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Energy and Covid 19 – Analysis of the Impact on the Global Energy Matrix

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ABSTRACT

Pandemics reverberated their times, changing social and economic contexts, prompting, and redirecting changes in social ties, business, and education, restructuring the world that generated them. In this context, this study aims to assess the impact of the COVID-19 pandemic on the global energy matrix, supported by an analysis of consumption, demand, and GDP from January 2019 to June 2021. The energy balance showed variations in this period, with impacts on the environment. We will assess whether the changes will be lasting.

Keywords: **Covid-19, global energy matrix, environment, pandemic.**

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1. INTRODUCTION

The great pandemics that devastated humanity allowed the analysis of their historical impacts in the fields, human, social, and economic, but one aspect, the impact on the area of consumption and generation of energy, was not specifically explained, which in a way it is understandable, because, until the eighteenth century, energy consumption was basic in the way it was used by man.
In the 19th and until the middle of the 20th century, even though the use of energy by man, the complexity and impact on human life was low compared to what we see in the second half of the 20th century until today.

The question to be answered in this article is whether situations of health and sanitation crisis affect or alter the use, demand, and consumption of present and/or future energy, and how. To carry out a correlation, we must define the scope of the areas of analysis and the time of their application, considered by this study.

The authors reviewed existing research and theories on the topic, through a systematic literature review, and a bibliographic and documental survey [1] [2].

1.1. Pandemic

Diseases, or rather the germs that cause them, are not prejudiced of any kind they are indifferent to us and our well-being, but we must respect them as skilful opponents and of great strength and resilience. They have been present in the world for a long time, of course, before humanity even existed.

These germs cause the individual diseases that afflict us, but in certain situations, individual diseases are classified [3] [4], basically: Epidemic: an unexpected increase in the number of disease cases in a specific geographic area; Pandemic: when the growth of the disease is exponential. This means that the growth rate of cases soars and that a virus covers a wide area, affecting many countries and populations; Endemic: an outbreak of disease that is consistently present but limited to a particular region.

The difference between an epidemic and a pandemic is not the severity of the disease but the degree to which it has spread. A pandemic crosses international borders, as opposed to regional epidemics.

Due to this classification, diseases when they become pandemics, due to their wide geographic reach, are the most worrying, as they cause negative effects on human groups and society [5], such as:

1st) Significant and widespread increases in morbidity and mortality, especially in low-middle-income countries.

2nd) Economic damages, whether due to short-term fiscal shocks or long-term economic losses that affect economic growth.

3rd) Individual behavioural changes, such as fear-induced aversion to workplaces and other public gathering places, these changes are the main cause of economic losses and negative impacts on the economy and economic growth during pandemics.

4th) Some of the measures taken to mitigate the effects of pandemics can cause significant social and economic disturbances.

5th) In countries that are politically unstable or whose democratic institutions are still incipient or weakened, pandemics can increase political stress and tension. In these contexts, outbreak response measures, such as quarantines, generated violence and tension between states and citizens.

1.2. Past pandemics

The three biggest pandemics that ravaged the world, classified as such by their estimated mortality, are presented in Table 1.

The studies carried out on the effects generated on society by the 3 epidemics noted, confirm, and highlight the negative effects on society, at the time of their occurrence, foreseen for this type of event.

Justinian's Plague contributed to the weakening of the Byzantine Empire in political and economic ways, by decimating the Empire's population, likely causing labour shortages and rising wages, trade was disrupted, the agricultural sector was devastated, prices soared, and tax revenues

fell, reducing the ability to resist invasions by their enemies, barbarian hordes invaded northern Italy dividing it, and North Africa and the Near East were invaded by Arabs [11].

Table 1 – Biggest pandemics in the modern world

Classification	**Epidemic**	**Date**	**Deaths Global(1)**	**Affected Regions**	**Notes**
1st	*Justinian' Plague*	*541-549*	*15 – 100*	*Europe and Asia*	*(c), (d)*
2nd	*Black Death*	*1346-1353*	*75 – 200*	*Europe, Asia, and North Africa*	*(a), (b), (c)*
3rd	*Spanish Flu*	*1918-1920*	*17 - 100*	*All World*	*(c), (e)*

(1) Millions of individuals.

(a) [6], 10; (b) [7], (c) [8]. (d) [9]. (e) [10]

The Black Fever shook the 14th-century European society, the cessation of wars and a sudden drop in trade immediately followed, with the drastic reduction in the amount of cultivated land, due to the death of so many workers. The shortage of labour forced the aristocracy to replace labour services with wages or cash rents, helping to eradicate serfdom and the development of a new economic system. New social systems developed, as well as modern economic, religious, and scientific ideas [12] [13], but outbreaks of violence occurred in communities, mainly to some groups accused of being responsible for the spread of the disease [14].

