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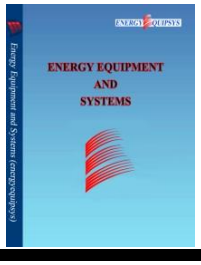

Impact of covid-19 on biofuels global market and their utilization necessity during pandemic

Authors

Behdad Shadidi [a*]
Gholamhassan Najafi [b]

[a] Department of Biosystems Engineering, Faculty of Agriculture, Bu-Ali Sina University, Hamedan, Iran

[b] Department of Biosystems Engineering, Faculty of Agriculture, Tarbiat Modares University, Tehran, Iran

ABSTRACT

In late 2019, the outbreak of a deadly Coronavirus shocked the world. Following the Covid-19 pandemic, governments were forced to enact a series of restrictive laws, including road and urban transportation. As a result of these restrictions, the consumption of fossil fuels in the world decreased and reduced the price and demand of these fuels. Because of the decline in this area, alternative fuels also faced serious challenges. Declining demand for alternative fuels has raised concerns about the development and future of these clean fuels. In this study, after presenting a quick look at biofuels' global markets, associated challenges ahead being examined in light of the declining demand and price of fossil fuels and biofuels. The results in this section showed that some social and economic constraints in the world are temporary due to the prevalence of Covid-19. As many countries reduced these restrictions in the second quarter of 2020, these limitation may be minimized shortly to zero with the discovery of vaccines and Covid-19 treatment. If it is supposed that the production of biofuels returns to its initial level in 2021, the development of biofuels should not be ignored because of the Covid-19. Obviously, in this case, the demand for biofuels will increase. According to new findings, the spread of coronavirus increases with air pollution. Therefore, the effects of coronavirus on air pollutants specifically NO_2 and CO_2 are investigated. The results revealed that the spread of coronavirus in 2020 has reduced NO_2 emissions by 40-50% and CO_2 emissions are also expected to be declined by 8%. This value is probably the largest reduction in CO_2 emissions since 1900. An effective solution to reduce air pollution is to develop the use of biofuels. At this time, the air pollution has been reduced due to a decrease in urban and road transportation. However, this pollution can be reduced by more development of biofuels to mitigate the spread of this deadly virus. Reduction in emissions is a result of declining social activity, rising unemployment, and severe economic problems.

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1. Introduction

The Covid-19 pandemic, also known as the coronavirus pandemic, is a new pandemic of coronavirus disease 2019 (Covid-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1]. In Wuhan, China, the disease was first reported in December 2019 [2].

[1] Corresponding author: Behdad Shadidi,
Department of Biosystems Engineering, Faculty of Agriculture, Bu-Ali Sina University, Hamedan, Iran
Email: b.shadidi@basu.ac.ir

The disease was declared a public health emergency of international significance in January 2020 and a pandemic in March 2020 [3]. The initial signs of a Covid-19 infection are coughing, fever, and short breath, and it can affect the kidney, causing pneumonia and unexpected death in the later stages [4]. The vulnerability of older people is high, with a death risk of ~ 22% of cases infected with Covid-19 [5]. As of 2 December 2020, the total number of confirmed cases of Covid-19 has reached over 64 million, and over 1,491,289 people have already died [6]. Most nations are currently seeking to combat the spread of the virus by screening for Covid-19 in large numbers and maintaining social distancing policies with a focus on human health [7]. Figure 1 displays the geographical distribution until 2 December of the current Covid-19 pandemic [8].

Infections and the coronavirus replication cycle are shown in Fig.2. The most severely affected organ of a person infected with SARS-CoV-2 in severe cases is the lungs (host) [9].

Figure 3 shows the Distribution of Covid-19 deaths, worldwide, as of 2 December 2020 [8].

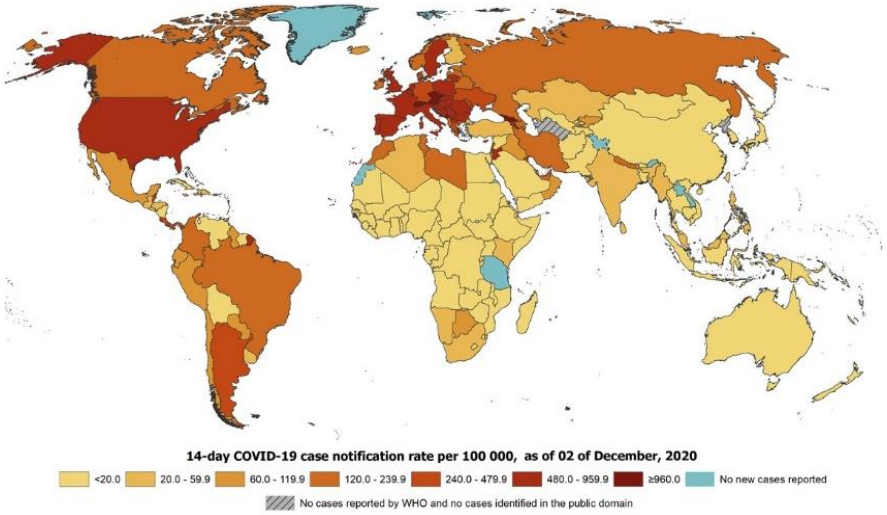

Fig. 1. Worldwide regional distribution of Covid-19 cases, as of December 2, 2020 [8].

