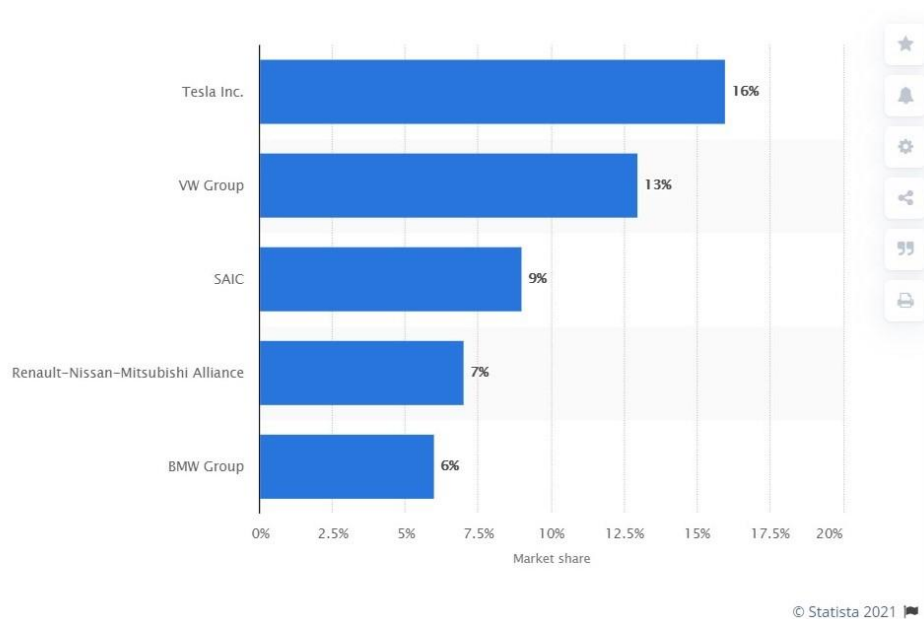
⁶¹ BloombergNEF, "Electric Vehicle Outlook 2020", <https://about.bnef.com/electric-vehicle-outlook/>

⁶² Deloitte, "Electric vehicles: setting a course for 2030", <https://www2.deloitte.com/uk/en/insights/focus/future-of-mobility/electric-vehicle-trends-2030.html>

2025. Moreover, Deloitte predicts that half of all electric vehicles sold globally in 2030 will be in China, while Europe and the United States will account for 27% and 14% of the worldwide market share.

3.3 Players' moves

Automobile manufacturers are developing 35 new all-electric cars for introduction this year. Last year, due to the existence of significant competitors such as Tesla, Volkswagen Group, Chinese SAIC, Groupe Renault, Daimler AG, and BMW Group, the market was already concentrated, as shown by the following market share table. These firms are spending significantly on the development of technologically sophisticated electric cars and the expansion of their product lines. Similarly, several firms are acquiring, merging, expanding regionally, and forming strategic alliances in order to acquire a competitive advantage in the sector.



Tesla's Model-3 has a significant lead, with over 100,000 more sales than the second most popular vehicle, the Renault Zoe. Around the world, one in every seven electric vehicles sold was a Tesla Model-3. While sales suffered in Europe and North America, it benefited from local manufacture in China, where it has surpassed all other EV models in terms of sales. Renault Zoe was revised last year and deliveries began in Europe in the last months of 2019, with sales 48 per cent greater than the previous year. Volkswagen's e-Golf is still selling well (+35 per cent year on year), owing to VW's aggressive drive to increase production and sales in the wake of the new ID.3. The Hyundai Kona is currently manufactured in the Czech Republic for European markets, enhancing 2020 availability. The Mitsubishi Outlander is the first PHEV in the top ten sales ranking,

having debuted in 2013, facelifted twice, and remaining one of the few PHEVs capable of using DC fast charging. The Audi e-tron quattro has overtaken the Tesla Model X as the segment's leader, a position that has maintained since 2017.

Tesla was the market leader in the plug-in and battery electric passenger vehicle categories in 2020, accounting for 16 per cent of the plug-in market and 23 per cent of the battery-electric market. Tesla sold 500,000 vehicles globally in 2020, a 35 per cent increase over the year before, which enabled the organization to remain profitable for several consecutive quarters despite the pandemic. The electric vehicle maker said that it would work to reduce costs, boost efficiency, and expand production capacity at current factories in the near future. In fact, Tesla is expanding its manufacturing and battery facilities in Berlin (where manufacturing is expected to begin this year) and in Texas, in order to enhance the production of current models and introduce new cars, such as the Cybertruck. Additionally, Tesla's CEO Elon Musk said that the firm is expected to introduce a \$25,000 vehicle in the next years, therefore repositioning the category away from the luxury sector and toward the common end.

Remaining in the United States, Ford said that it expects electric cars to account for over half of its worldwide sales by 2030, as part of the company's newest recovery strategy. By 2025, it intends to increase its investment in the electric to more than \$30 billion. Already in February, the company announced its \$22 billion investment plan in EVs, of which around \$7 billion had already been committed since 2016. Ford's 2030 sales forecast corresponds to more than 1.5 million electric vehicles, based on 2020 sales. Additionally, the COO Thai-Tang said that Ford thinks its EV business may eventually be more profitable than its existing business, due to car connectivity and battery developments.

Meanwhile, General Motors has declared its intention to sell only electric cars by 2035 and to phase out fuel cars in the United States by that year, spending \$27 billion over the next five years on electric and autonomous cars R&D. Additionally, the firm has set a goal of selling more than 1 million electric vehicles annually in the US and China by 2025.

Moving to Europe, Stellantis (born from the FCA-PSA merger in 2021) and Foxconn have recently decided to join forces through a strategic partnership. Mobile Drive, a 50/50 joint venture, will combine Stellantis' expertise in vehicle design and engineering expertise, with Foxconn's global software and hardware development capability for smartphones and electronics. Mobile Drive will focus on infotainment, telematics and cloud service platform development through software innovations that should include applications based on artificial intelligence, 5G communication,

and smart cockpit integrations. This partnership will benefit both companies. On one hand, it allows FCA and PSA to strengthen their position on the main eastern market and to acquire numerous digital technologies developed by the Taiwanese giant. On the other hand, Foxconn, famous above all for being the company that assembles iPhones for Apple, will accelerate its debut in the world of the car and, in particular, of the electric car. It has not to be ignored in fact that Foxconn is the first assembler of Xiaomi smartphones and could also be involved in the construction of the Mi Car of the Chinese tech-company, which in e-mobility is already a leader with scooters. Moreover, Xiaomi has decided to invest 10 billion dollars over the next ten years for the cause, and it is not the only one. In fact, staying on the subject of big tech, even the Chinese giant Huawei has big projects in the sector concerning electric cars. The company could collaborate with the car manufacturer Chongqing Sokon, in addition to having announced the investment of 1 billion dollars in the course of 2021 for the development of technologies for 100% electric and self-driving cars. In addition, Foxconn is also closely linked to Apple, being its largest supplier, and who knows if in perspective the question cannot somehow intersect with the much talked Apple car.

