



### Research Article

## EFFECTS OF 2019 NOVEL CORONAVIRUS (COVID-19) OUTBREAK ON GLOBAL ENERGY DEMAND AND THE ELECTRICITY PRODUCTION WITH RENEWABLES: A COMPREHENSIVE SURVEY

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### ABSTRACT

The main purpose of this work was to survey the effect of pandemic COVID-19 on global energy demand and electricity production with Renewable Energy Sources (RES). The comprehensive survey showed that electricity city production with non-renewables such as coal and oil decreased, resulting in a reduction of coal demand and CO<sub>2</sub> emissions. Additionally, the global energy demand enormously declined at worldwide and the European Countries that have been affected the most because of the appearance of a huge amount of COVID-19 confirmed cases and deaths such as Italy (at the regional level and national), Spain, France, the United Kingdom, and the United States. On the other hand, statistically significant results indicated that electricity production in conjunction with RES especially including solar and wind energy increased pronouncedly. Notwithstanding the short-term period of the pandemic of the COVID-19 outbreak, there would be still a great interest in green energy and this pandemic would not have much impact on the long-term trend of Renewable Energy growth.

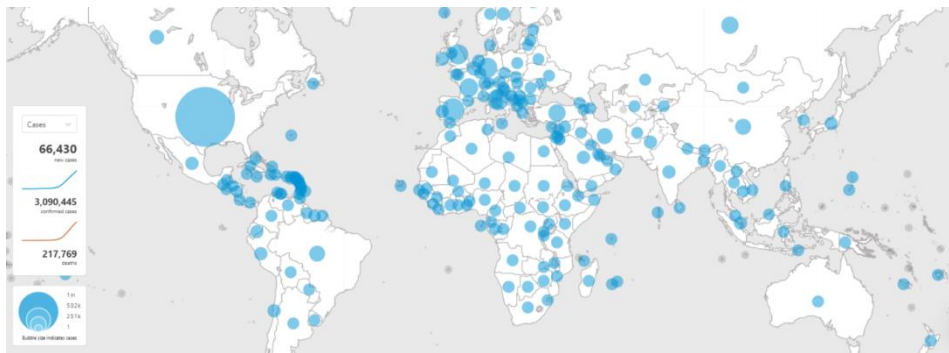
**Keywords:** Coronavirus, COVID-19, pandemic, energy demand, renewable energies.

### 1. INTRODUCTION

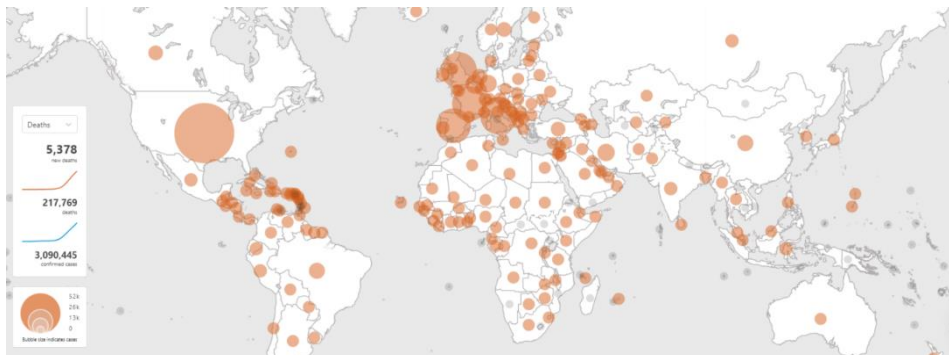
A novel coronavirus in humans which caused acute respiratory syndrome was identified by Chinese researchers in December 2019, and it was officially named coronavirus disease (COVID-19) in the literature as of February 11, 2020 [1]. Before Wuhan in the Hubei province defined as the epicenter of COVID-19 was cut off on January 23, 2020, the first death on January 11, 2020, was declared by Chinese reporters [2]. COVID-19 did not stay in being regional and it had spread to the European continent, resulting in the first death of Italy on February 21, 2020, and it was then declared as 'pandemic' by the World Health Organization (WHO) on March 11, 2020 [3]. Hence, Italy was the first country among European Countries facing serious and fatal problems and a huge amount of death because of pandemic COVID-19, followed by Spain, France, England, and Germany, respectively [4].

