

Impact of *Covid-19* on the U.S. Energy Production

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Abstract

The COVID-19 pandemic impacts exceed the world's imagination to go beyond health-related issues to impact every single aspect of our lives, including how we produce and consume energy daily. This research aims to provide an in-depth analysis of the impacts of the COVID-19 pandemic on renewable and non-renewable energy production. The study selects the United States (U.S.) due to 2020 energy data readiness at the time of the study. The U.S. energy data is mainly collected from the U.S. Energy Information Administration (EIA) from January to July 2018 to 2020, and August 2019 and 2020.. The data is analysed by thoroughly studying the energy value variations month-by-month. The study outcomes show that, as a result of the COVID-19 lockdown and restrictions on people's mobility and activities, non-renewable energy has a drastic decline, while renewable energy has significant growth. The residential sector's energy consumption notably increases with the lockdown's imposition, while the other sectors decrease. The prices of fossil fuels are slightly affected by the pandemic, where the maximum drop in prices is approximately \$24.64 for petroleum liquids.

Keywords

Energy Production, Energy Consumption, Fossil Fuel Costs, COVID-19 Impacts, Renewable Energy

1. Introduction

The covid-19 outbreak first started in Wuhan, China, and then it spread out to the entire world to be declared as a pandemic disease by The World Health Organization (WHO) on March 11, 2020 (WHO, 2020). The quick spread and risks associated with the virus forced the world to impose lockdown to contain the virus. The deadly virus impacts are not limited to severe health issues and a high mortality rate. Coronavirus effects went beyond that to affect the economy, businesses, education, lifestyle, energy, and shutting down shopping places, factories, governmental places, etc. (Bandyopadhyay, 2020). However, according to Eroğlu (2020), COVID-19 does not directly impact energy sectors regardless of the types of impact effects, but it indirectly affects energy. For instance, the global lockdown led to reducing air pollution, greenhouse gases (GHG) emission that cause the skies to be clearer, allowing for more sunlight to pass into solar farms through the atmosphere (Peters et al., 2020), and less electricity demand and consumption (Abu-Rayash et al., 2020).

Due to the continuous advancements in technology and growing industrial sectors, energy demand is always rising. Figure 1 shows the energy consumption in the year 2019 for different countries, with the top two countries being China and the U.S., with 141.1 and 94.65 exajoules, respectively (Sönnichsen, 2020). The rest of the countries demonstrate an energy consumption that is less than one quarter that of China.

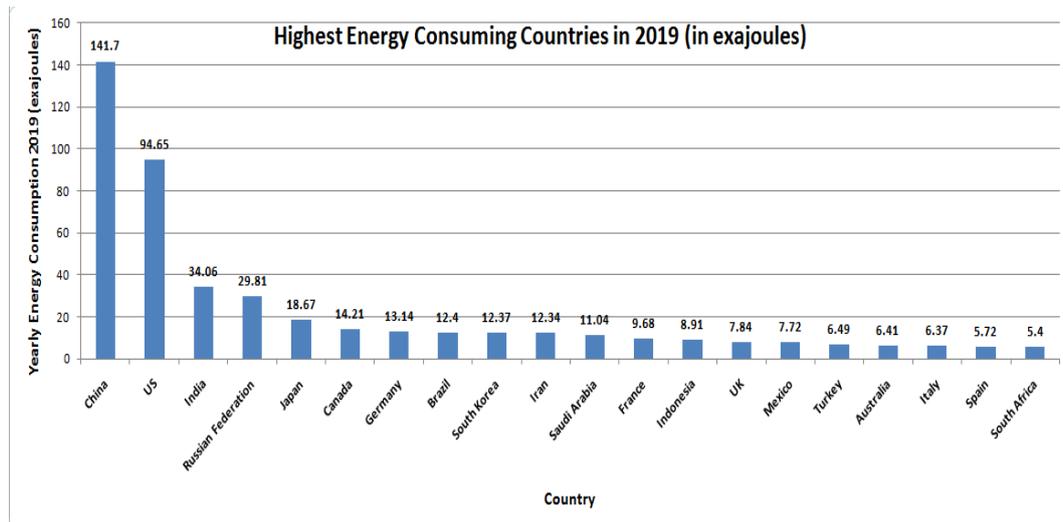


Figure 1. Worldwide energy demand in 2019

In this light, this paper's main objective is to investigate and provide an analysis on how COVID-19 impacts energy production involving renewable and non-renewable resources, energy consumed by major sectors (residential, commercial, industrial, and transportation), and the variations in fossil fuel costs in U.S. dollars.