The Spanish Flu pandemic took place during World War I and authorities discouraged social interaction, which fuelled rumours of enemies spreading the virus and created a climate of suspicion and mistrust that characterized the period and much later. Researchers estimate that, in a typical country, the pandemic reduced real GDP per capita by 6% and private consumption by 8%. The flu was particularly deadly for young adults without pre-existing conditions, which increased its economic and social impact. The inefficiency of governments in managing the crisis provoked a

wave of workers' strikes and anti-imperialism, a reaction to growing inequality, noting that in 1917 the Russian revolution had taken place [15] [16].

1.3. 21st-Century Pandemic

COVID-19, a disease of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), which still affects humanity, is the pandemic of the 21st century. First identified in Wuhan, Hubei province in December 2019, China, where there is an interaction between humans, pigs, birds, and other animals, due to the live animal market, which favoured the spread of this virus between them. species, the main hypothesis of its transmission, producing variables for which man has no immunity, being transmissible in the incubation period, before the onset of symptoms, a critical condition. With atypical cases of pneumonia, in December 2019, in a few months the disease caused by the virus, the World Health Organization - WHO, which identified the 2019 coronavirus on February 11, 2020, and quickly spread, declared the outbreak as a global pandemic, in 11 of March 2020 [17] [18].

So far there is no treatment for the disease, except prevention such as vaccination, confinement, use of a mask (minimum efficiency of 95% filtering capacity), and social distancing as the best way to prevent airborne contagion due to the virus in suspended particles.

In just over a year and a half since the declaration of the COVID-19 pandemic, globally, the disease, its consequences, and sequelae remain out of control, even with the beginning of vaccination. Its rapid evolution and expansion have drastically altered people's lives, with direct and severe impacts on the global and local economy, in the public and private sectors. Massive blockages, economic recession, tourism stoppage, reduced agricultural production, the decline in the financial sector, intense reductions in the supply and demand aspects of the economy at the international level tourism [17] [19], significant expansion of home office activities, high demand for medical, hospital and funeral services, expansion of social inequality and poverty to extreme levels in a short period, are aspects of the pandemic that have come to dominate the daily scene in global level.

After 14 months of the WHO declaration of the pandemic, the world accumulates 164 million cases, with 3.40 million lives lost to COVID-19, affecting 191 countries [20] [21].

1.4. World Energy Demand

Energy comes from a set of sources, which form what we call the energy matrix. That is, it represents the set of sources available in a country, state, or in the world, to supply the demand (need) of energy. While the energy matrix represents the set of energy sources available to move vehicles, prepare food, and generate electricity, the electrical matrix is formed by the set of sources available only for the generation of electrical energy. Thus, we can conclude that the electrical matrix is part of the energy matrix. [22].

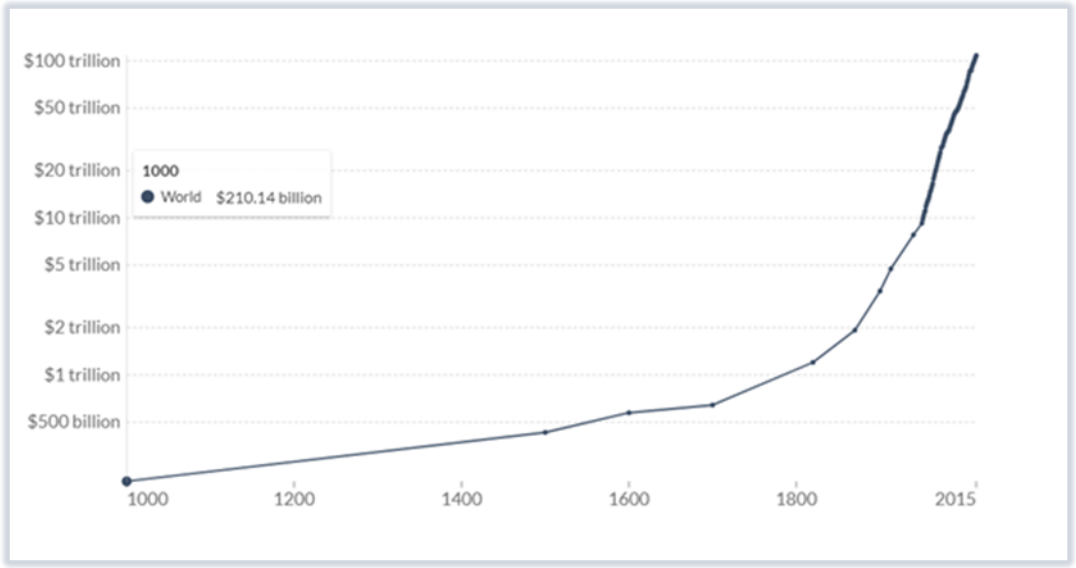
The composition of the energy matrix varies greatly from one country or region to another and can change significantly depending on the period. Variables include [23]: The availability of usable resources in the domestic market or the possibility of importing them; The range and type of energy that needs to be met; Policy choices determined by historical, economic, social, demographic, environmental and geopolitical factors.