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As of May 1, 2020, COVID-19 confirmed cases surpassed 3,090,445 worldwide with 217,769 deaths as seen in Fig. 1 and Fig. 2, respectively [5]. According to the blue bubble size in Fig. 1, the United States had the most confirmed cases, almost half of which were in New York. Many countries took the precautions to hinder the spread of the COVID-19, mainly consisting of borders closing, schools-universities closure, flight restrictions, compulsory mask use in public areas, shutting down restaurants and cafes, self-isolation at first and restriction of movement afterward (especially at groups over 65 years old and less than 20 years old in Turkey) and the implementation of weekend lockdowns. The International Monetary Fund (IMF) declared that they had the tools to help the countries because of pandemic COVID-19 on March 10, 2020 [6]. Apart from international foundations, countries helped each other. Turkey had so far delivered aid to at least 57 countries around the globe to help their fight against COVID-19 outbreak in conjunction with the aid packages including testing kits, medical masks, protective overalls, gloves and disinfectants [7].



**Figure 1.** Worldwide map of COVID-19 confirmed cases by country (as of May 1, 2020)



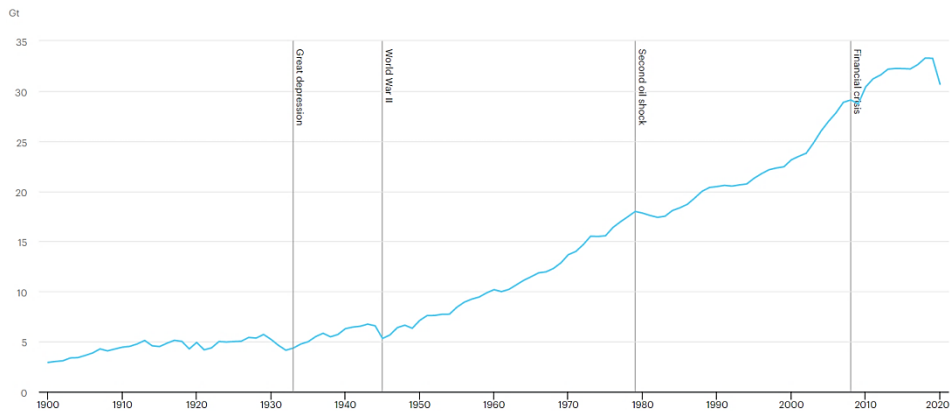
**Figure 2.** Worldwide map of COVID-19 death cases by country (as of May 1, 2020)

In this pandemic crisis, all forces including high oil prices, environmental crises, and increasing energy demand were weakened by COVID-19. The economic growth reversed toward a worldwide recession. Consequently, the energy demand reduced, leading to a surplus in oil production and reduced price. In addition, with the slowdown of economy and transportation, global warming and air pollution might lose their positive reasoning for Renewable Energies (RE). The question was that what would be the impact of these all on RE. This study examined

the effect of pandemic COVID-19 on energy demand and RE development for countries all over the world.

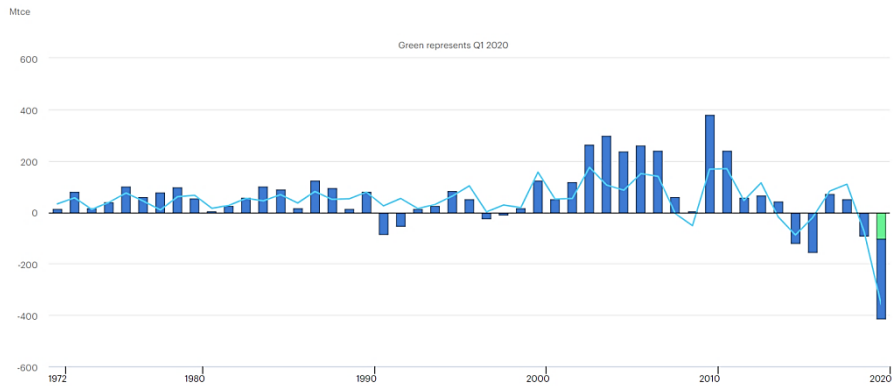
## 2. ENERGY BALANCE

The COVID-19 pandemic outbreak represented the biggest shock effect to the global energy system in more than seven decades, with the drop in demand this year set to dwarf the impact of the 2008 financial crisis and result in a record annual decline in carbon emissions of almost 8% as illustrated in Fig. 3 [8]. This figure showed that the International Energy Agency (IEA) ensured an almost real-time view of the COVID-19 pandemic's extraordinary impact across all major fuels. Furthermore, mainly the declines in coal and oil use – global energy-related CO<sub>2</sub> emissions were set to fall by almost 8% in 2020, reaching their lowest level since 2010. This would be the largest decrease in emissions ever recorded – nearly six times larger than the previous record drop of 400 million tonnes in 2009 that resulted from the global financial crisis.