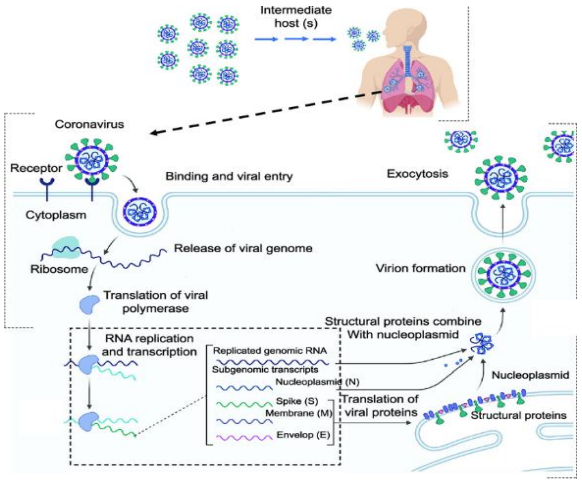

Fig. 2. Coronavirus Infection Mechanism and Replication Cycle [9].

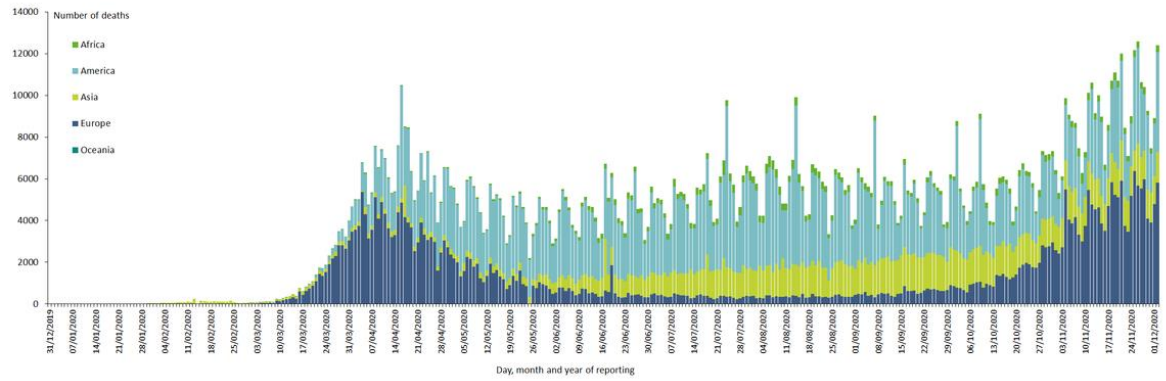

Fig. 3. The Covid-19 Death Spread, Worldwide, as of 2 December 2020 [8].

Travel restrictions have been described as playing an important role in regulating the initial distribution of Covid-19 [10-11-12-13]. It has been established that remaining at home is more effective in treating both the initial and final stages of infectious diseases [13-14-15] Quarantines, entry bans, and other restrictions were placed on citizens of current or recent travelers to several countries in the most affected areas following the start of the Covid-19 pandemic [16]. Some industries have also been shut down to limit mobility. A possible advantage of these steps is the reduction of industrial and transport emissions and the enhancement of urban sustainability [17]. By March 2020, the average global road haulage activity had declined to almost 50% of the 2019 standard in regions with lockdowns. Air travel has almost completely stopped in some regions, with aviation activity dropping by over 90% in some European countries [7].

Now the question is why, considering the introduction of a social distance strategy, the Covid-19 transfer speed is still higher in some regions? Therefore this hypothesis establishes that indirect exposure can also play an important role in the transmission of Covid-19. There are pollutants and surfaces in the environment around us that can unwittingly expose human beings to the virus. In order to investigate the prevalence of coronaviruses, more focus should also be paid to environmental contaminants. Air pollution may play a significant role in the spread of Covid-19 including environmental pollutants, which should be considered as a role player in the indirect spread of the virus. With all its pollutants, the air is the primary atmosphere in which the human interact and inhale it every day [18]. Studies have shown that air pollutants are capable of lowering immune system levels and thereby weakening the body against various pathogens and viruses. With knowing this subject, a hypothesis emerged that air pollution could have a synergistic effect on coronavirus output [19]. A major association between coronavirus transmission and air pollution in certain parts of Italy has been reported by Conticini et al. that people living in an environment with high pollutant levels are more likely to develop chronic respiratory problems and are ideal for any infectious agent [20]. In another study, researchers reported that Covid-19-related deaths were higher in regions of Britain with high levels of NO_x [21]. Other researchers have also reported links between air pollution and Covid-19 outbreaks [22-23-24]. Some studies have shown that NO_x decreases lung activity and increases airway infection [25].

