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What Lies Ahead for Energy and Carbon Emissions Post COVID-19

A. Pourmovahed[1], Z. Veneziano[2], M. Stewart[3] and A. K. Thirumal[4]

[1] Professor of Mechanical Engineering
Phone number: +001 810 762-9758, e-mail: **apourmov@kettering.edu**

[2] Mechanical Engineering Student
Phone number: +001 810 762-9500, e-mail: **vene8996@kettering.edu**

[3] Mechanical Engineering Student
Phone number: +001 734 347-9849, e-mail: **stew9690@kettering.edu**

[4] Mechanical Engineering Graduate Student
Phone number: +001 810 282-4836, e-mail: **thir4960@kettering.edu**

Kettering University
Flint, Michigan, U.S.A. 48504

Abstract. Energy supply and demand patterns changed as the response to the COVID-19 pandemic evolved and remained uncertain. The outbreak has been a one-of-a-kind situation unlike anything seen in the last one hundred years. As a result of various measures put in place by governments, travel was vastly reduced, and air travel diminished to near zero. Consumption and the price of fossil fuels decreased significantly and hundreds of millions of metric tons of CO_2 emissions were prevented. The impact of Covid-19 on the worldwide energy industry and greenhouse gas emissions has been drastic but seemingly temporary. In 2020, wildfires in western United States more than made up for the reduction in global emissions in the first half of 2020 due to the pandemic. Renewable energy has made major advances recently, but fossil fuels still supply 84% of the global energy. Advancements in aircraft efficiency and extensive utilization of electric vehicles charged with renewable sources of electricity offer remarkable opportunities for improving our environment. Without major changes in the energy and transportation industries, greenhouse gas emissions are likely to return to their 2019 levels before long.

Key words. Energy Industry, COVID-19, Renewable Energy, Greenhouse Gases

1. Introduction

In early 2020, the world was on track to continue its CO_2 emissions into the atmosphere when due to the COVID-19 pandemic followed by an unprecedented shutdown of major industries throughout the world and a reduction in travel due to health concerns, a monumental drop in CO_2 emissions occurred [1]. Millions of professionals have been working from home since spring, 2020 and much of the world has been shopping online instead of visiting brick and mortar stores. The energy industry before COVID-19 was dominated by fossil fuels. According to [2], hydroelectric, other renewables and nuclear energy make up about 16% the entire global energy supply. Similar data from another source is shown in Fig. 1.

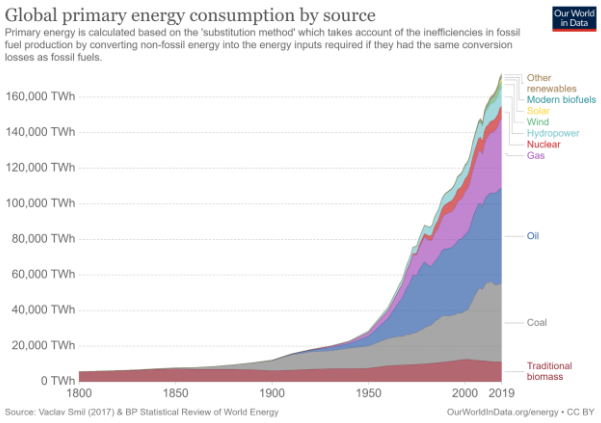

Fig. 1. Worldwide energy consumption by source [3]

To slow down and lessen the anticipated catastrophic effects of *Climate Change* on many communities, numerous countries have policy targets to reduce the amount of CO_2 - and other greenhouse gases such as methane – they emit into the atmosphere. About 200 countries are a part of the *Paris Climate Agreement.* Each country will meet certain requirements to keep the global average temperature rise well below 2, preferably to 1.5 ºC, compared to pre-industrial levels [4]. Countries have their own goals due to the different nature of their industries and challenges they face. Fig. 2 shows the goals for the major countries that were responsible for 50% of the greenhouse gas emissions (*GHG*) in 2012. The United States pulled out of the *Paris Climate Agreement* in June 2017 but rejoined in February 2021.