**Figure 3.** The global energy-related to CO<sub>2</sub> emissions between 1900 and 2020 years

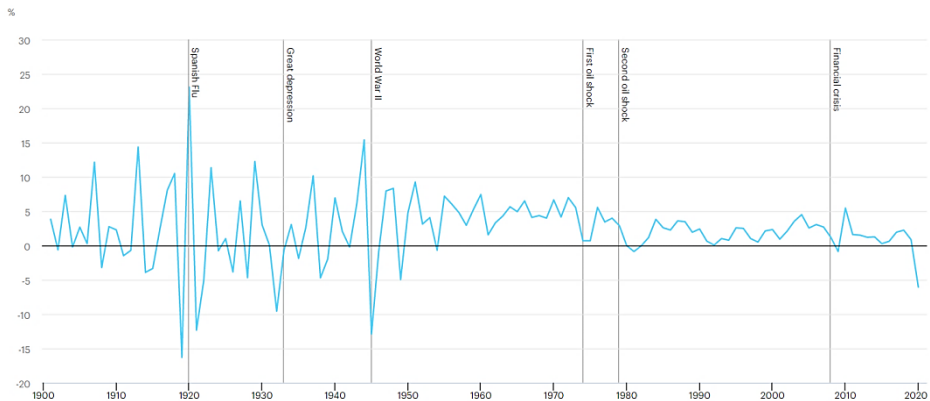
The annual change in coal demand between 1971 and 2020 years was denoted in Fig. 4 [8]. Coal is particularly hard hit, with global demand projected to fall by 8% in 2020, the largest decline since World War II. Following its 2018 peak, coal-fired power generation was set to fall by more than 10% this year. It was speculated that the decreasing of the coal demand would be around 400 Mtce, resulting in the lowest peak in coal demand. This inherently caused electricity production from coal to decrease gradually.



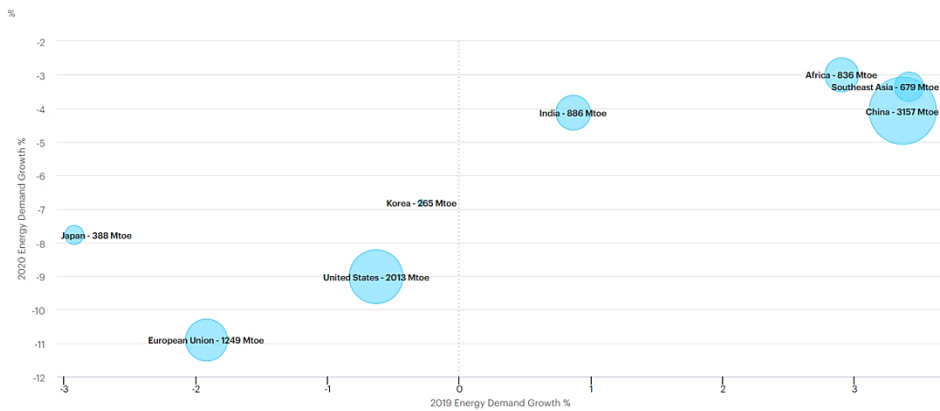
**Figure 4.** The annual change in coal demand between 1971 and 2020 years

### 2.1. Energy Demand

Regarding the rate of change of global primary energy demand between 1900 and 2020 years, it was clearly seen in Fig. 5 [8] that the rate of change fluctuated. Between Spanish Flu in 1920 and World War II, the rate of change exhibited different characteristics. The top peak was observed at Spanish Flu, whereas World War II caused the peak to be the lowest value. It was also clearly observed that the trend of the rate of change was a positive region, meaning that energy demand did not notably decrease between 1945 and 2018 years. But, the appearance of the pandemic COVID-19 caused the curve to be a negative region, resulting in the presence of lower energy demand.