A significant global problem has been the correlation between economic growth and pollution since the 1970s [26]. Covid-19 has a devastating effect on economic development. Due to Covid-19, strict regulation over movement and business operation has resulted in an economic downturn, which is expected to reduce environmental emissions in turn. In recent years, industry, governments, the public, and the financial community have paid greater attention to pollution created by the fuel supply sector. The economic downturn triggered by Covid-19 and sharp cuts in infrastructure spending is at risk of distracting attention from these initiatives.

The effect of Covid-19 on the global economy is especially acute in the markets for petroleum products, as restrictions on foreign travel and regional and local movement prevent the free circulation of people and goods, resulting in a strong toll on the demand for transport fuel. The effect on the global demand for biofuels is still difficult to be calculated. Because of the decline in this area, alternative fuels also faced serious challenges. Declining demand for alternative fuels has raised concerns about the development and future of these clean fuels. Nevertheless, in this study, first, we take a quick look at some main markets, led by the question to what degree the current gasoline and gasoil forecasts and the current blending goals will reduce biofuels demand. Then in the following, we will discuss the impact of corona on air pollution and the parallel role of biofuels, and the need to continue using this type of fuel during the corona to help reduce its prevalence.

2. Global Market of Biofuels

After the advent of Covid-19 and its rapid dissemination across the world, demand for crude oil has dropped sharply due to a decrease in economic activity, resulting in a dramatic drop in the price of crude oil [27]. Competition between major oil producers has driven the price of crude oil further down. The price of crude oil decreased from $61.14 on December 31, 2019, to $40.78 on October 18, 2020, and even reached its lowest level of $ 14.10 during the April 2020 period, as shown in Fig.4 [28]. The drop in oil prices has also resulted in a decline in transport fuel prices. The average monthly rack price for unleaded diesel dropped from $1.25 per gallon in December 2019 to $1.04 in October 2020. At the same time, the average monthly fuel rack price of gasoline decreased from $1.67 per gallon in December 2019 to $1.04 per gallon in October 2020 (Fig.4) [28].

The effect of Covid-19 on the market for biodiesel, which is one of the alternative fuels to diesel fuel, is likely to be lower than that of gasoline demand for a variety of reasons. First, because of the reduction in demand for transportation, diesel fuel consumption could decrease less than gasoline consumption. In heavy-duty trucks, agricultural machinery, building equipment, and other manufacturing activities, diesel fuel is primarily used. Therefore, although its demand is expected to drop due to economic activity decreases, the restrictions on shelter in place might not reduce diesel demand as much as expected for gasoline. In the absence of further data, the decrease in demand for diesel due to Covid-19 per month is presumed to be half of the decrease in demand for gasoline per month [27]. Then, given the share of biodiesel in diesel use, it is expected that there will be a reduction in the amount of biodiesel requested.

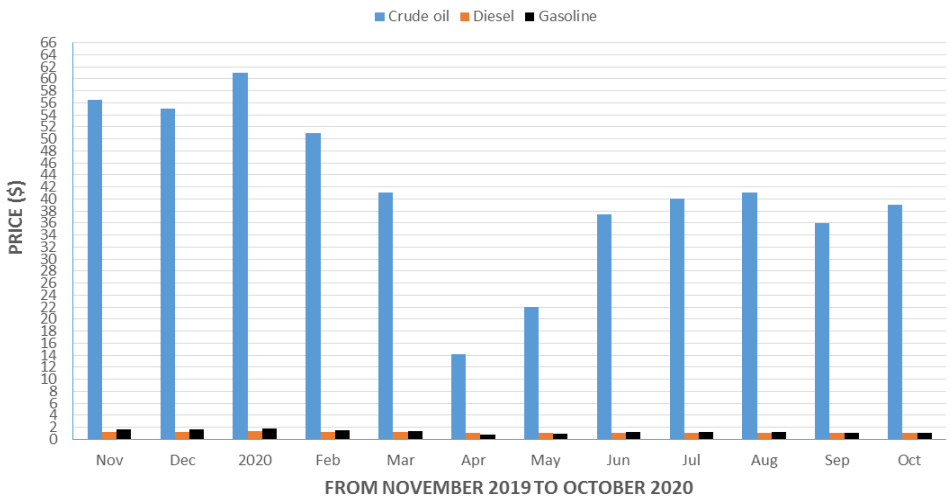

Fig. 4. The price of crude oil, diesel and gasoline as of 18 October 2020 [28].