2. Literature Review

The daily restrictions imposed on the people's mobility and activities because of Covid-19 impacted the environment and energy sector (Eroğlu, 2020). As a result of the lockdown in Barcelona, Spain, better air quality is observed (Tobías et al., 2020). This is expected since air pollution has notably reduced during April 2020 (Eroğlu, 2020; Peters et al., 2020); where the coronavirus crisis was at its peak. According to Peters et al. (2020), The PM (particulate matter) concentration dropped during the 24-hour curfew in late March to April in Delhi, India. That led to a clearer sky and higher irradiance levels; hence, 6% more sunlight hits the P.V. installation areas in Delhi. Furthermore, the lockdown caused the electricity demand to decline by 14% in April in Ontario, Canada (Abu-Rayash et al., 2020). Based on Ontario's electricity data, it is worth noting that the pandemic has also resulted in reciprocating electricity demand throughout the week; the lower electricity demand is on the late weekdays (Wednesday to Friday) and weekends which was not the case before the pandemic.

The Covid -19 virus has also significantly influenced the world's energy sectors, including non-renewable and renewable energy sources. According to data from the International Energy Agency (IEA), the global total energy demand is projected to fall by a net figure of 6.1% (Sönnichsen, 2020). It should be noted that the figure is subject to change as it is highly dependent on how the virus will spread and affect the world in the remainder of 2020. Moreover, the year 2020, when compared to 2019, will witness an approximate drop in the demand for oil of 9.6 million barrels per day worldwide (Sönnichsen, 2020). Besides, coal power generation has drastically dropped in several countries like the US, India, Italy, South Korea, and China by 40%, 31%, 20%, 11%, and 9%, respectively, as a result of the waning demand for electricity [8]. The plummet in demand was mainly observed between January and April, depending on when the lockdown was enforced in each country.

The United Nations (U.N.) has set a promising blueprint represented in a set of sustainable development goals (SDGs) aiming towards a brighter future for the world. The SDG7 aims to "ensure access to affordable, reliable, sustainable, and modern energy". Birol (2020) claims that investments in clean energy are also affected by the virus outbreak. According to Eroğlu (2020), countries have second thoughts regarding the incentives meant for clean energy, and instead, they focus on investing in fighting Covid-19. Hence, countries have become more cautious about how and where they spend their money; especially after the International Energy Agency advised them to take precautions to avoid falling into a financial crisis (Birol, 2020). Consequently, Eroğlu (2020) speculates that there will be a severe reduction of current and ongoing renewable energy investments caused by the postponement and lack of incentives from the governments in 2020.

In this study, the impacts of the Covid-19 pandemic on USA renewable and non-renewable energy production, energy consumption by diverse U.S. sectors, and fossil fuel costs are analyzed in-depth using energy data collected from the U.S. Energy Information Administration. The sections of this paper are organized as follows: introduction, previous work, methodology, results and discussion, conclusion, and lastly, the list of references.

3. Methods

This research uses quantitative U.S. energy data amassed from Independent Statistics & Analysis, U.S. Energy Information Administration (EIA) to study the impacts of the COVID-19 outbreak on USA energy production, consumption, and cost. From January to July 2018 to 2020 for energy production and consumption, the study period is August 2019 and 2020 for fossil fuel prices. The choice of U.S. energy data over others is due to the availability of 2020 energy data by the time this research is conducted. There are four energy data sets downloaded in an excel sheet format from EIA containing production of all types of USA renewable energy sources; biogas, biomass, solar, wind, etc., primary non-renewable energy sources; coal, crude oil, natural gas, and fossil fuels. Also, energy consumption by the residential, commercial, transportation, and industrial sectors are gathered along with costs in U.S. dollars for some primary energy resources. The analysis is based on studying the value and pattern variations in 2020 months to the corresponding months in 2018 and 2019.