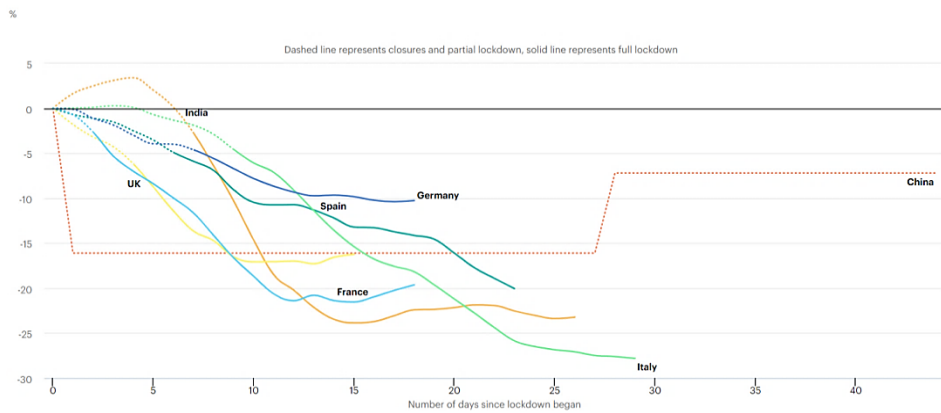
**Figure 5.** The rate of change of global primary energy demand between 1900 and 2020 years



**Figure 6.** Energy demand growth by region in 2019 and 2020

The energy demand growth by region in 2019 and 2020 was evaluated in Fig. 6 [8]. Energy demand was set to decline in all major regions in 2020. Demand in China was projected to decline by more than 4%, a reversal from average annual demand growth of nearly 3% between 2010 and 2019. In India, energy demand would decline for the first time, following on from low demand growth in 2019. However, it is advanced economies that would experience the greatest declines in energy demand in 2020. In both the European Union and the United States, demand in 2020 was most probably to fall around 10% below 2019 levels, almost double the impact of the global financial crisis. That is, during the COVID-19 period, the sharp decrease was observed in United States, Japan, Korea, and European Unions, whilst a pronounced increase emerged with India, Africa, Southeast Asia, and China. This showed that the energy demand growth was less than 0 in the countries facing crucial issues and a large amount of death due to pandemic COVID-19 especially in the United States and European Unions.

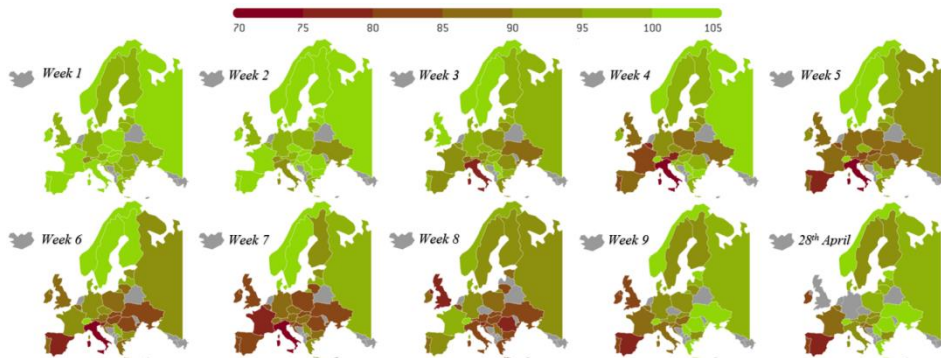
As demonstrated in Fig. 7 [8], the global electricity demand decreased by 2.5% in Q1 2020, though lockdown measures were in place for less than a month in most countries. As the first to implement containment measures, in mid-January, China was experienced the world's largest demand reduction in Q1 2020, of 6.5%. Its impacts were more limited in other parts of the world, where restrictions began in March and were progressively introduced. Electricity demand fell by 2.5% to 4.5% in Europe, Japan, Korea, and the United States in Q1 2020 relative to Q1 2019 because of the huge percentage of the appearance of COVID-19.