The Covid-19 crisis has significantly altered the global context of biofuels. Restrictions imposed around the world and stalling of economic activity have reduced the demand for transportation fuel. Global gasoline demand is projected to decline by 9% and diesel demand by around 6% by 2020. Since a large proportion of biofuels are used to combine with fossil fuels, this decrease in demand often affects the demand for biofuels [29]. Ethanol production is expected to decline by 18% (720 million tons) and biodiesel and hydrotreated vegetable oil (HVO) production by 3% (21 million tons) as demand for fossil fuels declines due to the global pandemic (Fig.5).

Some social and economic constraints in the world are temporary due to the prevalence of Covid-19. As many countries reduced these restrictions in the second quarter of 2020, these restrictions may be minimized shortly to zero with the discovery of vaccines and Covid-19 treatment. Obviously, in this case, the demand for biofuels will increase. If we assume this happens in 2021, the production of biofuels could return to the level of previous years. Therefore, the development of biofuels is inevitable and should not be forgotten because of the Covid-19.

3. Air Pollution

According to the World Health Organization (WHO), air pollution is called the "invisible killer" and kills 7 million people annually, even more than the total death from diseases such as malaria, tuberculosis, and AIDS [30]. As we know, Covid-19 is a new disease and human knowledge about this disease is increasing day by day so that in the latest findings of this virus, some scientists have also stated that people living in infected areas are prone to severe symptoms.

3.1. NO_2 Emissions

The cause of atmospheric nitrogen dioxide is the combustion of fossil fuels, including oil, gas, and other fuels [31]. However, the majority of NO2 in cities comes from nearly 80% of motor vehicle emissions. It is estimated that anthropogenic pollution produces about 53 million tons of NO2 annually [32-33]. NO and NO2 are vulnerable to other chemicals and create acid rain that is detrimental to the atmosphere [34-35]. WHO cites NO2 as one of the six typical air contaminants in the atmosphere. For this purpose, as a precise measure to assess whether the outbreak of Covid-19 affects environmental contamination, the volume of NO2 in the atmosphere is used. Lung linings are inflamed by NO2 and can decrease immunity to lung infection. Our body's lung tissues can be corrupted by high levels of NO2 in the air we breathe. A dangerous air pollutant is nitrogen dioxide

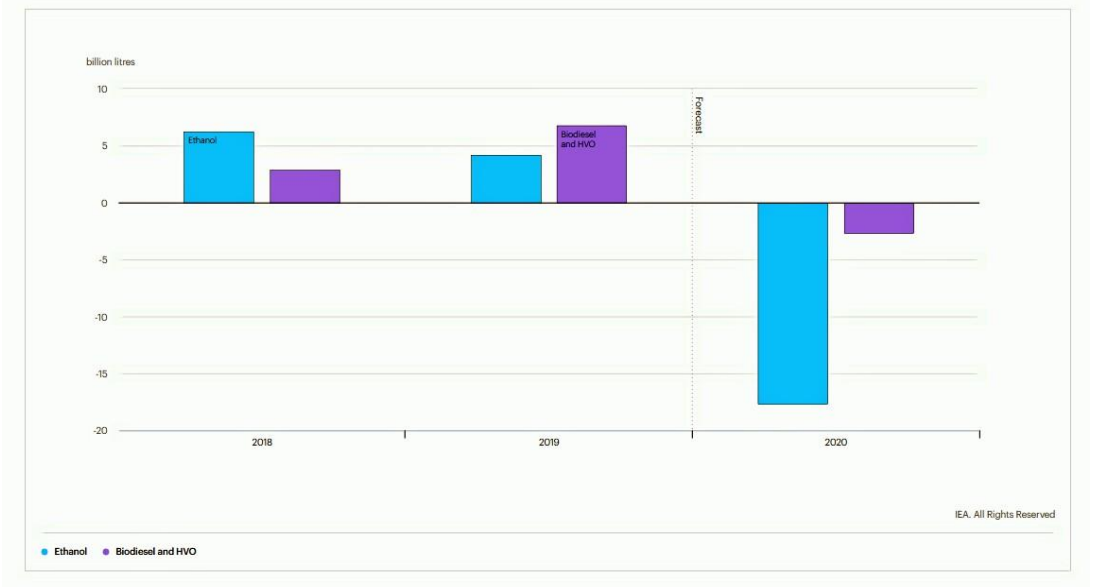

Fig. 5. Annual change in biofuel production [29].

because it leads to the production of brown photochemical smog, which can have a major impact on human health [36]. Increased levels of NO_2 may have a significant impact on people with asthma, often resulting in repeated and violent attacks [31].