4. Results and Discussion

4.1 Covid-19 Impacts On USA Energy Production

In this section, the impact of Covid-19 on USA renewable energy production compared to non-renewable production energy is studied from 2018 to 2020. Figure 2 depicts the output of the USA for the primary non-renewable energy sources, which are coal, crude oil, natural gas, and fossil fuels for the years 2018 to 2020. The blue line represents 2018, and the red line is for 2019. The non-renewable energy production increases in all months of 2019 relative to 2018. While in 2020, represented by the green line, an increase in the first three months of 2020 is noticed. From late March, which is the beginning of quarantine in the USA, there is a sharp decline in production until approximately May. At some points, the 2020 production is way less than the 2019's, and it even has the lowest production from late April till July compared with the two previous years. When the full lockdown was gradually lifted in June, growth in 2020 production was noticed.

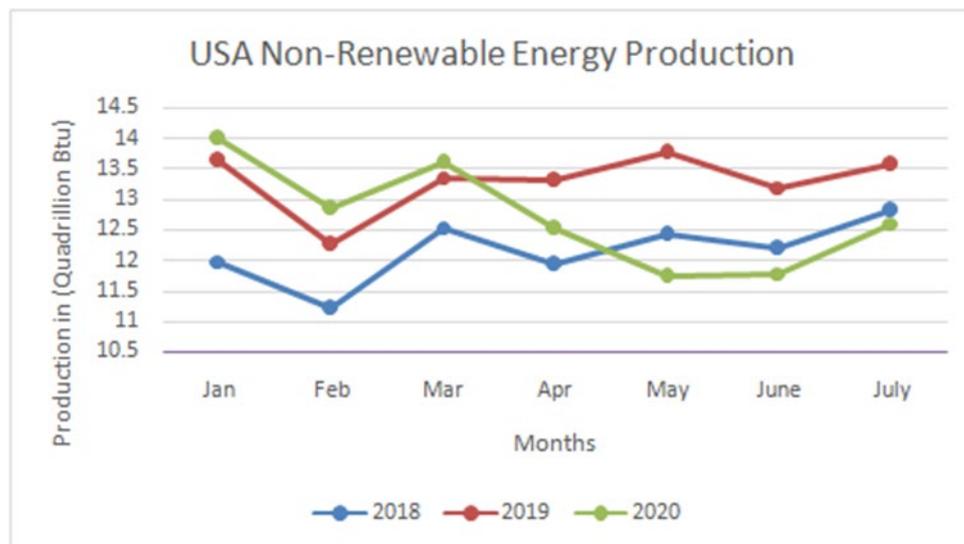


Figure 2. Non-renewable energy production in the USA – 2018 - 2020.

Figure 3 shows the percentage differences in USA non-renewable energy production between every two consecutive years; 2018 and 2019, and 2019 and 2020. The 2018-2019 production difference represents the blue line, and overall, there is a higher energy production during the 7 months in 2019 to the relative dates in 2018. For example, the production in January 2019 is higher by 13.79% than in January 2018,

and then it starts to drop rapidly to reach 6.5% in March, but it is still higher and never reaches the point of equal or less production. On the contrary, the production percentages of 2020 compared to 2019 in red color are way less at some points during the lockdown months. Such as in May 2020, the non-renewable energy production is less by 14.8% than May 2019 production. This drop-in production is a result of shutting down some factories and industries that contribute to either energy production or huge energy consumption. Besides, closing markets, business places, transportation, and governmental places that also usually consume a big portion of energy.