**Figure 7.** Reductions in electricity demand after implementing lockdown measures in selected regions

### 2.2. The electricity consumption

Regarding the electricity consumption relative to 2019 for European Countries, it was seen in Fig. 8 [9] that the electricity consumption exhibited sharp changes especially for the countries struggling with COVID-19 such as Italy, Spain, and France. In Italy, the change in electricity consumption was 1% in Week 1 of COVID-19 appearance, and it was observed that the consumption decreased to 6% in Week 2. Furthermore, it reached its peak value of 21% in Week 3 during which Italy had its first death. Similar to Italy, Spain and France lived the same scenarios in terms of electricity consumption. The change in electricity consumption was around 2% in Spain and France at first, and it attained 15% and 22% reductions in France and Spain at the end of Week 5, respectively. Hence, this graph indicated that the pandemic enormously affected the electricity consumption of European Countries.

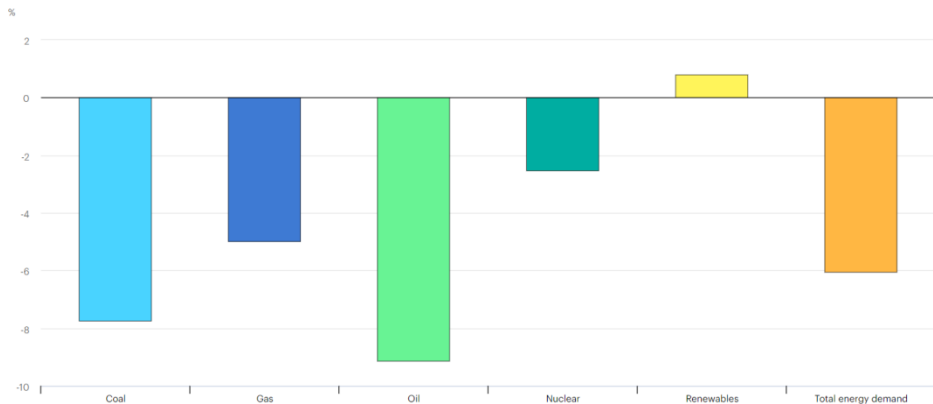


**Figure 8.** Electricity consumption relative to 2019 for European Countries

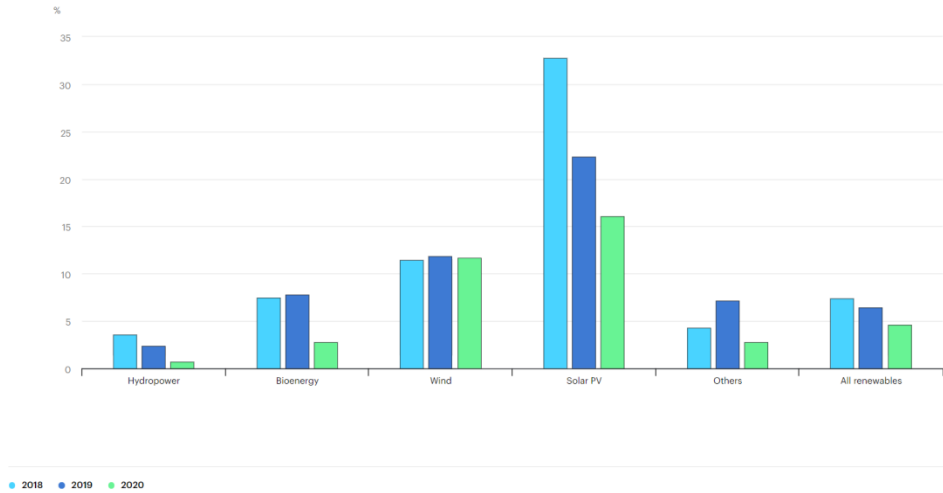
### 2.3. The role of renewables and others