Carbon Brief's Paris climate pledge tracker : INDC database

Number of parties that have submitted an I/NDC	192	CARBON BRIEF'S I/NDC TRACKER	Parties that haven't submitted an I/NDC	3
Share of global emissions covered by I/NDCs	87.6%	DATA SUMMARY	Emissions not covered	12.4%

Country	Date	Summary of the I/NDC	Link to I/NDC	Share of 2012 GHG
China	30/06/2015	A peak in carbon dioxide emissions by 2030, with best efforts to peak earlier. China has also pledged to source 20% of its energy from low-carbon sources by 2030 and to cut emissions per unit of GDP by 60-65% of 2005 levels by 2030, potentially putting it on course to peak by 2027.	http://www4.unfccc.int/ndcre	23.75%
USA	31/03/2015	[The US plans to withdraw from Paris and not meet this pledge] 26-28% domestic reduction in greenhouse gases by 2025 compared to 2005, making its best effort to reach the 28% target. This includes the land sector and excludes international credits at this time. Carbon Brief has a more detailed article on the US INDC.	http://www4.unfccc.int/ndcre	12.10%
EU	06/03/2015	At least a 40% domestic reduction in greenhouse gases by 2030 compared to 1990 levels. Carbon Brief has a more detailed article on the EU INDC.	http://www4.unfccc.int/ndcre	8.97%
India	01/10/2015	A 33-35% reduction in emissions intensity by 2030, compared to 2005 levels. Also pledges to achieve 40% of cumulative electricity installed capacity from non-fossil fuel based resources by 2030. Will also increase tree cover, creating an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent by 2030. India intends to cover the $2.5 trillion cost of its pledge with both domestic and international	http://www4.unfccc.int/ndcre	5.73%

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Fig. 2. Environmental goals agreed upon at the 2015 *Paris Agreement under the United Nations Framework Convention on Climate Change* by the top 4 emitters of greenhouse gases in 2012 [5]

The renewable energy sector had seen a promising surge before COVID-19. Between 2004 and 2013, the renewable energy sector grew by 30% [6]. Most of this energy came from hydro power plants. However, the solar and wind industries are growing the fastest as shown in Fig. 3.

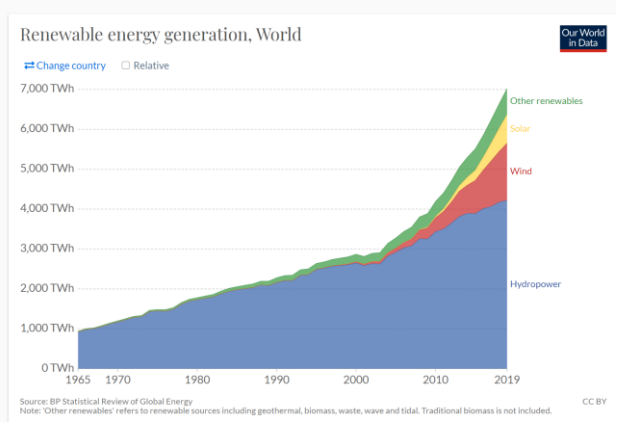

Fig. 3. World renewable energy production by source [7]

A large sector in the energy industry is the transportation sector. According to [8], [9], in 2019 this sector used 28% of the total energy consumed in the United States. The transportation industry includes automobiles, trains, boats, and airplanes. The world is expected to see a continuous increase in electric vehicle use because of policy changes and consumer choice. The current percentage of vehicles that are electric is around 3% and projected to increase to 10% in 2025 and 58% in 2040 [10].

Globally, about 90% of the total tonnage is moved by ships [11]. The shipping industry continues to increase its efficiency and is slowly incorporating renewable energy such as wind power and hybrid systems for ship propulsion [12].

Fig. 4 shows the "*efficiency*" of 14 passenger aircraft. Compared to the industry average of 31 passenger-km/L, the newly developed twin-engine aircraft are much more fuel efficient than the quad-engine larger aircraft. In 2016, on average, very large quad-engine aircraft used on transpacific flights had 24% lower fuel efficiency than aircraft with two engines [13]. This is one reason the large quad-engine aircraft are exiting the market quickly.

Fig. 4. Difference from industry average fuel efficiency (31 passenger-km/L) for 14 aircraft types used on transpacific routes, 2016 [13]

Commercial aircraft are unlikely to see a switch to a different fuel type other than biofuels any time soon. As seen in Fig. 5, CO_2 emissions of aircraft are ⅓ of what they were per passenger-km in 1970 [14], [15].