According to Mercedes-Benz, the company expects to earn the same amount from electric cars as it does from combustion engine vehicles by 2030, making it the first German carmaker to declare a specific date for the break-even point. Additionally, the firm (namely, Daimler Truck AG) formed a 50/50 joint venture with Volvo called Cellcentric, which will begin hydrogen fuel cell manufacturing in 2025. Both truck producers want to employ electric batteries mainly for smaller trucks as well as large vehicles that can be recharged overnight. However, hydrogen is seen as crucial for long-distance and for large vehicles transporting products to various destinations requiring many refuelling pauses. In principle, the collaboration will research, manufacture, and commercialize hydrogen fuel-cell systems for long-haul trucking, with the goal of decarbonizing the EU and become climate neutral by 2050.

BMW has had an oddly diverse history with electric cars. The corporation was one of the early adopters of them. Since its introduction in 2013, the BMW i3 has sold more than 170,000 units worldwide. The i8 was released shortly afterwards, in 2014, and it's still one of the coolest EVs on the market, despite the fact that it's simply a plug-in hybrid, rather than a completely electric vehicle like the i3. i8 has also surpassed all of its rivals in terms of sales, with over 20,000 units on the road. However, after this robust start, BMW failed to capitalize on its early entry advantage, allowing other manufacturers, most notably Tesla, to expand their market share. In fact, the manufacturing of the i8 stopped in 2020, and BMW has not introduced a new battery-electric

vehicle since 2013, with the exception of revisions to the i3, which is beginning to look a little aged. Moreover, BMW had only shifted its focus away from EVs and toward electrification of its conventional gasoline-powered cars. None of them indeed, with the exception of the BMW 330e, had completely electric models.

Remaining in Germany, Volkswagen, which has invested billions in its transition to electric vehicles, predicts that one in every five cars sold will be electric by 2025, increasing to one out of two by the end of the decade. Indeed, they plan to invest over €73 billion in battery technology and digitalization over the next five years. Moreover, VW expects to sell 1 million electric or hybrid vehicles this year, an almost tenfold increase over 2019. Although sales of battery vehicles tripled to 231,000 last year, the group predicts an even quicker take-up this year, supported by new model debuts from the Volkswagen brand, Audi, and Porsche. Around half of the 1 million electric vehicles will be battery-only vehicles, with the remainder being plug-in hybrids. VW also anticipates profit margins to increase to the high half of its estimated range of 5.5-6.5 % for the year, up from 4.8 per cent in 2020. Finally, the firm aims to introduce six new models this year, with most of the battery vehicles delivered in Europe, where the automaker has to expand its electric vehicle sales to avoid penalties for environmental violations. Among them, VW ID.4 is predicted to be the most popular model.

The Italian Lamborghini is also part of the same family, and from the second half of this decade will be fully electric. In May, CEO Stephan Winkelmann presented the strategic plan for the next 10 years, declaring that 1.5 billion euros will be invested. over the next four years, making this the largest amount ever in the history of the Italian brand. The electric Lamborghini will be the culmination of a strategy designed in four phases: the celebration of the internal combustion engine, with the launch of two new models between 2021 and 2022. The arrival of the first hybrid Lamborghini, with a third new model expected in 2023, and the conversion of the entire range to hybrid power by 2024. At that point, everything will be ready for the fourth model announced: the electric Lamborghini. Most of the plan's resources will go to the Aventador and Huracan models, without neglecting the evolution of Urus. Two-thirds of this amount will go to research and development, which will be carried out entirely in Italy, at the Sant'Agata plant, certified CO2 neutral since 2015. The research will therefore support the electrification process of the brand, with the aim of identifying technologies and solutions capable of combining top performance and driving dynamics with the conversion to electric.

Finally, looking at the future, there are also some notable startups to mention. One of the most promising is the Chinese Nio, which plans to begin delivery in Norway in September of this year, marking the company's first expansion outside of China. Having said that, it's simple to understand why Nio chose Norway over other European nations. Over half of all new automobiles sold in Norway last year were indeed EVs, a figure that has been steadily growing year after year.

Lastly, Lucid Air is scheduled to enter the market this year, with a vehicle that has a range of 800 kilometres, a quarter more than any existing Tesla, and a recharging system capable of recharging hundreds of kilometres in few minutes. The startup, acquired by the Kingdom of Saudi Arabia in 2019, aims to replicate not just Tesla's battery performance in its vehicles, but also the stock market ascent that pushed it to become one of the most valued firms. According to the company's investor presentation, it expects first to burn \$7.5 billion between 2022 and 2024 and then to earn \$321 million in 2025 and \$1.5 billion in 2026. Revenues would increase as well to \$2.2 billion next year, growing to \$9.9 billion in 2024, and reaching then almost \$23 billion by 2026⁶³.

⁶³ P. McGee, "Lucid takes on Tesla as electric vehicle competition heats up", Financial Times, <https://www.ft.com/content/8e01e59e-5b89-46c2-a798-6945fa2f255d>

Conclusions

This piece of work wanted to allow the reader in a first point to understand how the pandemic has impacted the energy industry. The lack of transports caused a decrease of 20 million barrels of oil production per day, and the missed months of operating factories led to an overall 6% decline in energy generation. Furthermore, the source of the electricity mix also changed, in better, allowing the renewables to gain a 20% market share, and being the only source to increase its total output, in a year in which coal, oil, nuclear and gas lost from 3 to 8 per cent. In the EU, the decrease in electricity demand and higher renewable production has driven non-renewable generation down, while the US produced more electricity from renewables than from coal for the first time in their history. All this, made possible to improve the air that we breathe, reducing drastically CO₂, NO₂ and PM₁₀ pollution.

However, the economic recession caused by the lockdowns was terrible, decreasing almost every national GDP worldwide. New interventions from the state were needed to avoid a global catastrophe, and they did not miss. EU not only expanded its sovereign debt purchasing, but made available 750 billion euros with the NextGenerationEU to achieve its goal of decarbonization by 2050, defining that at least 37% of them must be invested in climate issues, such as clean and renewable energy, the energy efficiency of buildings and sustainable transport. Italy will receive the largest part of this money and have allocated nearly 70 billion to the "Green Revolution and Ecological Transition" in its recovery plan (PNRR). USA's new administration maintained its electoral promises, and Joe Biden introduced the \$2.3 trillion American Jobs Plan, which plans to spend 200 billion only for EVs and R&D in climate projects. China had also set targets to become net-zero by 2060 in its 14th Five-Year Plan, even if it still strongly relies on coal and oil, even if it is the most advanced in photovoltaic.

Finally, the gasoline and diesel car market experienced an unprecedented decline of 14% YoY. Meanwhile, EVs grew their market share to 4.5%, surprisingly increasing their sales by 1 million units during a global recession. Almost every manufacturer has now understood the potentiality of this market, and they continuously spend and plan to invest to develop their electric vehicles in the following years, when the traditional car sector will experience an obvious decline.

Some targets and plans were introduced even before the pandemic, such the EU Green Deal, but there is no doubt that the recession has sped up the process of decarbonization. First of all, the output reduction in oil and coal, and the consecutive growth of renewables, anticipated significantly their peaks and allowed solar and eolic to be cheaper and more available. Moreover,

the public opinion, such as in my case, understood how two months closures significantly increased the quality of the air and gave space back to nature. Then, the state intervention played a significant role, conceding billions, and in some cases also trillions, that otherwise would have never been spent for the cause. In fact, always reminding that from a health point of view the pandemic was, and still is, a disaster, these investments wouldn't have been so large in amount, and for sure wouldn't have been implemented in such a fast and short-term way.