On the other hand, all fuels except for renewables were set to experience their greatest contractions in demand for decades as shown in Fig. 9 [8]. In some cases, annual declines would be stronger than those in the first quarter. Coal demand could decline by 8%, in large part because

of a fall in electricity demand of nearly 5% over the year, pushing down output from coal-fired generators by more than 10%. The recovery of coal demand for industry and electricity generation in China limited the global decline in coal demand. Gas demand across the full year could fall much further than in Q1 2020 owing to reduced demand in power and industrial applications. Oil demand dropped nearly by 9% on average across the year, returning oil consumption to 2012 levels. Nuclear power demand could also fall in response to lower electricity demand. However, RES demand was expected to increase because of low operating costs and preferential access to many power systems as illustrated in Fig. 10 [8]. Recent growth in capacity, with some new projects coming online in 2020, would also boost output. Biofuels, however, was most probably to see demand decline, directly impacted by lower transport activity. RES demand increased by about 1% from 2019 levels, in contrast to all other energy sources. Renewable electricity generation grew by nearly 5% despite the supply chain and construction delays caused by the COVID-19 pandemic crisis. In doing so, renewables almost reached 30% of electricity supply globally, halving the gap with coal (from 10 percentage points in 2019). Overall, renewables growth was more sluggish than last year but in line with the general slowing trend since 2016. The output of hydropower remained the largest uncertainty in 2020, as it accounts for almost 60% of all renewable generation globally and is dependent on rainfall and temperature patterns.



**Figure 9.** Projected change in primary energy demand by fuel in 2020 relative to 2019



**Figure 10.** Annual growth for renewable electricity generation by RES, 2018-2020

#### 2.4. The situations in Turkey

After the Covid-19 outbreak, it affected Turkey with a big percentage. Fig. 11 demonstrated a summary of the timeline of the Covid-19 pandemic in Turkey. Turkish Government started with installing thermal cameras in major airports in the last weeks of January. The flight cancellation occurred in the first week of February. Two-week quarantine for international travelers was introduced on 11 March as the first confirmed case was announced. Schools were closed, mass prayers were suspended especially at mosques, restaurants, cafes, sports and cultural facilities halted their activities, all large events were canceled. Travel was restricted. Except for returning citizens, intercity buses, and trains, the borders were closed on 27 March. Neither entry nor exit was allowed for the residents of 31 large cities.



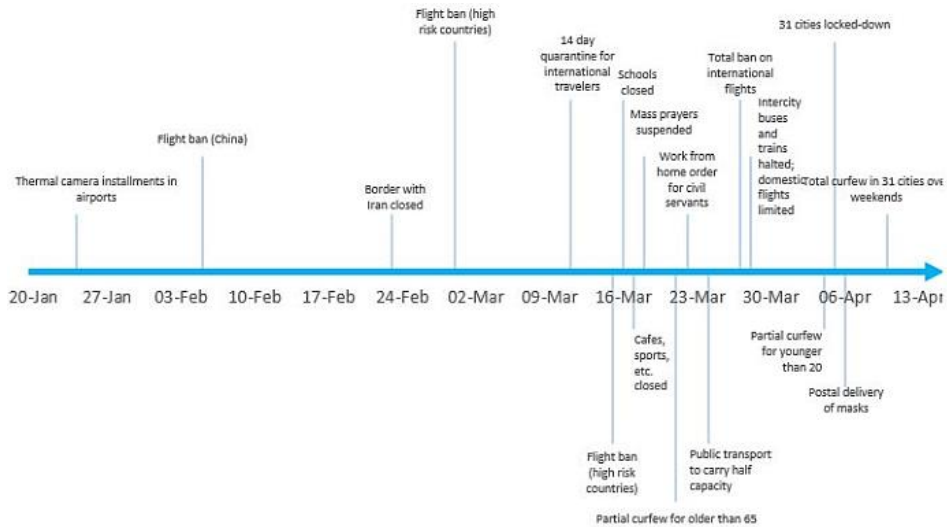


Figure 11. Timeline of Covid-19 pandemic in Turkey [10]

Regarding electricity consumption, the daily change of peak-time electricity consumption during the COVID-19 crisis compared to 2019 as illustrated in Fig. 12. It was seen that a fluctuation with the decline occurred between February 10 and March 23. The lowest point was reached in mid-April, indicating that production dropped to 74% of 2019 levels. Afterward, there was a recovery period in the second half of April extending to early May. Indeed, by 7 May, production in 2020 has bumped up to 92% of that in 2019.