During the Covid-19 pandemic, with restrictions and quarantine in various parts of the world, due to reduced road transport and urban traffic, researchers reported a sharp drop in the concentration of air pollutants, especially at the level of nitrogen oxides (NOx).

Figure 6 displays the average nitrogen dioxide concentrations in 2019 and 2020 from March to April (upper panels) and July to August (lower panels) and their difference charts, using data from the Copernicus Sentinel-5P satellite [37].

Average nitrogen dioxide concentrations are shown in Fig.7 in five major European cities. Compared with 2020 using Sentinel-5P data, the upper panel shows concentrations (using a 14-day moving average) in 2019, while the lower panel shows in situ observations. The gray shades denote the lockout times in 2020, gradually shifting from tight steps (dark gray) to loose (light gray). The percentages shown in red reflect the decline in 2020 for the same period compared to 2019 [37-38].

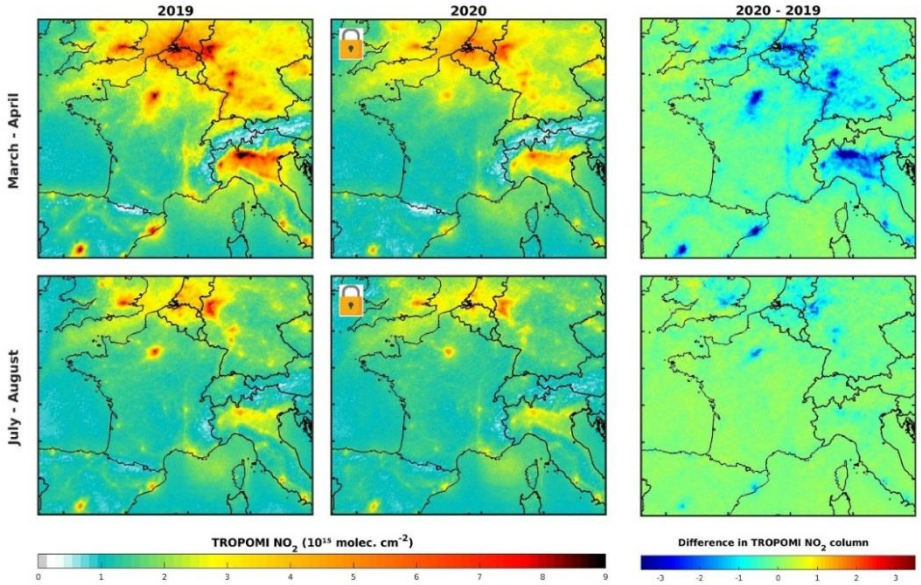

Fig. 6. The average concentrations of NO_2 in 2019 and 2020 from March to April and July to August [37].

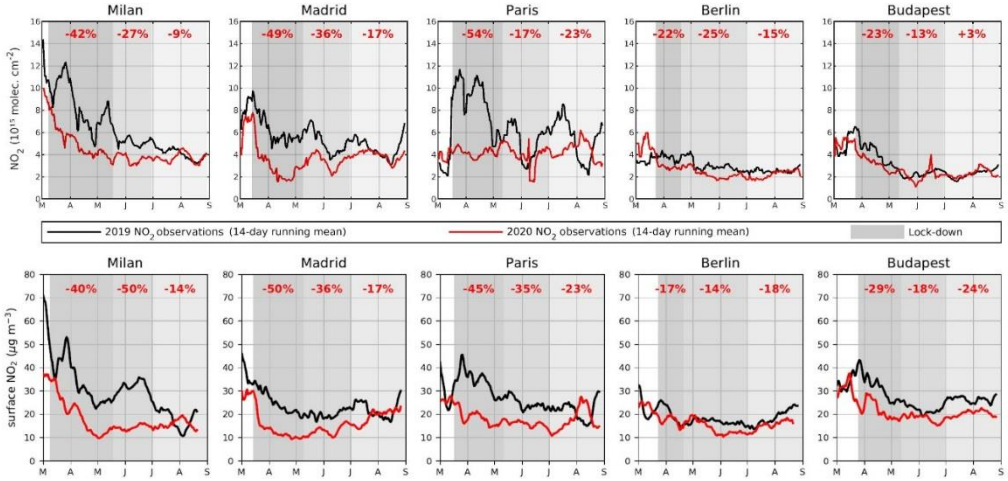

Fig. 7. The average concentration of NO_2 in five major European cities [37].

The data show that in the first period of the lockdown in southern Europe in particular Spain, Italy, and France, the greatest decreases of 40-50% were observed [37].