Only time will say if institutions will be able to stay in line with the target years, and there is no parallel universe to see how this objective would have been achieved without the pandemic and the recession caused by it. Probably global governments would have taken the decarbonisation direction (some of them such as the EU already took it before the pandemic) but the general belief is that this black swan really was an opportunity that will facilitate and accelerate the energy transition, and this study is proof of how politics didn't miss to catch it, matching the recovery from a crisis with massive investments for a more sustainable future.

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Summary

Introduction

During the first lockdown period at the beginning of 2020, billions of people from all over the world were forced to stay at home for more than two months consecutively. In this period most of them rediscovered the joy of little things and had more time to deepen the study of topics in which, otherwise, would be harder to find the time for. Personally, I was shocked by the constant news regarding the environment and how the air that we breathe was becoming always less polluted, due to many factory closings. Moreover, the oil-demand shock gave me the opportunity to think: is this the peak of the oil and coal era? Will the institutions and the companies exploit this momentum to put in action efforts to challenge the energy transition? These questions allowed me to analyze deeper this topic, being always more interested in finding a response.

For this reason, I decided to write this thesis to study if the measures implemented as a response to the pandemic recession really facilitated the transition to renewable energy, and to a more sustainable way of living. Doing so, this work is structured in three main chapters, characterized by a precise and logical order.

To begin, I evaluated how the lockdown measures affected the world economy, in particular, the energy industry. I investigated the effect of the closures on the oil demand, characterized by a devastating reduction caused by the lack of mobility. Then, the topic shifts to the energy demand and how the source of the electricity mix changed during the last year. And finally, I reported facts and data that demonstrate how CO₂ in the air really decreased in the atmosphere.

However, the real answer to the questions is found in the second chapter, and partly in the third. In fact, the main pillar of this work is the analysis of all the major policy response made by the most powerful governments in the world (EU, USA and China) and my local country, Italy. The reader will find so the investigation and the conditionalities of the “recovery plans” of the politics mentioned, namely the NextGenerationEU, the Italian PNRR, the American Jobs Plan and the Chinese 14th Five-Year Plan, all released in the last twelve months. Diverse billions of dollars were indeed planned to be invested to recover from one of the greatest recessions of the last 80 years, and this work wants to discover if they will allow us to become a net-zero planet in the next decades.

Finally, to achieve the target of decarbonisation is crucial to switch from internal engine combustion cars to vehicles that do not produce emissions, and the most advanced in this category, are the EVs. For this reason, in the last chapter, is interesting to understand on one hand the consumers' behaviours that lead to a massive decrease in car sales, while EVs outperformed the traditional market, and on the other hand how the manufacturers are responding to this shock, examining their business strategies for the following years. In brief, the chapter will give an idea of how the recession influenced negatively the 2020's results of the car market, and how instead allowed EV's to gain market share continuing to advance their growth.

For this kind of work, capturing scientific data by myself was practically impossible, given that also institutions have some large discrepancies among them. So, the methodology for this work

was to collect and interpret the most reliable information and reports released, analyzing deeply governments and institutional papers. The more peculiar data for the industries were found from the International Energy Agency, the US Energy Information Administration, the National Aeronautics and Space Administration and the European Automobile Manufacturers' Association. While for topics related to the policies and the national plans to fight the pandemic's downturn, I went directly to the sources, reporting information from the European Commission, the Italian Government, the White House, but also the OECD and IMF. Finally, it does not miss the opinion of expert journalists, especially from the Financial Times, the Economist, Il Sole 24 Ore and Bloomberg.

Chapter I: COVID-19 and energy demand in 2020

1.1 COVID-19 outbreak

While at the end of December 2019 and beginning of January 2020 we were thinking about good resolutions for the new year and were completely unaware of the health emergency that would be created, a new highly contagious virus and completely unknown to our immune system had begun to circulate in a remote location of the globe. We would never have thought, at the time, that this apparently distant virus could have spread and caused so many problems on an individual and collective level, for health and economic systems. But in just over two months the global scenario has changed radically, and we have had to adapt and meet the new needs. Wuhan became an isolated city, and the Chinese New Year celebrations were cancelled there and in other Chinese cities, such as Beijing and Macau. At the end of January, the risk of the epidemic spreading, moved from moderate to high and on January 27 the WHO wrote that it was "very high for China and high at the regional and global level", declaring it a pandemic on the 11th of March 2020.

1.2 Global lockdowns

Due to the COVID-19 pandemic, curfews, quarantines, and similar restrictions have been implemented in numerous countries and territories around the world. Gyms, swimming pools, cinemas, theatres were closed. Museums, cultural centres, wellness centres, discos and ski resorts, all sporting events cancelled, and license exams suspended. Following the Italian example, almost all the EU members were in lockdown by the end of March, starting from Spain and France to the northern countries (except Sweden, which kept much of his society open during the pandemic). By April 2020, about half of the world's population was under lockdown, with more than 3.9 billion people in more than 90 countries or territories having been asked or ordered to stay at home by their governments.

1.3 Effect of lockdowns on oil demand

Oil demand, in general, is sufficiently resilient to financial and economic shocks, as this source is mainly used to move people and goods. About 50% of it is used for road transport, a value that exceeds 60% if it includes air and sea transport. However, in the historical moment described before, in order to limit the spread of Covid-19, more than 65 countries have chosen to implement a complete lockdown by imposing the closure of all activities deemed non-essential,

requiring where possible to work from home and allowing travel only if strictly necessary. The shock, therefore, has the peculiarity of directly hitting the main source of oil consumption: *transport*. The peak of losses in global consumption was recorded in April 2020, with a decline of more than 20 million barrels per day, mainly attributable to the decision of the world's largest consumers (Europe, India, China, and the United States) to implement drastic restrictive measures.

Compared to the classic oil crises that periodically afflict the market, that of 2020 has a strong peculiarity. It is a demand-driven crisis, in which the factors of production and distribution, such as Opec+ decisions, have not played a central role. In January 2020, world demand was stable at the maximum values of 100-102 million barrels per day. In February, the first sudden drop of 5-6 percentage points was noted due to the explosion of the pandemic crisis in China, with a temporary block of manufacturing activity for a few weeks. The demand situation seems to stabilize around the end of the month with the improvement of sanitary conditions in China and the consequent industrial recovery, but this is just an illusion. In March, in fact, the gradual blockade of Western economies imposes an unprecedented reduction in demand. In the span of 30 days, more than 20% of world daily consumption is missing, mainly connected to the transport sector of industrialized economies. With the first reopening in May, an immediate rebound in consumption takes place during the summer period, which however does not completely reach the previous levels due to the displacement of the pandemic crisis in other geographical areas (Brazil and India) in which the adoption of restrictive measures continues on a large scale.

During the Great Lockdown in 2020, not only the demand fell, but also oil's price on the stock market collapsed. The contracts for future crude deliveries dropped below zero for the first time in history on April 21, 2020. Stocks for US oil exchanges (WTI) for delivery in May reached a negative peak of -37.63 dollars a barrel with a decline of more than 305%.

Finally, one of the many industries affected negatively by the COVID-19 pandemic is the airline industry, which engines are fueled completely by oil (for the moment). According to the International Air Transport Association (IATA), there has been a drop in global passenger traffic of 65.9% compared to 2019, with -75.6% for international flights and -48.8% for domestic ones.

1.4 Effect of lockdowns on energy demand

During the various lockdowns, due to the strong reductions in services and the closure of production plants, the electricity demand has fallen to low levels, not fully collapsed because of the downside of the lockdown itself, which forced millions of families to stay at home.