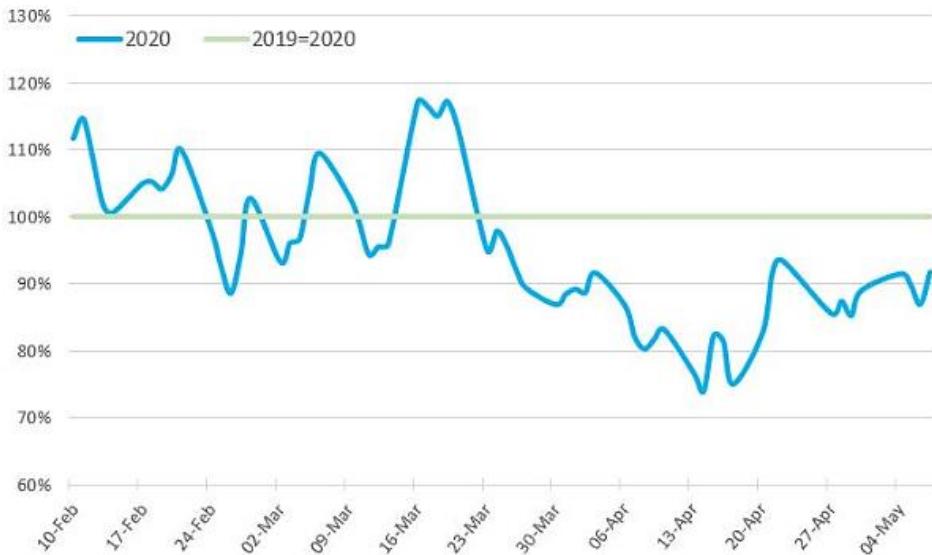
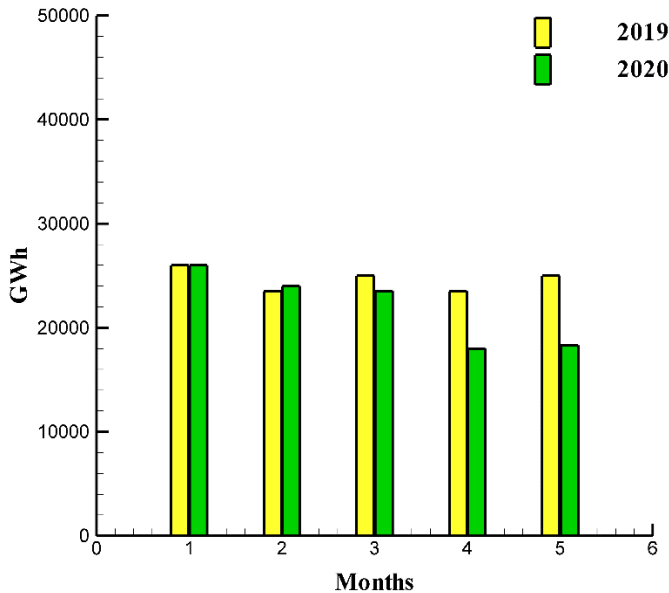


Figure 12. Daily change of peak-time electricity consumption [11]

Moreover, the electricity demand for the first 5 months for 2019 and 2020 was shown in Fig. 13. The graph indicated that demand in 2019 was almost stable and had little changes, whereas an obvious decline emerged with the occurrence of the Covid-19 outbreak in 2020. For March, April, and May of 2019, demands were 24866 GWh, 23795 GWh, and 25027 GWh, respectively. For the same months of 2020, they were 23623 GWh, 19130 GWh, and 19551 GWh, respectively. Considering the first five months of 2020, it is seen that there is a decrease in electricity demand decrease by 10.7 billion kWh compared to 2019.



**Figure 13.** The electricity demand of first 5 months for 2019 and 2020 years

Fig. 14 denoted the electricity generation by different sources between April 2019 and April 2020. It was concluded from the graph that the electricity generation from thermal sources enormously decreased with the occurrence of Covid-19 after January 2020. However, there was no big change in terms of generation from RES including geothermal, solar, and wind energy in the same months. Approximately 24.7 terawatt-hours (TWh) of electricity was generated in March 2020, whilst total electricity generation in April 2020 decreased to 20.2 TWh, indicating a fall of 15.4% in average daily electricity generation when compared to the previous month. Moreover, in April 2020, electricity generation decreased by 15.1% as compared to the same month of the previous year.