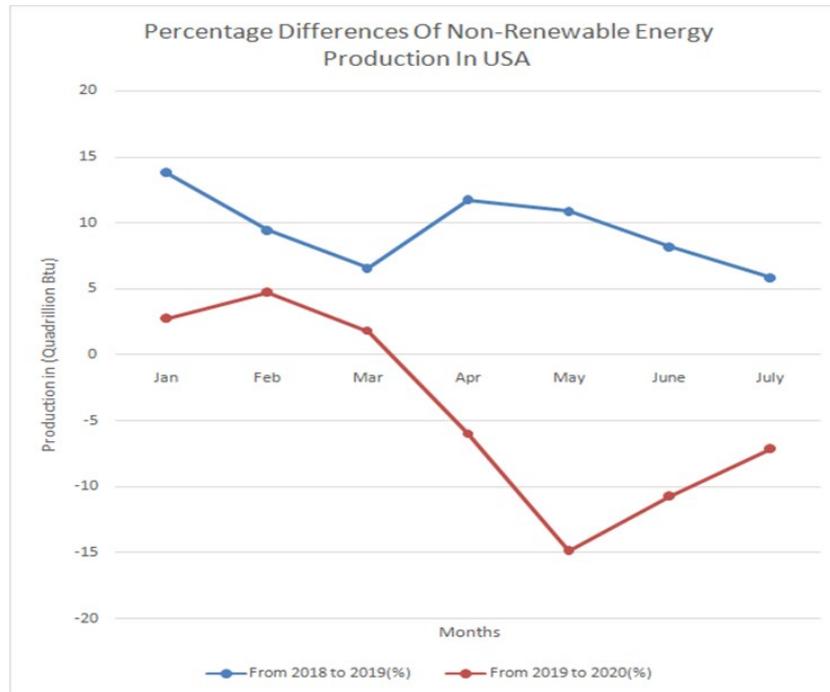


Figure 3. USA production differences in (%) for 2018-2019 and 2019-2020.

Despite the decrease in the USA's non-renewable energy production, renewable energy seems to be less affected by the novel crisis. According to the International Energy Agency (IEA) (2020), renewable energy generation worldwide increased by 3% in the first quarter of 2020 compared to the same months in 2019. IEA justifies the increase by stating that it is due to the solar and wind projects completed by the end of 2019, and renewable energy sources are not affected by the electricity demand reduction. Figure 4 supports what was stated by IEA and shows a rise in the 2020 U.S. renewable energy production by almost more than double the 2018 and 2019 productions. The production went from approximately 400 quadrillion Btu in 2018 and 2019 to nearly 1000 quadrillion Btu in 2020 throughout all months. Where Btu stands for British Thermal Unit, and 1 quadrillion Btu equals 1.055×10^{18} Joules in the International System of Units (S.I.). More interestingly, 2020 renewable energy production is still higher than the two previous years' production.

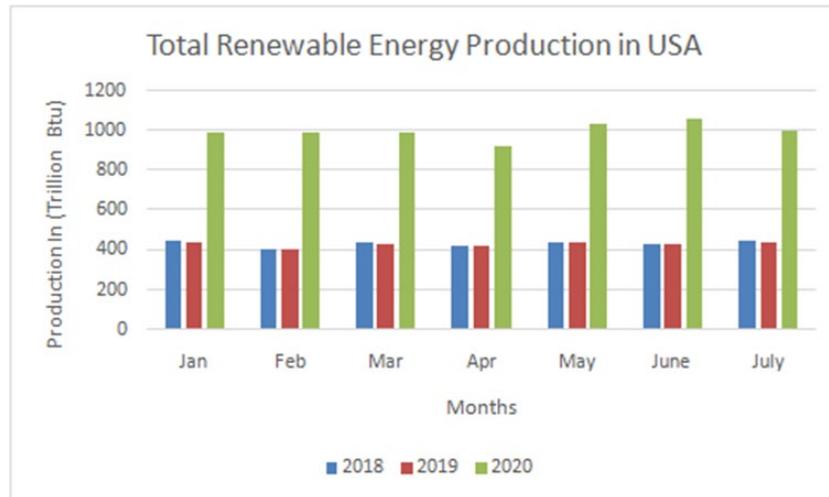


Figure 4. Renewable energy production in the USA.