Energy is fundamental for human development, its availability determines access to health, food, education, safety, and well-being [23], this relationship became evident after the British Industrial Revolution, 1760, based on energy from the coal, and from which energy has become a key production factor [24], as Figure 1 demonstrates, the inflection of the World Gross Domestic Product (GDP) curve starts from mid- from the 18th century.

Energy from this period, of great economic and social changes, is identified as an economic good, which, because it is poorly distributed, is expensive and subject to price fluctuations that are often unpredictable, and an indicator of inequalities between countries, when analysed. by their relationship with the Gross Domestic Product (GDP) of their economies, or by the per capita energy consumption of their inhabitants [25].

The correlation of energy with the economy, causes it to be "evil" economic. It is an economic good, capable of improving the standard of living of billions of people. Energy drives economic productivity and industrial growth and is fundamental to the functioning of any economy [26]. Ensuring universal access to electricity, especially for billions of people in developing countries, who do not have access to services or whose consumption levels are far below industrialized countries, is a crucial goal that can spur growth and transformation in world [27].

Figure 1 – World GDP in the millennium last – [28]



Sources: World GDP - Our world in data based on World Bank and MADDISON (2017) [29]; OurWorldInData.org/economic-growth

BARNEY and FRANZI [30] argue that energy is responsible for at least half of industrial growth in a modern economy, while representing less than a tenth of the cost of production.

To show the relationship between the world economy and energy, Figure 2 shows the variation in the World GDP over the 20th and 21st century and Figure 3 shows the variation in energy demand (global consumption) during the same period, where it is verified that positive or negative variations in GDP correspond to variations in the same module of demand.

1.5. Global Energy Matrix

Currently, as shown in Figure 4, fossil fuels dominate the energy matrix at a global level, accounting for more than 80% of the total needs, the total energy production (2018) was 583.9 EJ or 1621.9 x 10^3 TWh, and in the generation of electric energy, contained in the global matrix, it accounts for the consumption of fossil sources, in about 64% of the total needs.

1.6. The Energy Matrix before December 2019

The first human cases of COVID-19 were first reported by officials in Wuhan City, China, in December 2019 [31].

The global energy matrix was shown in Figure 4, but it is necessary to discuss that the format of the matrix shown is not static, it will necessarily undergo changes, seeking to meet extremely important priorities and, necessarily, essential for the maintenance of human society.

Figure 2 – Global annual change in real GDP - 1900-2020 – IEA Sustainable Recovery (2020) [32]

1 – Spanish Flu, 2 – 29' Crush, 3 – II War, 4 – 1º Oil Chock, 5 – 2º Oil Chock, 6 – Financial Crises.
2020 values are predictions.
IEA based on IMF World Economic Outlook (January and April 2020) [33], OECD Interim Economic Outlook Forecasts (March 2020) and MADDISON Project Database (2018) [29].

The future energy matrix must, on the one hand, meet energy equity, so that individual access to energy becomes a global reality, achieved through economic growth or social actions, but it must also achieve (allow) environmental sustainability.

More objectively, in 2050, with a population between 8.7 and 9.4 billion, we must ensure that all inhabitants of the world will have access to energy within minimum values that guarantee their "well-being", to exemplify the Report from the World Bank reports that in 2019, 840 million people did not have access to electricity in the world [33], and in Figure 5 we see a high correlation between lower energy consumption and lower Human Development Index (HDI), a developed

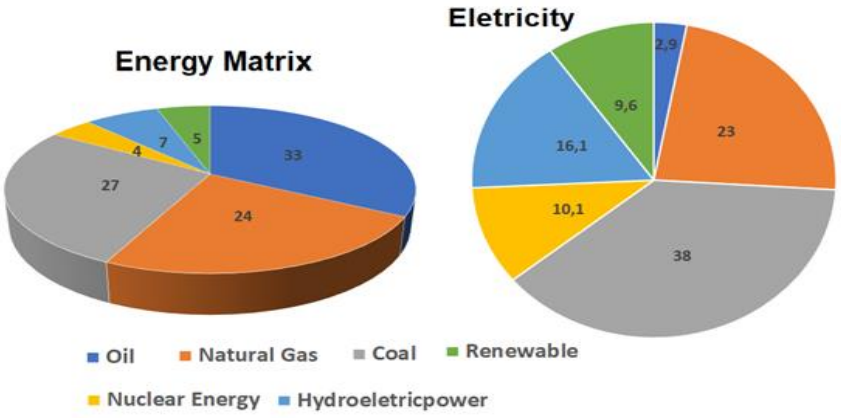
index in 1990 and used by the UN to compare the quality of life of countries [34], where it appears that 80% of the world population consumed less than 100 Giga Joule per inhabitant [35].