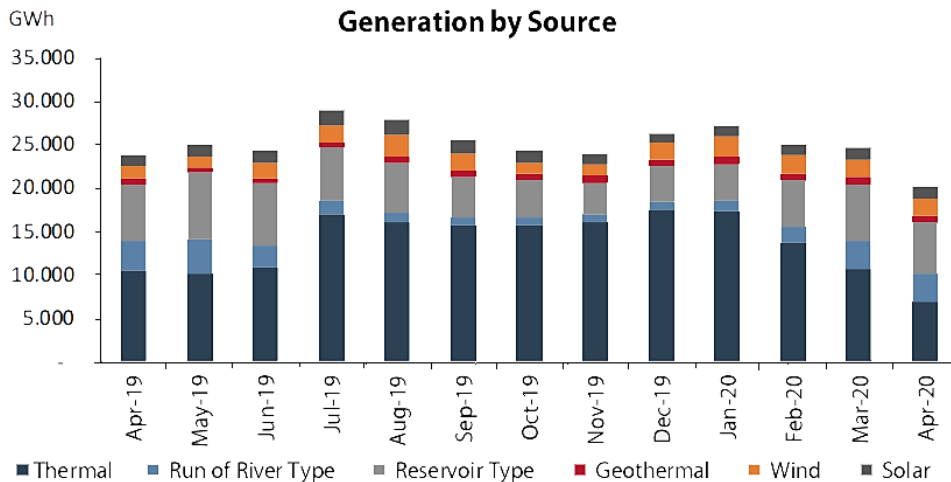


Figure 14. Electricity generation by different sources in Turkey [12]

### 3.CONCLUSION

In this study, the effect of nowcasting of pandemic COVID-19 outbreak on global energy demand and RES was investigated by dealing with a comprehensive survey. At first glance, it was observed that electricity production with non-renewable energy resources such as coal decreased from the birth of the pandemic to the present time. Furthermore, the energy demand enormously declined in the countries at which the pandemic formed seriously. However, in contrast to non-renewables, electricity production with RES especially including wind and solar energy increased pronouncedly during the pandemic period. 30% of the global electricity supply was ensured with renewables, halving the gap of coal. Furthermore, the reduction of electricity demand and generation occurred in Turkey during this pandemic period. But, electricity generation from RES did not change even though the generation from non-renewables decreased enormously. Consequently, it was speculated that the social and economic consequences of lockdowns may prevail in the short-term as it is happening now. This would have mid-term impacts on many sectors including RE. However, RE may experience flourishing in the long run, not only due to economic recovery but also because of the solid experience of the current days in its favor.

### REFERENCES

- [1] World Health Organization. Rolling updates on coronavirus disease (COVID-19) URL: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen> [accessed 2020-03-27]
- [2] Secon H, Woodward A, Mosher D. Business Insider. A comprehensive timeline of the new coronavirus pandemic, from China's first COVID-19 case to the present URL: <https://tinyurl.com/r6johyw> [accessed 2020-03-23]
- [3] World Health Organization. 2020 Mar 12. WHO announces COVID-19 outbreak a pandemic URL: <http://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/news/news/2020/3/who-announces-covid-19-outbreak-a-pandemic> [accessed 2020-03-27]
- [4] Worldometers. COVID-19 coronavirus pandemic URL: <https://www.worldometers.info/coronavirus/> [accessed 2020-03-19]

- [5] World Health Organization. Rolling updates on coronavirus disease (COVID-19) URL: <https://covid19.who.int/> [accessed 2020-05-01]
- [6] The financial help of The International Monetary Fund. (IMF) <https://www.imf.org/en/search#q=covid&sort=relevancy>
- [7] Help of other countries URL: <https://www.aa.com.tr/en/latest-on-coronavirus-outbreak/turkey-sent-aid-to-at-least-57-countries-to-fight-virus/1820195>
- [8] The charts from International Energy Agency URL: <https://www.iea.org/search/charts?q=Covid>
- [9] Russian data on load and temperature are all taken from The Unified Energy System of Russia, available at URL: <http://www.so-ups.ru/index.php?id=ees>
- [10] <https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker>
- [11] <https://www.teias.gov.tr/en-US>
- [12] [http://www.tskb.com.tr/i/content/4429\\_1\\_Energy%20bulletin\\_april\\_22052020.pdf](http://www.tskb.com.tr/i/content/4429_1_Energy%20bulletin_april_22052020.pdf)