Also, because of the coronavirus, many countries in the world have turned to distance education [39]. With distance education, social mobility, which causes many carbon emissions (HC and CO emissions), such as student programs, has also declined. Moreover, after scientific events, meetings, and political events began to take place in the form of remote conferences, global environmental emissions have declined. Based on the above, it can be said that the outbreak of the Coronavirus has reduced atmospheric pollution in the world [40].

The use of biofuels in combination with fossil fuels can reduce exhaust emissions [41]. For example, biodiesel-diesel blends fuel will reduce HC and CO emissions. In novel methods, NOx emission can also be reduced by adding cerium oxide and molybdenum oxide nanocatalysts to these fuel blends [42].

3.2. CO_2 Emissions

The spread of the Coronavirus has created unprecedented restrictions on social, sporting, cultural, and economic activities around the world and has had a significant effect on energy use [43].

Recent reports show that global energy demand in the first quarter of 2020 compared to the same period in 2019 decreased by 3.8% due to the decline in these activities. If the restrictions continue for the coming months, the annual energy demand is likely to fall by 6%, and if the restrictions are reduced, it will fall below 4% in 2020, and the growth in demand that has existed in the past few years will disappear. We can see that this decline was unprecedented after World War II (Fig.8) [44].

As can be seen in Fig.9, the major reduction in CO_2 emissions is the result of this dramatic reduction in energy demand in 2020 due to the global pandemic. In 2020, global CO_2 emissions are estimated to decline by 8%. This reduction is probably the largest in CO_2 emissions since 1900. Before this pandemic, the largest decrease occurred during World War II, so that the decrease in emissions in 2020 due to the coronavirus is almost double that time [44].

Fig. 8. Level of change in global demand for primary energy [45].

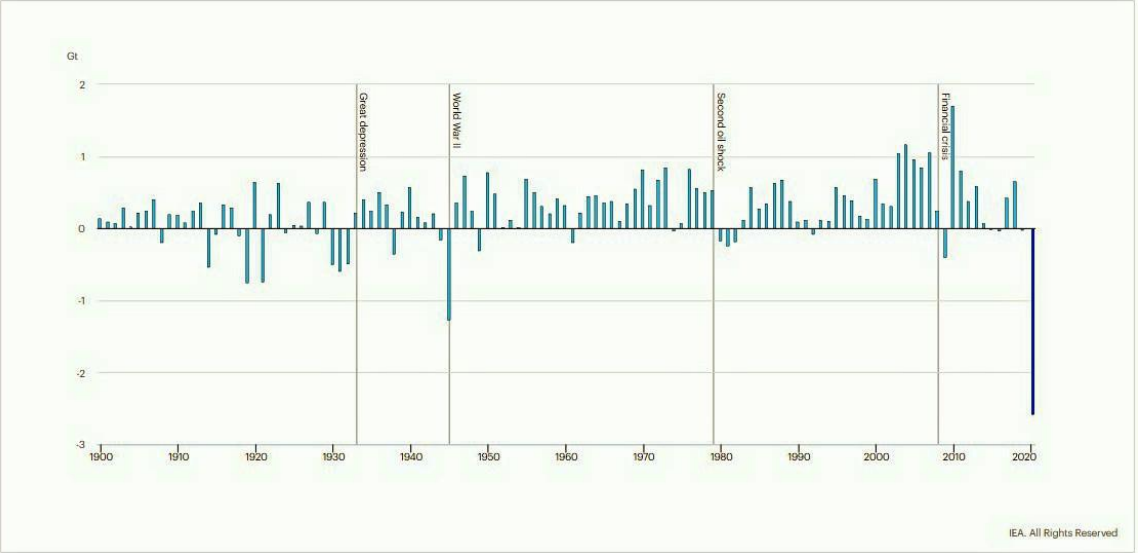

Fig. 9. Annual change in global energy-related CO_2 emissions [46].

As is clear, this reduction in CO_2 emissions is the result of a global health crisis, declining social activity, rising unemployment, and severe economic problems. So there is no reason for any celebration. With the change in the current situation and the resumption of business and social activities in the future after this global pandemic, CO_2 emissions will increase worldwide and will continue its past trend. Therefore, to achieve long-term goals, we must ignore this temporary reduction and continue to develop and research new energies, especially biofuels, which will lead to a permanent, not temporary, reduction in emissions.

The reduction of urban and road transport due to quarantine has indeed reduced air pollution, but it is important to pay attention to some points.

1. As explained, according to new findings, air pollution increases the spread of coronavirus. Therefore, it is possible to reduce air pollution by developing the use of biofuels. Now that air pollution has been reduced due to a decrease in urban and road transport, it is better to help reduce this pollution by developing biofuels and reduce the spread of this deadly virus.