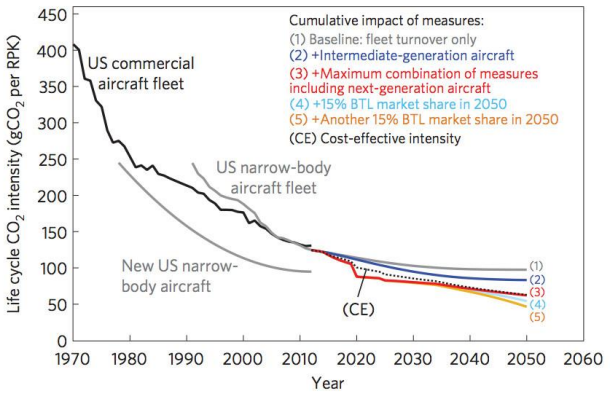

Fig. 5. Life cycle CO_2 intensity of aircraft (grams per revenue passenger km) of US commercial passenger aircraft fleet operating in domestic service (black) and of the narrow-body fleet (gray), historical development (1970–2012), and projections (2013–2050) [15]

2. COVID-19 Impact on CO_2 Emissions

In early 2020, COVID-19 swept the world quickly and eventually affected over 213 countries and territories. To contain the pandemic, many communities throughout the world imposed restrictive measures such as shelter-in-place, lockdown or stay-at-home orders. With millions of people working from home, a vast number of businesses closed, and travel paused or cancelled, not surprisingly, the impact on CO_2 emissions has been immense. This is illustrated in Figs. 6-9 [16]-[18].

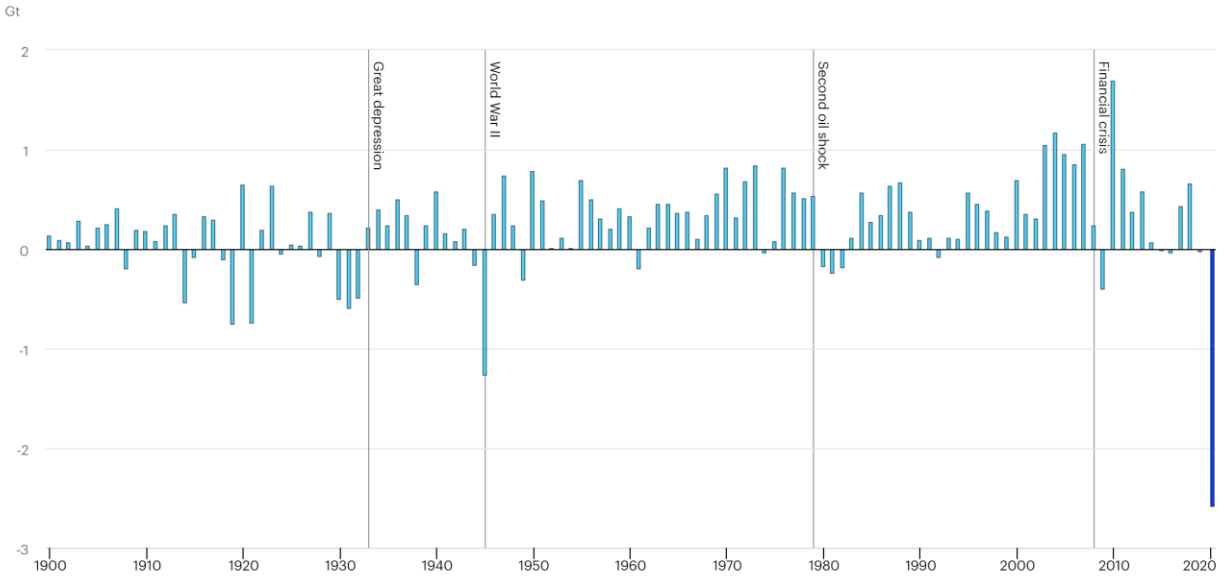

Fig. 6. Annual change in global energy-related CO_2 emissions, 1900 – 2020 [16]