Another effect to be taken into consideration is the significant drop in all the transportation means, including but not limited to, aviation and other various forms of vehicles. This occurrence has also caused instabilities in the different parts of the energy sector, particularly the manufacture and prices of oil. Figure 5 demonstrates how the primary energy demand for different energy sources was affected. The sharpest decline has taken place in both oil, with a 9.1% reduction, and coal, with a 7.7% reduction (Sönnichsen, May 2020).

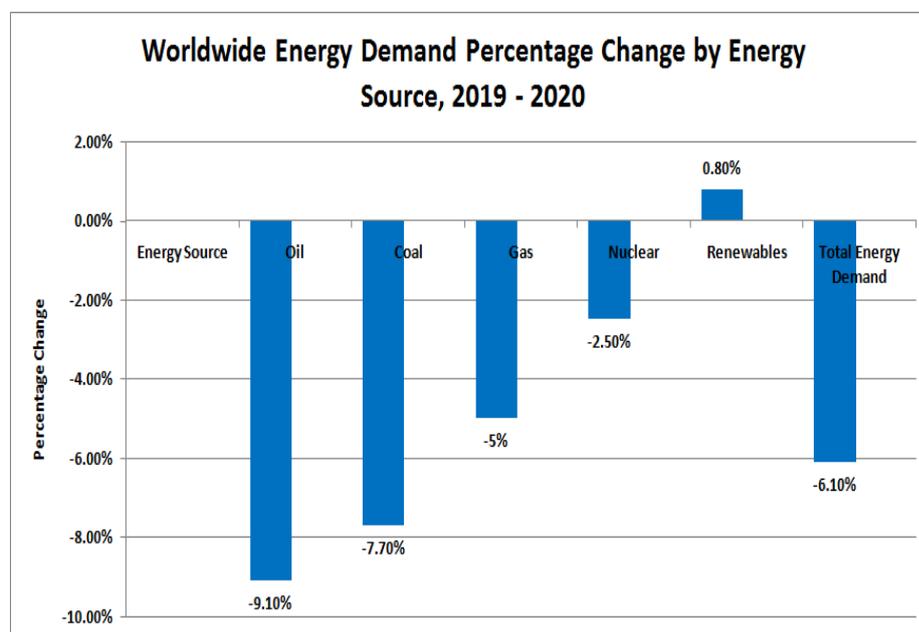


Figure 5. The worldwide energy demand percentage change by energy source, 2019 – 2020

4.2 Covid-19 Impacts On Energy Consumption by Sector

This research investigates which USA sectors have been affected by COVID-19 and which ones show resilience against the virus impacts in terms of energy consumed. The selected sectors for this study are USA residential, commercial, industrial, and transportation sectors. With many industrial sectors and businesses forced to halt their activities to combat the spread of the virus, the energy demand in various sectors of society has seen a significant alteration. As people were forced to practice social distancing, over a billion students, from both schools and universities were forced to resume their education at home through online platforms ("Everyone Included: Social Impact of COVID-19", 2020) . Simultaneously, with many companies and businesses shutting down, employees were forced to rely heavily on telecommunication means. As a consequence of these staggering developments, energy consumption in

residential sectors has shown a sudden spike as opposed to industrial, commercial, governmental, and education sectors, which have witnessed a never before seen plummet in energy demand. As evident in figure 6, daily residential use in the U.S. has revealed a rise of about 6%-8% in energy consumption, which would be easily eclipsed by a projected drop in the education and commercial sectors that lies in the 25%-30% range (Sönnichsen, March 2020).