2. Coronavirus is a virus that will damage the human respiratory system. Protecting this part of the body is essential in fighting the virus. Any external conditions that increase this damage should be avoided. So, the issue of air pollution will become more apparent. Air pollution, in addition to causing the further spread of the virus by damaging the human respiratory system, will increase the risk of death of the patients. Therefore, more attention should be paid to reducing air pollution and using alternative fuels to increase this reduction as much as possible to prevent more deaths in the world.

3. Another important issue is that due to health protocols and maintaining social distance to prevent the spread of coronavirus in the world, public acceptance of public transport has decreased in many countries. Due to the congestion of subways and buses and the possibility of the virus spreading in these public places, people will tend to use their vehicles, and this will increase air pollution. So looking to the future and the increasing trend of air pollution, even with the corona, increases the importance of using biofuels.

4. On the other hand, with the GMSAQ Model, the decrease in concentrations of various pollutants in China is estimated by Wang et al. [47]. As a result of the study, in cases where meteorology is unfavorable, the decrease in transport and industrial activities in China is insufficient to prevent air pollution. Therefore, it has been emphasized that more effort is required to achieve a substantial reduction in air pollution. In another study by Tobías et al. [48], it was found that during the outbreak in

Barcelona (Spain), there was a decline in air pollution, but there were major variations between the pollutants. In their study, the most notable reduction in NO_2 (nitrogen dioxide) being observed, while the smaller decrease in other pollutants was observed. So in these conditions, using biofuels can reduce other pollutants and use this opportunity to reduce air pollution.

5. Finally, let us not forget that these are not stable conditions. With the disappearance of this epidemic, the trend of air pollution will increase again, so any shortcoming in the development of biofuels in the future will have irreparable consequences on human and community health.

4. Conclusions

In this research, an attempt has been made to examine the need for the use and development of alternative fuels in these conditions of the Covid-19 epidemic from the perspective of the biofuels global market and air pollutions. In the biofuels global market research, the amount of demand reduction and the price of fossil fuels and biofuels were examined so that it was seen the price of crude oil decreased from $61.14 on December 31, 2019, to $40.78 on October 18, 2020, and even reached its lowest level of $ 14.10 during the April 2020 period. The average monthly rack price for unleaded diesel dropped from $1.25 per gallon and the average monthly fuel rack price of gasoline decreased from $1.67 per gallon in December 2019 to $1.04 per gallon in October 2020. Ethanol production is expected to decline by 18% and biodiesel and hydrotreated vegetable oil (HVO) production by 3% as demand for fossil fuels declines due to the global pandemic.

Some social and economic constraints in the world are temporary due to the prevalence of Covid-19. As many countries reduced these restrictions in the second quarter of 2020, these restrictions may be minimized shortly to zero with the discovery of vaccines and Covid-19 treatment. Obviously, in this case, the demand for biofuels will increase. According to new findings, air pollution increases the spread of coronavirus.

The results of the impact of Covid-19 on the air pollutants showed that the spread of the coronavirus has reduced the NO_2 emissions by 40-50% in some countries and the amount of CO_2 in the world by 8%. On the other hand, the use of biofuels in combination with fossil fuels can reduce exhaust emissions. Therefore, it is possible to reduce air pollution by developing the use of biofuels. Now that air pollution has been reduced due to a decrease in urban and road transport, it is better to help reduce this pollution by developing biofuels and reduce the spread of this deadly virus. A reduction in air pollutions is the result of a global health crisis, declining social activity, rising unemployment, and severe economic problems. So there is no reason for any celebration. With the change in the current situation and the resumption of business and social activities in the future after this global pandemic, air pollutions will increase worldwide and will continue its past trend. Therefore, to achieve long-term goals, we must ignore this temporary reduction and continue to develop and research new energies, especially biofuels, which will lead to a permanent, not temporary, reduction in emissions.

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References

[1] Naming the Coronavirus disease (COVID-19) and the virus that causes it. World Health Organization (WHO). https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it

[2] Novel Coronavirus-China. World Health Organization (WHO)
https://www.who.int/csr/don/12-january-2020-novel-coronavirus-china/en/ (accessed on 12 January 2020).

[3] Chowdhury M. A., Shuvho M.B.A., Shahid M.A., Haque A. K. M. M., Kashem M. A., Lam S. S., Ong H. C., Uddin M.A., Mofijur M., Prospect of biobased antiviral face mask to limit the coronavirus outbreak, Environmental Research (2021) 192:110294.

[4] Mofijur M., Rizwanul Fattah I.M., Saiful Islam A B.M., Uddin M. N., Ashra- fur Rahman S. M., Chowdhury M. A., Alam M. A., Uddin M. A., Relationship between Weather Variables and New Daily COVID-19 Cases in Dhaka, Bangladesh, Sustainability (2020) 12(20):1-10.