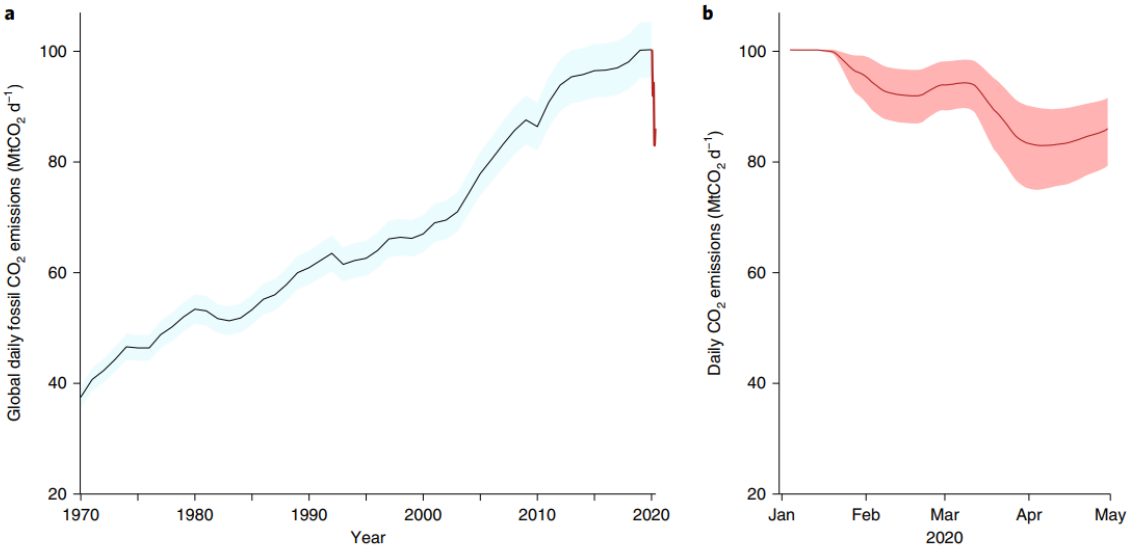

Fig. 7. Global daily fossil CO_2 emissions from 1970 to 2020 [17]

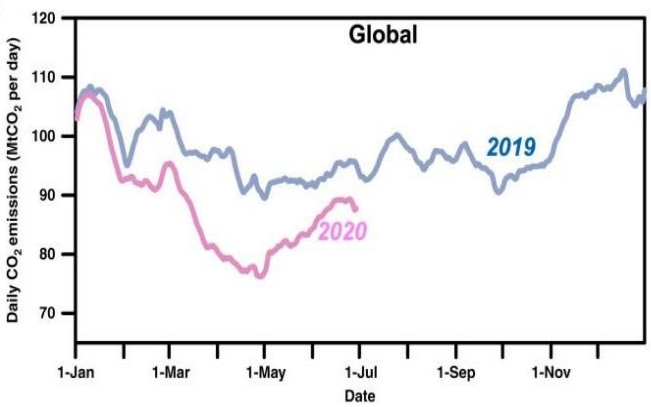

Fig. 8. Global daily CO_2 emissions [18]

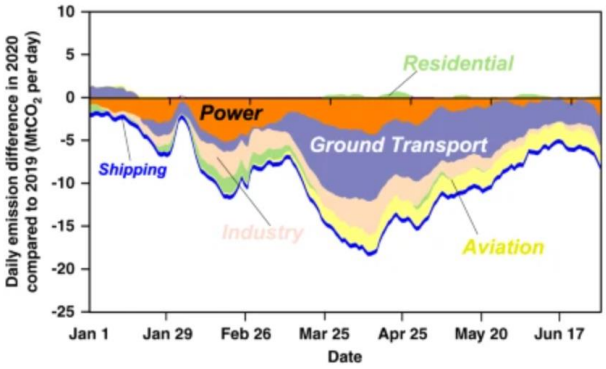

Fig. 9. 2020 daily global CO_2 emissions by sector relative to 2019 [18]

Fig. 6 shows the estimated annual change in global energy-related CO_2 emissions from 1900 to 2020. The data [16] indicates that the effect of COVID-19 on energy-related CO_2 emission reduction has been more sizable than during previous economic downturns or the *Second World War*. Global daily fossil CO_2 emissions from 1970 to 2020 [17] are shown in Fig. 7. According to [17], the daily global CO_2 emissions decreased by 17% by early April 2020 compared to the mean 2019 levels.

Fig. 8. Illustrates the global daily CO_2 emissions for the first half of 2020 and all of 2019 [18]. Global CO_2 emissions decreased by 1551 Mt (8.8%) in the first half of 2020 compared to the same period in 2019.

Fig. 9. Shows the 2020 daily global CO_2 emissions by sector relative to 2019 [18]. Restrictive measures put in place to contain COVID-19 and the slowing of economic activity and travel resulted in reduction of about 18 million tons of CO_2 emitted per day in April 2020. The ground transport sector was a major contributor to this reduction in emissions.

To put this in perspective, in the year 2020, 4.2 million ha burned in western United States due to wildfires. This translates to 896 million tons of wood burned which has produced 1.7 Gt of CO_2 [19]. This is 5% of the global CO_2 emissions from the burning of fossil fuels for energy, cement production and land use in 2017 (Fig. 10). In 2020, the wildfires in western United States more than made up for the reduction in global emissions in the first half of the year 2020 due to COVID-19.