On average, demand has fallen by 6% compared to 2019, starting from 10% in the first half of 2020, then reaching the levels of the previous year in November. In the epicentre of the virus, China, electricity consumption dropped by 11% in February 2020, but soon after the ending of the restrictions in April, it quickly stabilized to pre-covid levels, even reaching +6 % in August, confirming that when strengthening measures are indicted, they negatively impact the electricity demand.

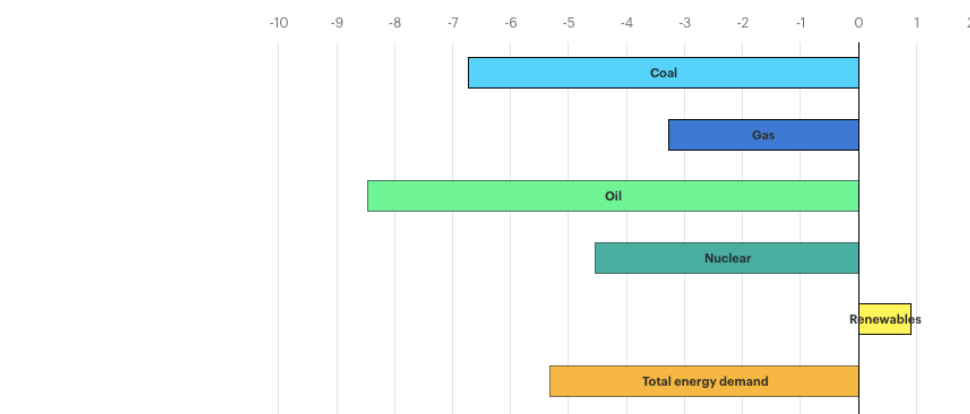
Catalyzing the structural fall in the electricity demand, COVID-19 heavily affected the downward coal use for power generation. This reduction in coal demand is strictly connected to the various examples of closures and suspensions of the production in different power plants from many

countries, confirming that the fuel has reached its peak after more than 200 years of absolute domination. It is also important to remember that the industry was in trouble even before the pandemic, due to the various campaigns of climate activists and the rise of green alternatives, increasingly cheaper due to “substantial innovations, impressive policy frameworks, and technologies cost downturn”⁶⁴.

However, during April and May 2020, there were days, and even months, in which countries were not burning a single gram of coal. As in the case of the UK, where the national grid did not operate for 35 days, the longest period since the start of the industrial revolution more than 230 years ago. This period was long almost two months in Portugal, while in Sweden it was closed the last coal-fired plant, two years before planned, confirming the choice of becoming a net-zero emission country before 2045.

Finally, if in the EU and the US there were strong declines in coal usage (-19% and -14%, respectively)⁶⁵, we face a different situation in Asia, where are placed the first two biggest coal consumers, China and India. In the continent, by contrast, coal-fired power generation increased by 1.2% annually thrived by China, which rapidly rebounded after the strong lockdown, in line with the electricity demand.

As we said, electricity demand has fallen in 2020, and many utilities have cut back on coal first because it is more expensive than gas, wind and photovoltaic. Also reminding the reduction of oil demand analyzed in the paragraph before is now understandable how the renewables seem to accelerate the trend of replacing fossils. The only sources of energy exploited in 2020 that had a growth (even if smaller than 1%), are exactly the green ones, reaching the 20% share on the total global energy mix, and reaching a record 29% in the share of the EU electricity generation in 2020, four percentage points higher than in 2019. Indeed, many countries across the EU during lockdowns have seen new highs in the share of variable renewables in the electricity mix. This share depends on many factors, first of all, the total demand, and the interesting fact here is that the renewables remained high as lockdown measures were softened, allowing the positive growth in the demand for them, even if the global energy growth was negative.



⁶⁴ S.E. Hosseini, “An outlook on the global development of renewable and sustainable energy at the time of COVID-19”, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7262507/>

⁶⁵ P. Jang, “Impacts of COVID-19 on energy demand and consumption: Challenges, lessons and emerging opportunities”, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7834155/#b0120>

The graph above, taken from the World Energy Outlook released in October 2020 by the International Energy Agency, shows the change rates of the different types of energy during the last year. Oil and coal, as described before, had the most significant declines, while the renewables were the fewest affected, towed the most by wind and photovoltaic (which supply chain is somewhat centralized, with 70% of it generated in China).

Although it is still early to understand if the pandemic will lead to more sustainable and renewable energy systems, there is no doubt that COVID-19 has facilitated the use of renewable energy and provided new opportunities for it. As in the European Union, where the decrease in electricity demand and higher renewable production has driven non-renewable generation down. In the first semester of 2020, weekly renewable production has been higher than fossil fuel, then reversed in July because of lower wind production. In fact, coal production was lower from January to August 2020, when started increasing to match 2019 levels, in line with the rise of the global demand described before.

Last year, the US produced more electricity from renewables than from coal for the first time in their history, as stated in the Short-Term Energy Outlook published in May 2020 by the US Energy Information Administration. To conclude, in China, the decline of the demand for electricity during the lockdown impacted negatively on coal-fired power generation. Renewables held a high share in the mix of energy, even in April, when the coal slightly recovered, picking up high again by the end of the year, and accounting for the double of the renewables in the Chinese electricity mix⁶⁶.

1.5 Effect of lockdowns on air pollution

Only in 2020, as far as Europe is concerned, a reduction in greenhouse gas emissions of 7.6% was recorded. The reasons are directly linked to a major change in work and life habits: with smart working, the reduction of business and tourist travel, the entire transport industry has seen a decline in use, and consequently, a collapse in emissions. However, the most positive environmental aspect has been the improvement in air quality: the collapse of transport has in fact lowered the concentrations of NO₂ and PM₁₀, the most harmful elements that worsen the purity of the air. The EEA's Air quality and COVID-19 report shows how this particle (mainly caused by road transports) fell in many countries under lockdown, and particularly in most polluted cities, such as Milan and Madrid, where this reduction has even reached 70%. This trend was confirmed, among others, by satellite images processed by NASA's Earth Data Covid-19 project, which shows that a few weeks of lockdown were enough for air pollution to decrease by a third and water and air quality to improve by over 40%⁶⁷.

When it comes to CO₂ emissions from the last year, we have seen how the pandemic restrictions accelerated the drops in the oil and coal demand, major sources of CO₂, and causing a global fell

⁶⁶ International Energy Agency, "Covid-19 impact on electricity", <https://www.iea.org/reports/covid-19-impact-on-electricity>

⁶⁷ National Aeronautics and Space Administration, Earthdata, <https://earthdata.nasa.gov/covid19/>

in the global carbon footprint by 5.8% for the IEA (shown also by the following graph)⁶⁸ and by 7% according to Global Carbon Project, in both cases the largest annual decline since WWII. To keep in line with the 2050 net-zero emissions goal, the world emissions must be reduced by 40% by 2030, renewables sources need to provide nearly 75% of global electricity generation by the same year (more than the double of today), and more than half of cars sold in ten years has to be electric⁶⁹.

Chapter II: New Green Policies and Investments

2.1 EU's response to the pandemic

As it should be clear now, the EU objective is to become a net-zero emission continent before 2050, in line with the Paris Agreement goals. In December 2020, during the Euro Summit, EU's leaders decided to accelerate the transition and the decarbonization, raising the intermediate targets and approving a cut in emissions of 55% by 2030, compared to 1990 levels, instead of a previous 40%.