Figure 3 - World Energy Demand – Base IEA Sustainable Recovery (2020) [32]

1 2 3 4 5 6

1 – Spanish Flu, 2 – 29' Crush, 3 – II War, 4 – 1º Oil Chock, 5 – 2º Oil Chock, 6 – Financial Crises.
Notes: 2020e predicted fall due Covid 19

Figure 4 –Global Energy Matrix (bp, 2020) [36]

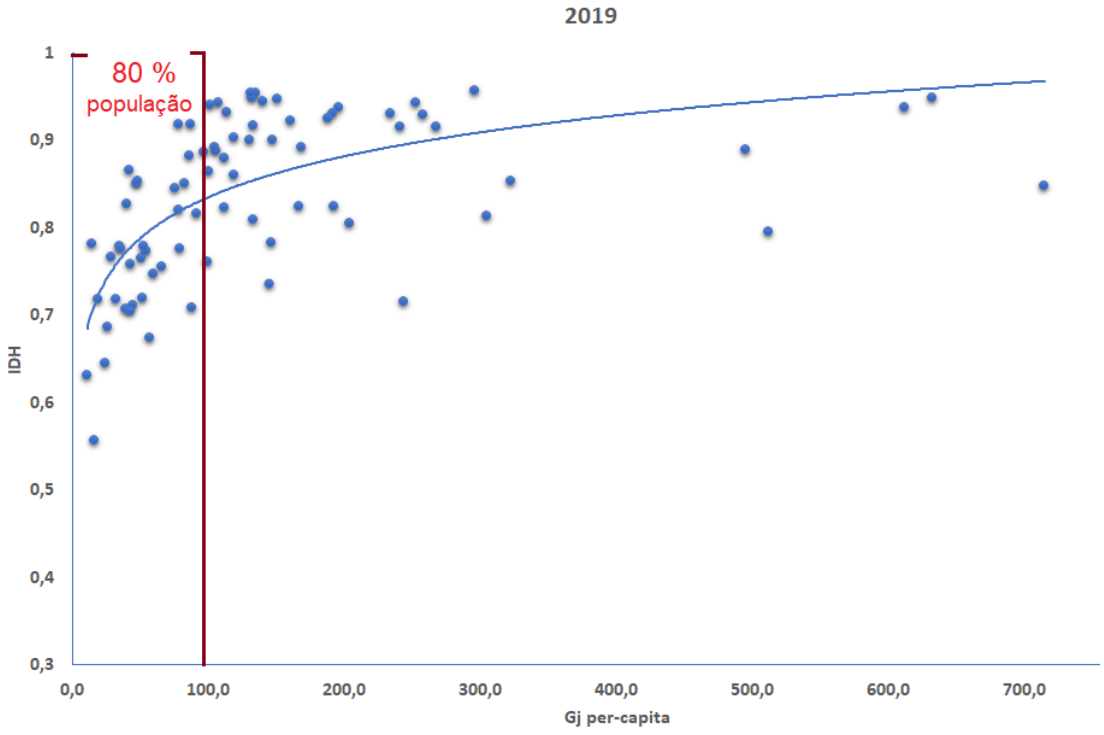


Source: bp. Plc – Statistical Review of World Energy 2020 | 69th edition [36].

Another important aspect in the analysis of the energy matrix for 2050 and that we must also ensure that, based on data from the International Energy Agency and the Global Carbon Project (GCP), the reduction of global CO2 emissions (largest responsible for the greenhouse effect) will reach the value proposed in the Intergovernmental Panel on Climate Change (IPCC), corroborated by the 2015 Paris agreement [37], to keep global warming below 1.5ºC, compared to the pre-industrial level between 1850 – 1900, in figure 6 we see that we have already reached the value of 1.0 ºC [38] [39].

Analysing the variation in CO2 generation (in addition to other greenhouse gases), shown in Figure 7, the trend shows that, on the current basis, we will reach the value of 1.5 ºC in 2030 [40].

Figure 5: Human Development Index and per capita primary energy use [35] [68] [69]



Source: STEINBERGER 2016 [35]