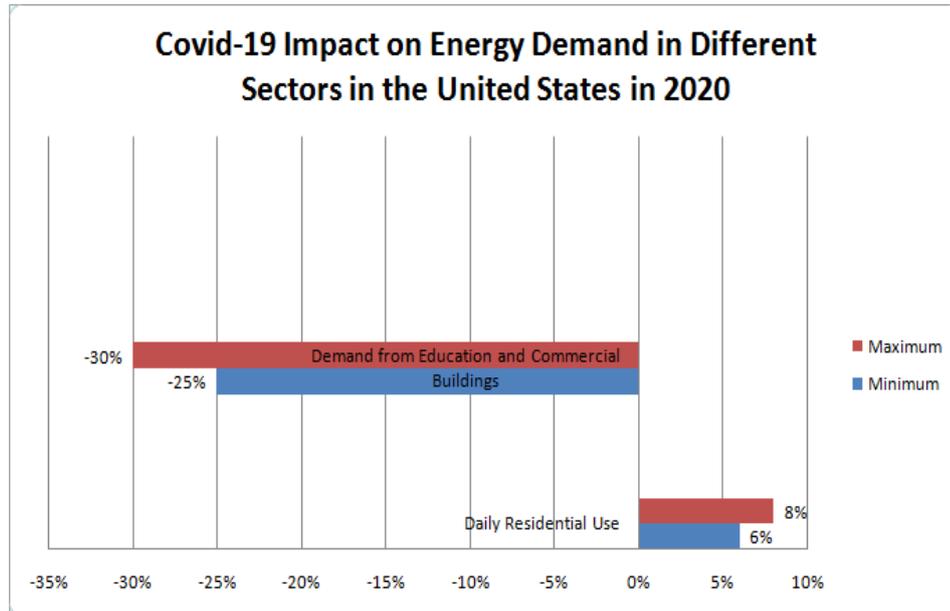


Figure 6. Change in energy demand in different sectors in the USA in 2020

Figure 7 depicts the USA energy consumption variations in 2020 relative to 2019 in percentage from January to July. From this figure, it is crystal clear that the transportation sector, represented in yellow, is the most affected one by the lockdown imposed in the USA in response to the COVID-19 outbreak. The transportation sector has a huge reduction in 2020; especially in April when the consumption reaches 32.57% lower than 2019's consumption. USA commercial and industrial sectors, represented in red and green, respectively, show a decrease in 2020 energy consumption. However, it is less severe than transportation. The commercial sector has lower 2020 energy consumption than the previous year's consumption to hit its minimum in May by 14.8% less consumption. The industrial sector starts to decline energy consumption approximately in March when it has -12.35%, where the minus indicates that it is lower than the energy consumption in 2019. The U.S. residential sector shows lower consumption in the first quarter of 2020 compared to the first quarter of 2019. Then, residential sector's energy consumption rises from almost late March to July exceeding 2019 energy consumption to be the most resilient one out of the four sectors.

The considerable drop in the sector's energy is due to the lockdown that limits America's massive population mobility. Which reduces their energy consumption in non-residential facilities, but consequently, increases the energy consumption in residences. For the commercial and industrial sectors that have a less intensive decline, this is because of a food supplying shops, supermarkets, pharmacies, hospitals, power providing companies, medicine factories, etc., that were still running during the lockdown.

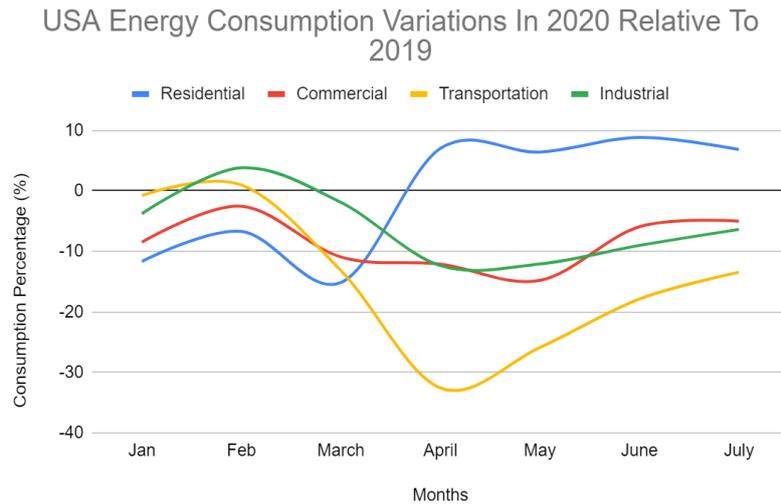


Figure 7. USA's primary energy consumption by sector.