The estimates offered by the European Commission in the European Economic Forecast, released in autumn 2020, show a clear contraction of the Euro Area GDP curve between 2019 and 2020 (from + 1.3% to -7.8%), offset by the stabilization of positive values for the following two years (+4, 2% in 2021 and + 3.0% in 2022)⁷⁰. Furthermore, although during the third quarter of 2020 the recovery in economic activity was more vigorous than expected and the large-scale vaccine distribution campaign is encouraging, the far-reaching economic prospects still remain uncertain. To recover from this massive economic contraction caused by the pandemic, at the end of May 2020, the European Commission presented the "Next Generation EU" (NGEU) plan, a package of emergency recovery tools and strategic investments that will mobilize over 750 billion euros to lay solid foundations for the benefit of future European generations. Next Generation EU is an ambitious plan aimed at harnessing the potential of the EU budget to mobilize investment and focus financial support in the crucial first years for recovery from the effects of the Covid-19 pandemic. More specifically, the NGEU supports the Multiannual Financial Framework for the seven years 2021-2027, making available to the Member States additional resources equal to 750 billion euros, integrating the package of ad hoc tools already introduced to tackle the pandemic such as the ESM, the PEPP, the SURE and the EIB measures. The provision is also known as the "recovery fund" and it comprehends the Recovery and resiliency facility, the European device for recovery and resilience, cornerstone of Next Generation EU, with its endowment of 672.5 billion euros, divided between 360 billion in loans and 312.5 billion in grants. However, the heart of Next Generation EU, the Recovery and resiliency facility, is based on the dual objective of stimulating

⁶⁸ International Energy Agency, "Global Energy Review: CO2 emissions in 2020"
<https://www.iea.org/articles/global-energy-review-co2-emissions-in-2020>

⁶⁹ International Energy Agency, "World energy outlook 2020", <https://www.iea.org/reports/world-energy-outlook-2020>

⁷⁰ European Commission, "European economic forecast: Autumn 2020",
https://ec.europa.eu/info/sites/default/files/economy-finance/ip136_en_2.pdf

investments for recovery from aggregate demand (recovery) and reforms that increase the sustainability of individual European economies, making them more "resilient" to the changes that are looming in years of recovery from the Covid crisis (resiliency). The interesting point here is that, given the large investments and their potential to create jobs, the individual national plans must comply with predefined criteria, concentrating investment and spending projects on 7 flagship areas: clean and renewable energy, the energy efficiency of buildings, sustainable transport, broadband deployment, digitalization of the public administration, cloud development and sustainable processors, education and training for so-called digital skills. It is so extremely clear how the Commission gives absolute priority to an ecological and a digital transition, recipients of a minimum spending ceiling in national plans. In fact, each state must direct at least 37% of spending to climate issues and at least 20% to enhance the digital transition. The European Commission vice-president, Frans Timmermans, underlined how a package of such huge resources to reform EU countries will perhaps never arise again, and that the main objective to reach is to transform the whole system and make the EU become the first net-zero emissions continent before 2050.

The European strategy towards climate action and environmental sustainability is not new, as it was already described in the Green Deal, introduced just before the COVID-19 outbreak, in December 2019. The European Green Deal is a series of measures to make energy production and the lifestyle of European citizens more sustainable and less harmful to the environment. In the intentions of the European Commission, the Green Deal "will transform the European Union into a just and prosperous society, with a modern market economy and where greenhouse gas emissions will be zero, and growth will be decoupled from the use of natural resources."⁷¹ In practice, the Green Deal will be financed with a large amount of public and private money. In the first ten years, the goal will be to mobilize around 1 trillion euros to finance it, more or less 100 billion per year. The objectives of the plan are 3. Firstly, to increase funding for the transition and to support sustainable investments over the next decade through the EU budget and associated instruments, in particular InvestEU. Then, to create a framework that allows individuals and the public sector to make sustainable investments easily. And thirdly, to provide support to public administrations and project promoters for the purpose of identifying, structuring and executing sustainable projects. A part of the Green Deal budget is destined to the Just Transition Mechanism, which aims to ensure a fair and just green transition mobilizing at least € 100 billion of investments over the period 2021-2027, to support workers and citizens in the regions most affected by the transition, and to alleviate the socio-economic impact of it

Finally, in November, the Commission has published "*An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future*", establishing how much these infrastructures are a key cornerstone to reach the objective of becoming the first climate-neutral continent and looking forward to supporting the long-term sustainable development of this sector.

⁷¹ European Commission, "The European Green Deal", <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52019DC0640&from=EN>

2.2 Italy's response to the pandemic

The recession induced by the pandemic is the most severe in contemporary Italian history in times of peace. In the first half of 2020, GDP was 12 per cent lower than the same period in 2019. In April, industrial production was more than 40 per cent below the level at the beginning of the year. From a strictly economic point of view, Italy recorded a drop in GDP of 8.9%⁷², double the average for world GDP, which suffered a decline of 4.4%. To deal with a phase of reallocation of consumption and production, a strong economy is needed, led by a state that invests and innovates.

For instance, it has been decided to allocate other funds for the so-called *ecobonus*, a measure promoted by the Italian Ministry of Economic Development, which offers contributions for the purchase of low-emission vehicles. The total amount made available is 500 million and is divided into 410 million for incentives for the purchase of low-emission models, and 90 million directed to the installation of infrastructures for the recharging stations of electric cars.

Another measure introduced for the first time in May 2020, is the *Superbonus 110%*⁷³, which serves to boost the Italian economy while at the same time fighting climate change. The Superbonus 110% allows all citizens to make their homes more efficient and safer for free, in an unprecedented collaboration between public and private, between the state and companies, between citizens and public administration. This benefit brings to 110% the deduction rate for expenses incurred from 1 July 2020 to 31 December 2021 (for the moment) for energy efficiency and photovoltaic systems installation. It is estimated that investments of approximately 18 billion euros are needed, which will allow the renovation of about 50,000 buildings each year, for a total annual surface area of 20 million square meters. Of this 18.51 billion, Italian Prime Minister Mario Draghi stated that 10.26 billion will come from the Recovery Fund (NGEU) and the remaining 8.25 from the Italian Complementary Fund.

Going back to the EU response to the pandemic, we have seen what instruments the Commission has made available, but not all 27 member states requested 100 per cent of the funds at their disposal from the Recovery and Resilience Facility. Italy did it and requested a total of 191.5 billion, split between loans and grants⁷⁴. These funds are crucial for the recovery of the national economy, as stated by Prime Minister Mario Draghi that defined the cornerstones of Italian industrial policy for the coming years, confirming the desire to strengthen the production of energy from renewable sources, high speed rail, electric mobility, production and distribution of hydrogen. Specifically, the Italian national plan for investing NGEU money, is the National Recovery and Resilience Plan (Piano Nazionale di Ripresa e Resilienza, PNRR), released the last week of April 2021, and divided into 6 missions (Digitization, innovation, competitiveness and

⁷² V. Pop, "Draghi under high pressure as spotlight falls on Rome", Financial Times,

<https://www.ft.com/content/28c32921-d458-4c23-9992-121b67b08ed7>

⁷³ "Ecobonus", Il Sole 24 Ore, <https://argomenti.ilsole24ore.com/storie/ecobonus-2020-guide-e-novita-detrazioni-110percento.html>

culture; Green revolution and ecological transition; Infrastructure for sustainable mobility; Education and research; Inclusion and social; Health)⁷⁵.