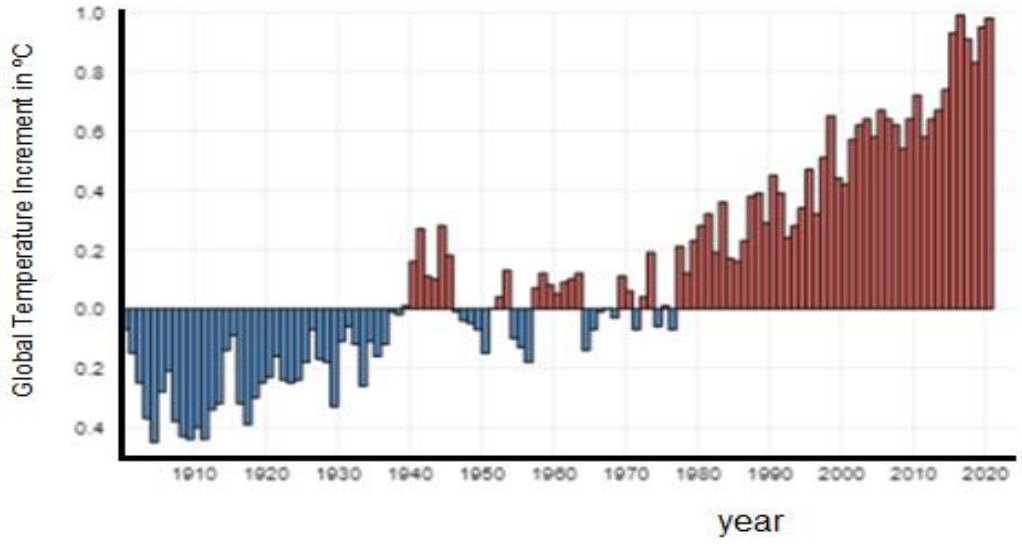
1.6. Energy Matrix in Times of Pandemic

Most governments, faced with the pandemic, declared a national emergency, and introduced in their countries measures of generalized physical distancing for the population, including

confinement, with strong restrictions on transport systems, logistical services globally, the mandatory use of masks, to reduce the spread of the virus and its consequences, such as the collapse of the hospital system and the high mortality of the population, implementing efforts to lower the curve of COVID-19 cases.

The effects of the new coronavirus pandemic go beyond health, economic, political, and environmental areas, reaching society. Specifically, the energy, electrical and thermal supply sector, both for transport and production, or for services and related and for social use, suffered notable impacts, not necessarily the same, although they are essential to guarantee the needs of society and individuals [41].

Figure 6 - Global surface temperature history since 1900 [39]



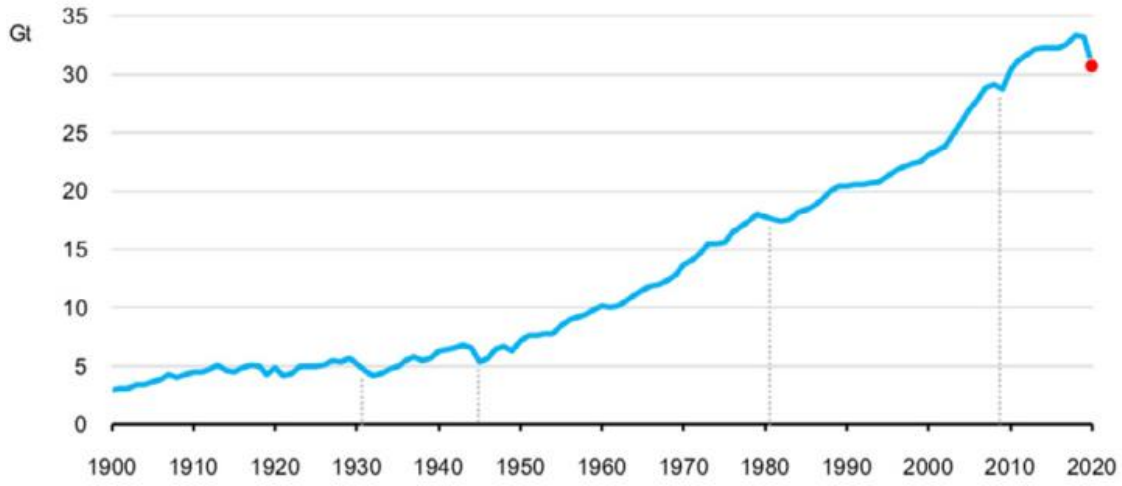
Source: LINDSAY (2021) [39]

For example:

• As a result of the global blockade measures due to the pandemic, mobility - 57% of global oil demand - declined on an unprecedented scale in early 2020. Road transport in regions with blockades in place fell by between 50% and 75%, the average global road transport activity has almost dropped to 50% of the 2019 level by the end of March 2020 [43].

• The sharp drop in global oil demand caused West Texas Intermediate (WTI) crude to trade negatively in April 2020, and Brent crude, another global crude oil price benchmark, dropped to $9.12 per barrel, its lowest price in decades [43].

Figure 7 – Global Energy-Related CO2 Emissions 1900 to 2020 (Gigatons CO2)



Source: International Energy Agency (2020) [42]. Global Energy Review 2020 [43].

• Global electricity demand decreased 2.5% in Q1 2020, full lockout measures reduced electricity demand by 20% or more, with lesser effects for partial lockouts. Correcting the effects of the weather, total blockages reduced daily electricity demand by at least 15% in Europe and the United States. Note that the greatest impacts were felt in economies that implemented strict measures and in those where services had greater weight in the economy [42].