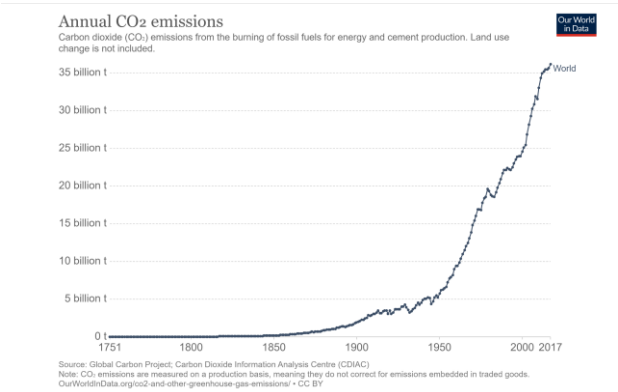

Fig. 10. CO_2 emissions from the burning of fossil fuels for energy, cement production and land use [20]

3. Covid-19 Effects on Crude Oil

In 2020, the pandemic had a severe, adverse effect on the transportation sector. The airline industry was especially impacted. As expected, this slowdown directly affected the world liquid fuel consumption as seen in Fig. 11. The steep drop began in the 1st quarter and continued until the end of the 2nd quarter of 2020. The *U.S. Energy Information Administration* forecasts for 2021 show steady recovery [21]. The energy supply and demand pattern changed as the response to COVID-19 evolved and remained uncertain. On April 20, 2020, the *West Texas Intermediate* (WTI) crude oil price dropped below zero for the first time in history. As shown in Fig. 12, the WTI crude oil price reached minus $37.63 a barrel which meant the sellers were paying the buyers to take the oil to avoid storage constraints and fees in Cushing, Oklahoma [22]. This was primarily due to the expiry of May WTI contracts on April 21, 2020 [23].

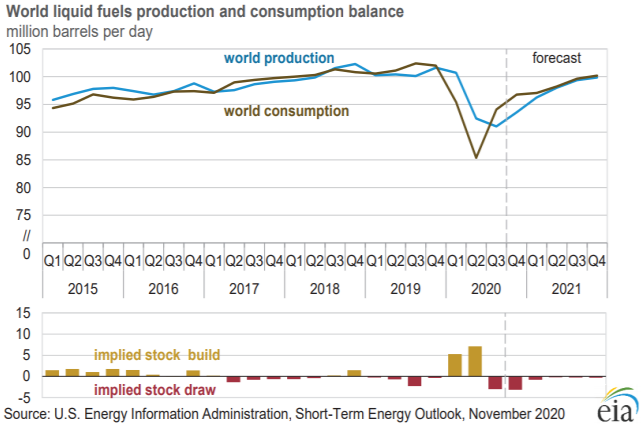

Fig. 11. World liquid fuel production and consumption [21]

In late 2020, crude oil prices had climbed back to their highest levels since early March in response to optimism caused by news of the efficacy and availability of several COVID-19 vaccines (Fig. 12).

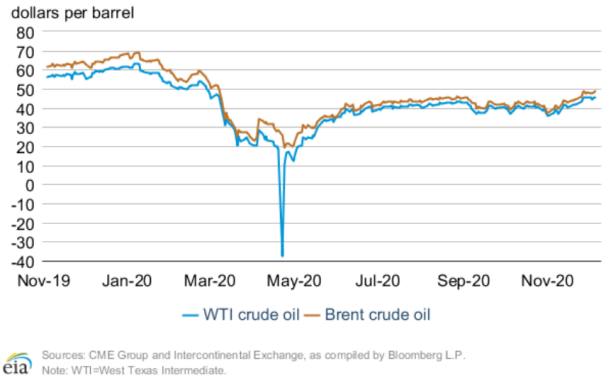

Fig. 12. Crude oil front-month futures prices [21]

Long term effects of the pandemic on the demand for oil remain uncertain but some factors point in the direction of a reduction in demand. Some of the changes in behavior and lifestyle caused by the pandemic may be permanent. Examples include food delivery, online shopping, teleconferencing and working from home. Higher fuel efficiency standards and broad use of electric cars and trucks are also likely to decrease the demand for oil in the long term [24].

4. Proliferation of Electric Vehicles

The world is expected to see a continuous increase in electric vehicle use because of changes in government policies and consumer choice. The current percentage of vehicles that are electric is around 3% and projected to increase to 10% in 2025 and 58% in 2040 [10].