One of Draghi's first moves, when he became Prime Minister in January, was to set up the Ministry of Ecological Transition, which will take charge of competencies related to the green economy and calls for proposals inherent to the second mission, "Green Revolution and Ecological Transition", which allocates a total of 68.6 billion, of which 59.3 billion from the Recovery and Resilience Facility and 9.3 billion from the national fund. Its objectives, among others, are to improve the sustainability of the economic system and to ensure a fair and inclusive environmental transition. The component of the second mission to receive most of the budget is the "Energy Transition and Sustainable Mobility", to which 23.78 billion is allocated with the aim of increasing the share of energy produced from renewable energy sources in the system and to promote renewables in energy communities through their self-consumption.

2.3 USA's response to the pandemic

Joe Biden had based much of his campaign on the fact that, once he became president, he would make key decisions to cut emissions through a clean-energy plan that would create millions of jobs in all federal states, thus making sure to restart the national economy in a sustainable way. The goal is to reach climate neutrality no later than 2050, directing large investments in clean energy and climate research and innovation, incentivizing the "rapid deployment of clean energy innovations across the economy, especially in communities most impacted by climate change"⁷⁶. Biden looked also very active on another means of transport, EVs. In fact, even if in the US there are one million of EV, Biden's direction was to prioritize the deployment of more than 500.000 charging stations in the next 10 years and to introduce a tax credit to incentivize the number of units sold.

On the first day in the office, January 27th, 2021, it took a short time to keep the promises made during the election campaign. In fact, President Biden immediately rejoined the Paris Agreement, because of the previous Trump's administration exit, defining climate change as an "existential threat to humanity" and promising a 2000 billion dollars stimulus package to reboot the economy and to achieve the US climate goal of tackling the emissions. Moreover, he established many teams related to the topic such as the White House Office of Domestic Climate Policy, led by the first-ever National Climate Advisor and Deputy National Climate Advisor, and the National Climate Task Force, which comprehends executives across 21 federal agencies.

Biden lived up to his promises also with the introduction of the American Jobs Plan on March 31, 2021, even larger than the previous plan, and with a scope of \$2.3 trillion. These billions will be invested over the next 8 years not only to revive the labour market (the unemployment rate that has reached 14.8% in April 2020⁷⁷) and the various U.S. infrastructures, but also to finance the

⁷⁵ "Piano Nazionale di Ripresa e Resilienza", https://www.governo.it/sites/governo.it/files/PNRR_3.pdf

⁷⁶ "The Biden plan for a clean energy revolution and environmental justice", <https://joebiden.com/climate-plan/>

⁷⁷ Statista, "Monthly unemployment rate in the United States from April 2020 to April 2021", <https://www.statista.com/statistics/273909/seasonally-adjusted-monthly-unemployment-rate-in-the-us/>

ecological transition. The largest part of the investment (1.3 trillion) goes precisely to infrastructure, which however should not be understood only as bridges and highways, but also to build, together with the private sector, a network of 500,000 EV chargers by 2030. In fact, for the EV market, 174 billion are available not only for the columns, but also for the replacement of 50,000 diesel vehicles and to make electric the vast fleet of American school buses, at least for 20%. Finally, the plan gives also much importance to technological research in the field of clean energy and to make the U.S. a leader in climate science. In fact, it will be invested \$35 billion in the full range of solutions needed to “achieve technology breakthroughs that address the climate crisis and position America as the global leader in clean energy technology and clean energy jobs”⁷⁸, while other \$15 billion will be invested in R&D climate projects such as “priority utility-scale energy storage, carbon capture and storage, hydrogen, advanced nuclear, rare earth element separations, floating offshore wind and biofuel/bioproducts”.⁷⁹

2.4 China’s response to the pandemic

China accounts for about a third of global warming-related carbon dioxide emissions. It derives approximately 60% of its electricity from coal, is the world's second largest producer of oil, and releases approximately 28% of global carbon dioxide. These factors contributed to President Xi Jinping's announcement that China would reduce carbon dioxide emissions to zero by 2060, in a surprising announcement made during the virtual United Nations General Assembly in September 2020.

On March 5th China unveiled its 14th five-year strategy for the period 2021-2025. For the first time in the country's history of drafting five-year plans, China's strategy does not have a clear GDP growth objective, but instead emphasizes targets for other factors such as unemployment rate, electricity use, and carbon dioxide emissions, in line with the mission to boost people's livelihoods and standard of production. The strategy includes twenty key indicators across a broad spectrum of fields, as well as eight mandatory objectives, seven of which are focused on ecological conservation and development.

The Five-Year Plans are extremely influential in the Chinese context, and the fact that up to ten of the 47 chapters address the environment is critical for recognizing the country's potential course of action. Additionally, China promises to prioritize "green development," to maintain Xi Jinping's "30-60" pledge for China to attempt to peak carbon emissions before 2030 and achieve carbon neutrality by 2060, and to serve as a global role model for climate governance. Even though, in the absence of GDP goals, assessing the plan's effect on China's carbon emissions trajectory over the next five years is challenging. More precisely, the FYP proposed to "accelerate China's shift to a green growth model"⁸⁰ decreasing its carbon pollution intensity (the amount of carbon dioxide emitted by one unit of GDP) by 18 per cent in five years, its energy intensity (the amount of energy used by one unit of GDP) by 13.5 per cent, and to increase the share of renewable energy in its

⁷⁸ The White House, “FACT SHEET: The American Jobs Plan”, <https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/>

⁷⁹ Id.

⁸⁰ L. Hongqiao, “Q&A: What does China’s 14th five year plan mean for climate change?”, CarbonBrief, <https://www.carbonbrief.org/qa-what-does-chinas-14th-five-year-plan-mean-for-climate-change>

energy mix to 20% from the current 15%. However, examining these declarations demonstrates that new standards of commitment can be seen as a starting point, as existing targets risk weakening global climate goals. If China meets its goal of minus 18% emission intensity reduction, China's CO₂ emissions could rise by up to 10% by 2025, relative to 2020, assuming annual GDP growth of 6% over the next few years (China actually hopes to reach more than 6 per cent in 2021). To put that in perspective, with China's estimated CO₂ emissions of well over 10 billion tons a year, an additional 10% will match the total CO₂ emissions of the UK, South Africa, and Egypt together.

Although Beijing would accelerate the transition to renewable energy, it will still continue to encourage "safe and productive coal usage". This was frustrating for many climate campaigners looking for a move away from coal, as was the lack of a target for reducing total energy consumption in the 14th FYP or an overall ceiling on carbon emissions, even though they would be included in future sectoral plans, similar to how the 13th FYP for Energy Development set a coal output cap of 4.1 billion tonnes. Indeed, the China Coal Association proposed capping coal usage at 4.2 billion tonnes in 2025⁸¹, a goal that may be included in the energy sector programme. In fact, more climate goals are likely to be announced later this year, with the government expected to issue a separate five-year energy plan in addition to the action plan for reaching peak emissions by the end of the decade. Indeed, similar to the 12FYPs and 13FYPs, experts anticipate that National Development and Reform Commission (NDRC) and National Energy Administration (NEA) will reveal more comprehensive goals for the energy sectors in the coming year, including coal consumption and production and clean energy generation and use.