• The International Labour Organization reported that globally, the reduction in working hours, due to the reduction in production due to the containment measures in 2020, resulted in job losses and a reduction in working hours for those who remained employed. In total, there were unprecedented global job losses in 2020 of 114 million jobs compared to 2019. Global labour income (not considering income support measures) in 2020 is estimated to have decreased by 8.3%, which equates to $3.7 trillion, or 4.4% of the 2019 global gross domestic product using 2019 market exchange rates [44].

• The reduction of formal jobs added to restrictions on informal work, resulted according to the State of Food Security and Nutrition in the World, prepared by the Institutions: Food and

Agriculture Organization of the United Nations (FAO), International Fund for Agricultural Development of the United Nations (IFA), United Nations Children's Emergency Fund (UNICEF), World Food Program of the United Nations (WFP), World Health Organization (WHO) [46], that between 720 and 811 million people in the world faced hunger in 2020. Considering the projected, about 118 million more people faced hunger in 2020 than in 2019. Almost 12% of the global population suffered from severe food insecurity in 2020, representing 928 million people - 148 million more than in 2019 [45]. Concerning these numbers, FAO estimates that healthy diets were already out of reach for about 3 billion people, especially the poor, in all regions of the world by 2019 [45]

• In the environmental aspect, there were improvements, the pandemic provided a historic reduction in the level of CO2 in the atmosphere, that is, the reduction of CO2 generation on a global basis, largely due to the impact of the pandemic on transport. Global energy-related CO2 emissions fell 5.8% according to the latest statistical data, the biggest annual percentage decline since World War II. In absolute terms, the decline in emissions of nearly 2 billion tonnes of CO2 is unprecedented in history – broadly speaking, this amounts to removing all European Union emissions from the global total [43].

The effects of the pandemic show that the palliative measures of physical distancing of the population and interruption of trade and travel, failed to respond to the pandemic, even because of the difficulty of reaching them, but emphasizing that they attenuated the effects of mortality. It should be noted that several countries have gone through or are going through second and third waves of contamination.

The solution to the pandemic, which was developed by science in historical time, is focused on the vaccine, although the offer is currently strongly limited to some countries, the World Health Organization predicts that by the second half of 2022 the whole world will be able to access the solution [46]. [46].

1.7. Post-pandemic Energy Matrix

Even though the Covid-19 crisis is due to a new disease, to which people have no immunity, in addition to its own health impact and mortality aspects, it also triggered, mainly due to the

quarantine applied by several countries, an economic crisis comparable to that generated by World War II [52].

The economic crisis, due to its magnitude, generated impacts on the daily lives of people all over the planet, impacts that resulted, based on the analysis of the studies presented, in a significant reduction in the generation of greenhouse gases, mainly CO_2.

In view of the situation and aiming to alleviate the socio-economic implications generated by the pandemic, the world's largest economies are taking unprecedented fiscal and monetary actions in response to the depression generated by the pandemic, according to the International Monetary Fund's analysis in 2021 the global economy is ready to start the most robust post-recession recovery in 80 years [48].

Governments hope that economically aggressive actions will result in rapid recovery for their countries, even though Covid-19 will cause permanent or at least long-term economic damage to the economies of poor or emerging countries [47] [48].

The World Bank predicts that the global economy should recover by 5.6% in 2021, against a reduction of 3.5% in 2020, mainly due to the strong recovery of some important economies, in carrying out the forecast. The Global GDP will grow by more than 2% from 2019 levels [49].