Since the emergence of the Covid-19 pandemic, there has been a steep decline in the sales of gasoline and diesel cars in Europe while sales of electric vehicles have more than doubled, primarily due to government incentives. According to [25], in November 2020, one out of every 11 new cars registered in western Europe was electric.

Several States and countries are ending the sale of gasoline-powered cars before long. In September 2020, California's Governor signed an executive order to end the sale of gasoline-powered cars in the State by 2035 requiring that all new passenger cars and trucks sold in California in 2035 be zero-emission vehicles [26]. Massachusetts is another State planning to phase out sales of new gasoline-powered cars by 2035 in order to combat *Climate Change* [27].

According to [28], in Norway, the largest crude oil producer in western Europe, the market share of electric cars increased to 54% in 2020 from 42% one year earlier. With hybrid vehicles included, the share of electrified vehicles was 83%. Sizable tax incentives are used to help ensure that all new passenger cars and vans sold in Norway by the end of 2025 are zero-emission vehicles. The incentives make most electric vehicles less expensive to purchase than similar gasoline powered models. Gasoline powered and diesel cars now have a combined market share of 17% in Norway [28]. The country currently has about 10,000 publicly available charging points.

In November 2020, the United Kingdom announced that it would ban the sale of new cars running entirely on fossil fuels in 2030, five years ahead of schedule [28].

5. Setbacks in Renewable Energy

As expected, the COVID-19 pandemic has slowed down the implementation of many new green energy technologies and renewable energy projects. *The International Energy Agency* predicted 13% decline in renewable electricity capacity additions in 2020 compared with 2019 [29]. This reduction in new green energy is mainly due to governmental restrictions on travel, social distancing, shortage of available workers to install new energy systems, financing challenges as well as supply chain disruptions.

A comparison of the COVID 19 pandemic to the 2007-2008 *global financial crisis* points to challenges ahead in the effort to limit environmental emissions. The *global financial crisis* also caused similar drastic reductions in greenhouse gas emissions partly due to the retraction of the transportation industry. Slower global economy combined with high fuel prices resulted in a reduction in driving and travel accompanied by a marked decline in greenhouse gas emissions (Fig. 13).

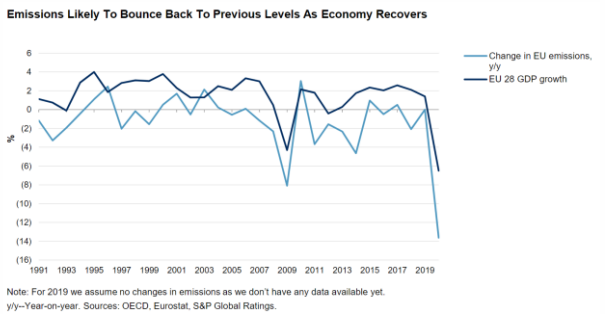

Fig. 13. Annual change in EU greenhouse gas emissions [30]

When oil prices returned to normal levels the following year, the world again saw a sharp increase in emissions back to pre-crisis levels. Likewise, to reduce the spread of the COVID-19 virus, economic activities and travel were drastically reduced if not stopped in much of the world during 2020. As shown in Fig. 13, this resulted in an even more significant reduction in emissions in the European Union.

6. Conclusions

In the first few months of 2020, COVID-19 swept the world quickly and was declared a global pandemic by the *World Health Organization* on March 11, 2020. To slow down the outbreak, many countries put in place various measures such as lockdowns, stay-at-home orders, social distancing requirements and limits on the size of gatherings. Travel was vastly reduced, and air travel diminished to near zero. Consumption and the price of fossil fuels decreased significantly and hundreds of millions of metric tons of carbon dioxide emissions were prevented in the first half of 2020. Many cities experienced periods of clean air and blue skies not seen for generations.

The impact of Covid-19 on the worldwide energy industry and greenhouse gas emissions has been drastic but seemingly temporary. In 2020, wildfires in western United States more than made up for the reduction in global emissions in the first half of 2020 due to the pandemic [19]. Renewable energy has advanced tremendously in the past two decades, but fossil fuels still supply 84% of the global energy [2]. Advancements in aircraft efficiency and extensive utilization of electric vehicles charged with renewable sources of electricity offer remarkable opportunities for improving our environment. Unfortunately, if history teaches us anything it is that without major changes in the energy and transportation industries, greenhouse gas emissions are likely to return to their 2019 levels before long.

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