Finally, China is the global leader in investments and production of clean energy power, and in order to achieve carbon neutrality by 2060, more than 90% of energy must come from renewable sources⁸², which means China's renewable transformation must be significantly accelerated. In the short term, one of the most pressing issues is to provide a functional power market that enables rapid growth of renewable energy penetration while containing renewable curtailments. This will necessitate not only hardware such as a smart grid and distribution capabilities, but also legislative mechanisms for business reform.

Chapter III: EV's results and perspective

3.1 Car industry in 2020

As the Covid-19 epidemic emerged in early 2020 and nations throughout the globe adopted lockdowns, worldwide automobile sales fell to an all-time low, with almost all major automakers suspending production lines for different periods of time. Despite a slight rebound throughout the

⁸¹ L. Zhihua, "China caps coal output goal at 4.1b tons", China Daily, <https://www.chinadaily.com.cn/a/202103/04/WS60401b45a31024ad0baac8f6.html>

⁸² Y. Rylander, "How ambitious is China's five-year plan on climate targets?", Stockholm Environment Institute, <https://www.sei.org/featured/how-ambitious-is-chinas-five-year-plan-on-climate-targets/>

year, the European Automobile Manufacturers' Association (ACEA) market data⁸³ indicates that worldwide car sales declined by an estimated 14% YoY, from 74.9 million units in 2019 to 63.4 million in 2020. While, according to Moody's, the 2020's decline was 16 per cent in worldwide light vehicle sales, around 14.5 million units. However, the decline in worldwide automobile sales in 2020 was substantially greater than the decline experienced during the global crisis of 2008.

When it comes to regional final results in 2020, the European passenger car market had a severe fall, owing mostly to the COVID-19 spread in the spring of 2020. Indeed, the region's performance was impacted by significant losses in the EU (-23%) and the United Kingdom (-29%). The pandemic had a limited influence on Eastern Europe, indeed Russia (-8%) and Ukraine (-5%) had more mild declines. North America's automobile demand improved slightly in the last quarter of 2020, even though full-year total sales of 13.2 million vehicles remain 18 per cent lower than in 2019. The US performance was consistent with the region's, declining 16 per cent to 11.2 million vehicles sold in 2020. China's whole automobile market was less affected by the pandemic than other areas. Indeed, total new vehicle registrations fell by around 9%. Finally, South America was one of the areas most hit by the spread of COVID-19, and the region's passenger car demand contracted by 29 per cent to 2.5 million units in 2020, due to the severity of the lockdowns. Brazil's market (the largest in Latin America) suffered comparable declines, losing 28 per cent year on year.

In terms of production, the full-year statistics continue to reflect the effects on the economy of the COVID-19. Following the spring shutdowns and a delayed restart in the third quarter, output was accelerated by the end of 2020 due to increased demand and the need to restore inventory. Production slowly began in Europe in 2020 and came to a halt by mid-March as a result of industrial closures caused by supply chain failures and health precautions implemented in response to the pandemic. From September, new orders had grown and plant line rates had increased. But finally, in 2020, European commercial vehicle and bus production declined by 17.7 per cent to around 3 million units. Last year, North American production fell by 20 per cent to 9.7 million units, mostly owing to pandemic-related closures between March and June 2020. In South America, passenger automobile manufacturing reached its lowest level since 2003 in 2020, falling 34 per cent to 1.8 million vehicles for the whole year. Finally, as previously said, China's economy improved in the fourth quarter of 2020, resulting in a comeback in passenger vehicle production. In the end, it produced more than 19 million automobiles last year, accounting for 31.5 per cent of global automobile output. However, although percentage growth remained negative compared to 2019, the overall year decreased only by 6.4 per cent, with decrease peaks reaching -19 per cent in January-September 2020.

3.2 EV's market in 2020

After their entrance into markets in the early part of the decade, electric vehicle sales have surged, increasing by an average of 60% per year. In 2010, just approximately 17 thousands

⁸³ ACEA, Economic and Market Report: EU automotive industry full-year 2020", https://www.acea.be/uploads/statistic_documents/Economic_and_Market_Report_full-year_2020.pdf

electric vehicles were on the world's roads. By 2019, that figure had risen to 7.2 million, with 47 per cent of them being in China. Nine nations had over 100,000 electric vehicles on the road, while at least twenty nations reported annual market shares greater than 1%. Additionally, electric cars in operation worldwide prevented the consumption of about 600,000 thousands barrels of petroleum products each day in 2019.

According to the IEA, worldwide EV sales continued their upward trajectory in 2020, exceeding the total for 2019, growing by 41% and establishing a record proportion of the global automobile market of more than 4.5%⁸⁴. This increase in global sales goes from the 2.1 million electric vehicles purchased in 2019 to around 3 million cars sold in the last year, with consumers spending 120 billion US dollars for them. As a consequence, there are now over 10 million electric vehicles on the road worldwide. Indeed, in the majority of nations, BEVs (Battery Electric Vehicles) and PHEVs (Plug-in Hybrid Electric Vehicles) were more resistant to the current crisis than traditional automobile markets. According to EV Volumes⁸⁵, global BEVs and PHEVs sales grew by 43% YoY, while the global light vehicle market analyzed in the previous paragraph fell by 14%.

Many are the causes of the missed impact of the pandemic on the market: first, continued battery cost declines; second, the upgraded original equipment manufacturer offerings in terms of model selection and performance; third, fleet operators facilitated their technology transition; and finally, the interest of electric car buyers, who are frequently wealthy households less affected by the recession. In fact, in order to understand how the market remained unaffected by the downturn, it's necessary to examine the typical electric vehicle consumer, who, in many countries, is richer than the ordinary consumer and hence may have been less impacted by the global recession. Moreover, over the previous year, approximately 100 new electric vehicle models became available, and major technological advancements and a broader selection of models have expanded potential customers' choices. Additionally, manufacturers have declared plans to produce another 200 new electric vehicle models over the next five years, many of which will compete in the popular sport utility vehicle class, and buyers may delay their purchasing to await the newest models.

These governmental initiatives aimed at stimulating the automobile industry in response to the Covid-19 epidemic are significantly different from some of the responses to the 2008–2009 financial crisis. To begin, there is a stronger emphasis on increasing the adoption of electric and hybrid automobiles. Second, many nations are taking a more integrated approach to the transportation industry, including charging infrastructure and support for public transportation or other mobility solutions. This fits within the larger framework of promises to clean energy transitions made before the Covid-19 pandemic, such as the EU Green Deal, and may be seen as complementing other 2020 pledges to reach net-zero emissions by 2050. These measures must be adapted to the Covid-19 crisis reaction in order to promote the automobile industry following long-term transportation decarbonization goals. But near-term efforts should be focused on sustaining

⁸⁴ International Energy Agency, “Global EV Outlook 2021”, <https://www.iea.org/reports/global-ev-outlook-2021?mode=overview>

⁸⁵ R. Irle, “Global plug-in vehicle sales reached over 3.2 million in 2020”, EV-volumes.com, <https://www.ev-volumes.com/country/total-world-plug-in-vehicle-volumes/>

strong support for electric car competitiveness while progressively eliminating purchase incentives as sales grow.

The EU's CO₂ emissions rule for vehicles and vans, which includes milestone objectives for 2025 and 2030, could help continue the pace. In 2020, the emissions goal was applied to 95%⁸⁶ of each manufacturer's new automobiles with lower emissions. Meanwhile, China will continue phasing down its New Energy Vehicle subsidy program and gradually tightening its NEV credit mechanism and objectives. In the US, the new administration's stimulus measures and long-term ambitions will serve as crucial guidelines for electric car markets. However, the resilience of electric vehicle sales in 2020 despite the Covid-19 downturn, the planned introduction of new electric vehicle models in 2021 and the increased state support for electric vehicles, already boost optimistic projections in the coming years.