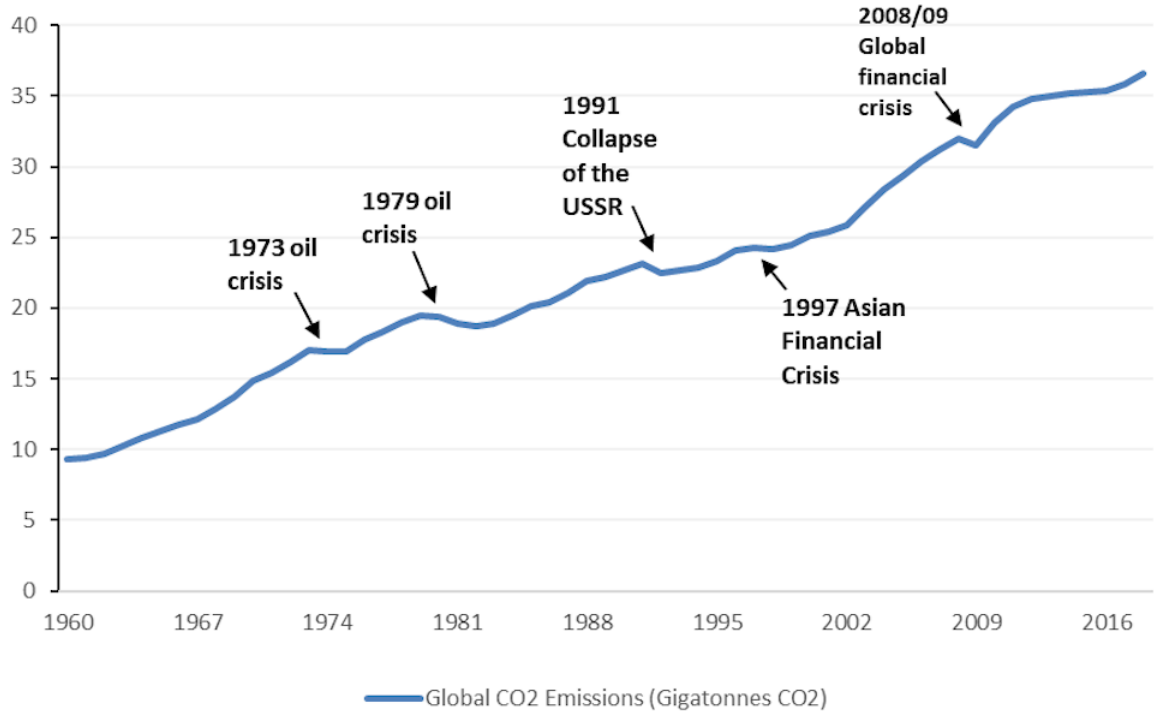
Achieving GDP growth will increase global energy demand by around 4.6% in 2021, offsetting the 2020 contraction and surpassing 2019 demand by 0.5% [43].

Demand for all fossil fuels is expected to grow significantly in 2021, this will be since the greatest increase in demand will occur in emerging markets and developing economies, the forecast for more advanced economies and a small reduction due to policies of increasing energy efficiency and reducing emissions [40], even with the main environmental indicators, worldwide, showing that our human activities must reduce the consumption of energy from fossil fuels [51].

With the increased consumption of fossil fuels, there will be a reversal of the drop in CO2 emissions that occurred in 2020 (20%), with emissions in 2021 reaching values slightly below or at the same levels of emissions as 2019 [43].

Figure 8 shows the variation in CO2 emissions generated by the major (financial) crises that occurred in recent decades, the figure indicates that during crisis there is a reduction in CO2 generation to the atmosphere, but that just after the generation curve returns to its growth trend [50].

Figure 8 – CO2 Emissions and Previous Economic Crises (OECD, 2020) [50]



(1) – 1st Oil Crisis; (2) – 2nd Oil Crisis; (3) – Collapse of the Soviet Union; (4) – Financial Crisis in Asia; (5) - Global Financial Crisis
Adapted from The Economist (2020), based on CO_2 emissions data from the Global Carbon Project. CO_2 emissions from the use of coal, oil, and gas (combustion and industrial processes).

1.8. The Antagonistic Reality of the Post Pandemic Energy Matrix

All predictions for the World reaction, in the economic and social view, the pandemic, antagonized the energy supply, a situation that proved to be greater and more impactful than the health emergency itself, which should extend the time for society's return to the usual conditions, generating an increase in inequality in the world.

The pandemic has not been stopped, although OECD countries and some others have reduced its impact, returning to almost normal living conditions, an energy crisis has now set in, which is also spreading across the world.

The spread of this energy crisis is biasedly correlated with the pandemic, analysing some of the causes, we can identify the confluence of several factors of consequence between actions, whether against the pandemic or the climate crisis and the energy crisis [53] [54] [55]:

a. Winter in much of the northern hemisphere, especially in Asia, was exceptionally cold earlier this year, followed by a cold spring in Europe, which increased demand for heating impacted both demand and supply of gas.

b. The intense cold in Texas also hampered US gas production, resulting in lower US liquefied natural gas (LNG) exports to Asia and elsewhere during the beginning of the year.

c. Unusually severe summer heatwaves and droughts in China, Europe, and the United States, and some other parts of the world have increased gas demand for electricity for cooling.

d. Potential sources of electricity generation were harmed. Wind generation (Europe and China) has been far below averaged this year due to long periods with below-average wind speeds.

e. Demand for gas and coal increased to offset the reduction in renewable energy production, pushing up prices [59] .

f. Drought conditions in China and South America have reduced hydropower production, attracting globally traded gas supplies to these markets.

g. The producers of gas, oil, and coal, in response to the record drop in prices and consumption at the height of the pandemic, have not increased, or are having trouble increase, their production in the face of increased demand.

h. The “green inflation” is due to governments restrictions on traditional energy sources to encourage renewable energy to meet global emissions targets [59].

i. China has promised an aggressive 65% reduction in its emissions by 2030 and cut coal mining sharply. The UK already relies on wind power to supply a quarter of its electricity needs, Germany having pulled another three nuclear reactors off the grid this year.

j. The push of savings towards the adoption of renewable energy has led investors to divest into traditional energy sources, the amount of divestment from 2014 to 2021 reached US$14.5 trillion [56] [57] [58].