4.3 Covid-19 Impacts On Fossil Fuel Costs

Furthermore, the impacts of the novel coronavirus on fossil fuel costs for electric power; coal, petroleum liquids, petroleum coke, and natural gas, are studied in this part of the research by thoroughly examining the costs in U.S. dollars (\$) per physical unit of August 2020 compared to August 2019. In August for the two consecutive years, the fossil fuel costs in U.S. dollars are displayed in the bar chart in Figure 8. A thousand tonnes of coal cost drops nearly by \$2 in August 2020 than what it was in August 2019. The cost of 1000 barrels of petroleum liquids in 2020 is \$59.83, which is lower than \$84.7; the cost in 2019. Hence, petroleum liquids have the most price decline among all. On the other hand, the petroleum coke cost increases roughly by \$2, and the natural gas is almost the same since the decrease is only \$0.03. Therefore, the impacts of COVID-19 on fossil fuel prices are not that huge compared to the effects on energy production and consumption.

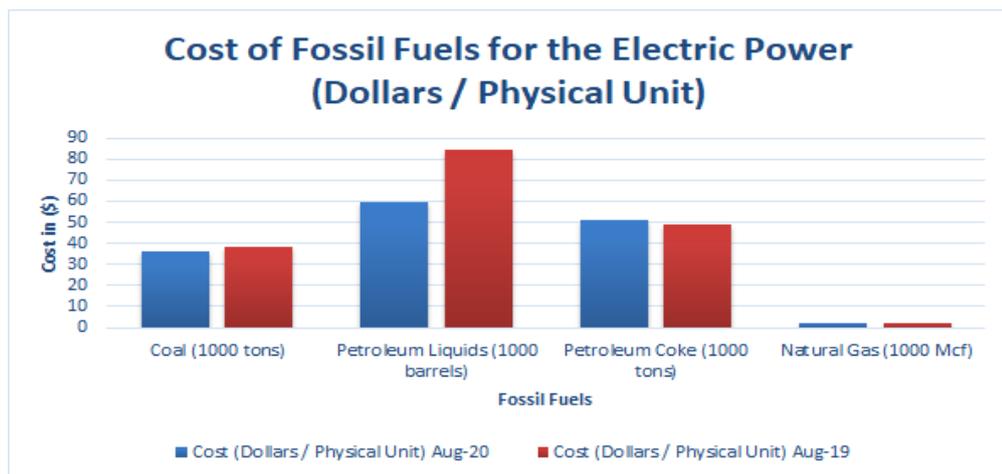


Figure 8. Fossil fuel costs in August 2018 and 2019.

5. Conclusion

This research paper examines the impacts of the novel coronavirus on energy production, energy consumption by sector, and fossil fuel costs. The study uses USA energy data collected from EIA, for the first seven months of 2018 to 2020, and August 2019 and 2020's fuel prices. The study outcomes show that the lockdown and restrictions on the population's mobility and activities as a response to the COVID-19 pandemic have prominent impacts on energy. The overall U.S. non-renewable energy production drops in 2020 to be even less than 2018's production at some points. Nonetheless, the production of renewable energy production increases by more than 100% of the previous years' production. That is due to the various renewable energy projects completed just before the pandemic. The energy consumed by the residential sector starts to rise with

the beginning of the lockdown and the new remote lifestyle. While the other sectors show a decline in consumption as a result of this sudden change. No huge difference in fossil fuel prices before and during the pandemic is noticed, except that petroleum liquids' cost falls by \$24.64 in August 2020. Overall, the study's results show that, the less human mobility, the less energy production and consumption the world needs, which supports the idea of distance work and education. The impacts of COVID-19 on energy production and consumption after COVID-19 ends is what the researchers must start to look into. It is expected that the energy production and consumption during weekdays after the pandemic will be less than the time before COVID-19 because of the new habit of having online work, activities, and study that leads to less mobility, and facility usages.

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Biographies

Rawan Asfour is currently pursuing her Master's degree in Renewable Energy Engineering at Effat University, Saudi Arabia. Rawan received her Bachelor of Science degree in Electrical and Computer Engineering from Effat University in 2020. She worked in the I.T. department, Electrical Hebron company, and Effat university maintenance department in 2018 and 2019 respectively. Her research interests are renewable energy sources including solar and wind energy.

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