To boost the EVs sales is crucial to invest in charging infrastructures, this is the reason why automobile manufacturers, environmentalists, but also consumers, are asking the EU to establish aggressive objectives for the deployment of electric car charging stations.

Finally, according to Bloomberg NEF's Electric Vehicle Outlook 2020⁸⁷, electric vehicles will be more affordable to manufacture than internal combustion engines ones in every light vehicle class throughout Europe by 2027. According to the study, electric cars and vans could account for the totality of new vehicle sales by 2035, including in southern and eastern Europe, assuming politicians enhance vehicle CO₂ goals and accelerate other market-stimulating measures such as the rapid roll-out of charging stations analyzed before.

3.3 Players' moves

Last year, due to the existence of significant competitors such as Tesla, Volkswagen Group, Chinese SAIC, Groupe Renault, Daimler AG, and BMW Group, the market was already concentrated. These firms are spending significantly on the development of technologically sophisticated electric cars and the expansion of their product lines. Similarly, several firms are acquiring, merging, expanding regionally, and forming strategic alliances in order to acquire a competitive advantage in the sector.

Tesla was the market leader in the plug-in and battery electric passenger vehicle categories in 2020, accounting for 16 per cent of the plug-in market and 23 per cent of the battery-electric market. Tesla sold 500,000 vehicles globally in 2020, a 35 per cent increase over the year before, which enabled the organization to remain profitable for several consecutive quarters despite the pandemic. The electric vehicle maker said that it would work to reduce costs, boost efficiency, and expand production capacity at current factories in the near future. Remaining in the United States, Ford said that it expects electric cars to account for over half of its worldwide sales by 2030, as part of the company's newest recovery strategy. By 2025, it intends to increase its investment in the electric to more than \$30 billion. Meanwhile, General Motors has declared its intention to sell

⁸⁶ European Commission, "CO₂ emission performance standards for cars and vans", https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en

⁸⁷ BloombergNEF, "Electric Vehicle Outlook 2020", <https://about.bnef.com/electric-vehicle-outlook/>

only electric cars by 2035 and to phase out fuel cars in the United States by that year, spending \$27 billion over the next five years on electric and autonomous cars R&D.

Moving to Europe, Stellantis (born from the FCA-PSA merger in 2021) and Foxconn have recently decided to join forces through a strategic partnership. Mobile Drive, a 50/50 joint venture, will combine Stellantis' expertise in vehicle design and engineering expertise, with Foxconn's global software and hardware development capability for smartphones and electronics. Mobile Drive will focus on infotainment, telematics and cloud service platform development through software innovations that should include applications based on artificial intelligence, 5G communication, and smart cockpit integrations.

According to Mercedes-Benz, the company expects to earn the same amount from electric cars as it does from combustion engine vehicles by 2030, making it the first German carmaker to declare a specific date for the break-even point. Additionally, the firm (namely, Daimler Truck AG) formed a 50/50 joint venture with Volvo called Cellcentric, which will begin hydrogen fuel cell manufacturing in 2025. Remaining in Germany, Volkswagen, which has invested billions in its transition to electric vehicles, predicts that one in every five cars sold will be electric by 2025, increasing to one out of two by the end of the decade. Indeed, they plan to invest over €73 billion in battery technology and digitalization over the next five years. Moreover, VW expects to sell 1 million electric or hybrid vehicles this year, an almost tenfold increase over 2019.

The Italian Lamborghini is also part of the same family, and from the second half of this decade will be fully electric. In May, CEO Stephan Winkelmann presented the strategic plan for the next 10 years, declaring that 1.5 billion euros will be invested. over the next four years, making this the largest amount ever in the history of the Italian brand.

Finally, looking at the future, there are also some notable startups to mention. One of the most promising is the Chinese Nio, which plans to begin delivery in Norway in September of this year, marking the company's first expansion outside of China. Lastly, Lucid Air is scheduled to enter the market this year, with a vehicle that has a range of 800 kilometres, a quarter more than any existing Tesla, and a recharging system capable of recharging hundreds of kilometres in few minutes.

Conclusions

This piece of work wanted to allow the reader in a first point to understand how the pandemic has impacted the energy industry. The lack of transports caused a decrease of 20 million barrels of oil production per day, and the missed months of operating factories led to an overall 6% decline in energy generation. Furthermore, the source of the electricity mix also changed, in better, allowing the renewables to gain a 20% market share, and being the only source to increase its total output, in a year in which coal, oil, nuclear and gas lost from 3 to 8 per cent. In the EU, the decrease in electricity demand and higher renewable production has driven non-renewable generation down, while the US produced more electricity from renewables than from coal for the first time in their history. All this, made possible to improve the air that we breathe, reducing drastically CO₂, NO₂ and PM₁₀ pollution.

However, the economic recession caused by the lockdowns was terrible, decreasing almost every national GDP worldwide. New interventions from the state were needed to avoid a global catastrophe, and they did not miss. EU not only expanded its sovereign debt purchasing, but made available 750 billion euros with the NextGenerationEU to achieve its goal of decarbonization by 2050, defining that at least 37% of them must be invested in climate issues, such as clean and renewable energy, the energy efficiency of buildings and sustainable transport. Italy will receive the largest part of this money and have allocated nearly 70 billion to the "Green Revolution and Ecological Transition" in its recovery plan (PNRR). USA's new administration maintained its electoral promises, and Joe Biden introduced the \$2.3 trillion American Jobs Plan, which plans to spend 200 billion only for EVs and R&D in climate projects. China had also set targets to become net-zero by 2060 in its 14th Five-Year Plan, even if it still strongly relies on coal and oil, even if it is the most advanced in photovoltaic.

Finally, the gasoline and diesel car market experienced an unprecedented decline of 14% YoY. Meanwhile, EVs grew their market share to 4.5%, surprisingly increasing their sales by 1 million units during a global recession. Almost every manufacturer has now understood the potentiality of this market, and they continuously spend and plan to invest to develop their electric vehicles in the following years, when the traditional car sector will experience an obvious decline.

Some targets and plans were introduced even before the pandemic, such the EU Green Deal, but there is no doubt that the recession has sped up the process of decarbonization. First of all, the output reduction in oil and coal, and the consecutive growth of renewables, anticipated significantly their peaks and allowed solar and eolic to be cheaper and more available. Moreover, the public opinion, such as in my case, understood how two months closures significantly increased the quality of the air and gave space back to nature. Then, the state intervention played a significant role, conceding billions, and in some cases also trillions, that otherwise would have never been spent for the cause. In fact, always reminding that from a health point of view the pandemic was, and still is, a disaster, these investments wouldn't have been so large in amount, and for sure wouldn't have been implemented in such a fast and short-term way.

Only time will say if institutions will be able to stay in line with the target years, and there is no parallel universe to see how this objective would have been achieved without the pandemic and the recession caused by it. Probably global governments would have taken the decarbonisation direction (some of them such as the EU already took it before the pandemic) but the general belief is that this black swan really was an opportunity that will facilitate and accelerate the energy transition, and this study is proof of how politics didn't miss to catch it, matching the recovery from a crisis with massive investments for a more sustainable future.