1.9. The Development of the Concise World Energy Matrix

The situation demonstrated is not something foreign to the energy market supply or demand crises are relatively frequent, governments should avoid that in the future, people have a perception that reaching the targets for emission of effect gases greenhouse has a high economic cost.

Renewable energy sources, wind and solar, are unreliable because of the variability related to variations in climatic conditions of the seasons of the year.

To ensure the reliability of the electric power system, which permeates people's lives, the countries are forced to depend on non-renewable traditional fuels hence the need for governments to rethink their energy policy.

There is no dispute, however, that climate change generated by greenhouse gases is the reason for more extreme temperatures: hotter summers and polar cold waves. Climate change aggravates droughts, which reduce hydroelectric energy, which is now prevalent in the generation of clean electricity. Wind and solar systems also suffer with the climates change [60].

From the need to find a solution, confusing or uncorrelated actions can lead to price volatility of carbon-based fuels, which, in turn, feeds energy price volatility, feeding back the process, rather than alternatives that can reduce the gap between energy generated by non-renewable and renewable energy.

But the current situation and future recurrent ones (see Figures 2, 3, and 8), whether originated from pandemics or social or political processes, suggest, or determine to accelerate the pace of transition to clean energy.

The transition process will have unpredictable adjustments and starts, whether in economic, social, or political action, let's say, also in individual decisions about what kind of car to buy, electricity to generate, housing to build, or production industrial.

What must be understood is that to supplement and maintain the reliability of a clean energy system, we must maintain and even implement the production of energy from plants, that utilize non-renewable fuels, like guarantee against climate change.

It will be very important, however, that these non-renewable fuel plants are developed to avoid the generation of pollutants in the atmosphere, gases and particulate as much as possible, which are also greenhouse generate effects.

The thermonuclear plants are the only ones compatible with this feature, which reaffirms the importance of nuclear energy production, which has already been presented and defended in numerous studies, regarding its efficiency, it is enough to analyse that in the USA, more electricity is produced with zero carbon via nuclear power plant, than all wind turbines and photovoltaic panels put together [61] [62] [63] [64] [65] [66] [67].

2.0. METHODS

The databases used to support the article were selected from:

1) Electronic databases selected as a source of scientific data, such as Google Scholar, Web of Science and INIS. The query strategy consisted of using search tools for keywords related to the topic, with the main descriptors “pandemics and society”, “Covid-19”, “energy consumption and savings”, “energy matrix” and “electricity”. as well as others to expand the themes.

2) Other databases, such as content expressed in books, interviews with scientists and reports.

The research was carried out from December 2019 to July 2021 and based on the content analysis, the information from these documentary and bibliographic references, when they presented the same objective approach as this study, were systematized, and correlated with each other.

3. RESULTS AND DISCUSSION

The Covid-19 pandemic caused a profound reversal in the economic scenario, social isolation measures to combat the pandemic have caused severe impacts on economic activity in several countries, in addition to millions of deaths, 120 million people pushed into extreme poverty the negative impact on employment fell disproportionately on people with lower levels of education and on women, giving the first signs that the crisis will widen pre-school income inequalities - existing before the arrival of the pandemic

The predicted electricity consumption for the year is 8.5% lower than in 2019, the first drop since the 2007-2008 financial crisis. Industry and commerce consumption were the most affected sectors. The reductions in energy demand were reflected in terms of greenhouse gas emissions studied in the electricity sector and in transport. Covid-19 caused a reduction in emissions around the world; however, everything indicates that this effect will be temporary. Policies and investments in the recovery process may further influence the emissions trajectory in the medium and long term.

4. CONCLUSION

The verification of the permanent growth of CO2 generation, even after crises of economic impact, confirms that the energy matrix will not change due to the COVID-19 epidemic, decline during the acute phase of the pandemic, happened due to the economic slowdown and not a structural change in how the world fuels its cars or produces the electricity it consumes.

The current indicators of the IPCC 2021, and the climate reality that we see daily, demonstrate that our consumption of energy based on fossil fuels will have to decrease and that we depend on a policy that develops new tools and takes advantage of the existing ones, which show effectiveness in mitigating the impacts of this energy migration.

It is important to note that nuclear energy is the only one that does not generate greenhouse gases during operation, with the ability to meet and alleviate variations in energy generated from renewable energy sources, providing reliability to the system which allows the electricity generated from variable energy sources, has an important position in the world's future power generation sources portfolio.

ACKNOWLEDGMENT

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