[5] Abdullah S., AbuMansor A., MohdNapi NNL., WanMansor W.N., NajahAhmed A., Ismail M., AhmadRamly Z.T., Air quality status during 2020 Malaysia movement control order (MCO) due to 2019 novel coronavirus (2019-nCoV) pandemic. Science Total Environment (2020) 729:139022.

[6] Worldometer, Reported cases and deaths by country, territory, or conveyance. https: //www.worldometers.info/coronavirus/ . (accessed on 2 December, 2020).

[7] M. Mofijur I.M., Fattah R., Asraful Alam Md., Saiful Islam A.B.M., Hwai Chyuan Ong., Ashrafur Rahman S.M., Najafi, G., Ahmed, S.F., Alhaz Uddin, Md., d Mahlia T.M.I., Impact of COVID-19 on the social, economic, environmental and energy domains: Lessons learnt from a global pandemic, Sustainable Production and Consumption (2021) 26:343–359.

[8] European Centre for Disease Prevention and Control. https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases. (accessed on 2 December, 2020).

[9] Acter T., Uddin N., Das J., Akhter, A., Choudhury T.R., Kim S., Evolution of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) as coronavirus disease 2019 (COVID-19) pandemic: A global health emergency, Science of The Total Environment (2020) 730:138996.

[10] Chinazzi M., Davis J.T., Ajelli M., Gioannini C., Litvinova P., Merler S., Piontti A.P., Mu K., Rossi L., Sun P., Viboud P., Xiong X., Yu H., Halloran E. Longini M., Vespignani A., The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak, Science (2020) 368:395-400.

[11] Aldila D. Khoshnaw S., RaisAnwar E.Y., Bakry A., Samiadji B., Anugerah D., Alfarizi M., Ayulani I., Salim, Sh., A mathematical study on the spread of COVID-19 considering social distancing and rapid assessment: the case of Jakarta, Indonesia, Chaos Solitons Fractals (2020) 139:110042.

[12] Beck M.J., Hensher D.A., Insights into the impact of COVID-19 on household travel and activities in Australia –the early days under restrictions, Transport Policy (2020) 96:76–93.

[13] de Haas M., Faber R., Hamersma M., How COVID-19 and the Dutch 'intelli- gent lockdown' change activities, work and travel behaviour: evidence from lon- gitudinal data in the Netherlands, Transportation Research Interdisciplinary Perspectives (2020) 6:100150.

[14] Cohen M.J., Does the COVID-19 outbreak mark the onset of a sustainable con sumption transition? Sustainability (2020) 16:1-3.

[15] Pirouz B., Haghshenas S.S., Haghshenas S.Sh., Piro P., Investigating a serious challenge in the sustainable development process: analysis of confirmed cases of COVID-19 (new type of coronavirus) through a binary classification using artificial intelligence and regression analysis, Sustainability (2020) 6:1-23.

[16] Sohrabi C., Alsafi Z., O'Neill N., MehdiKhan Kerwan A., Al-Jabir A., Iosifidis Ch., Agha R., World Health Organization declares global emergency: a review of the 2019 novel coronavirus (COVID-19), International Journal of Surgery (2020) 76:71-76.

[17] Jiang P., Fu X., VanFan Y., Klemeš J., Chen P., Ma S., Zhang W., Spatial-temporal potential exposure risk analytics and urban sustainability impacts related to COVID-19 mitigation: a perspective from car mobility behavior, Journal of Cleaner Production (2021) 279;123673.

[18] Daraei H., Toolabian K., Kazempour M., Javanbakht M., The role of the environment and its pollution in the prevalence of COVID-19, Journal of Infection (2020) 81(2):168-169.

[19] Wu X., Nether R.C., Sabath B.M., Braun D., Dominici F., Exposure to air pollution and COVID-19 mortality in the United States: a nationwide cross-sectional study, medRxiv (2020) 1-36.

[20] Conticini E., Frediani B., Caro D., Can atmospheric pollution be considered a co–factor in extremely high level of SARS-CoV-2 lethality in Northern Italy? Environmental Pollution (2020) 261:114465.

[21] Travaglio M., Yu Y., Popovic R., Leal N.S., Martins L.M., Links between air pollution and COVID-19 in England, Environmental Pollution (2020) 268:115859.

[22] Karan A., Ali K., Teelucksingh S., Sakhamouri S., The impact of air pollution on the incidence and mortality of COVID-19, global health res policy (2020) 39(5):527-532.

[23] Coker E.S., Cavalli L., Fabrizi E., Guastella G., Lippo E., Parisi M.L., Pontarollo N., Rizzati M., Varacca A. , Vergalli S., The Effects of Air Pollution on COVID-19 Related Mortality in Northern Italy, Environmental Resource Economy (2020) 76:611-634.

[24] Pozzer A., Dominici F., Haines A., Witt Ch., Münzel T., Lelieveld J., Regional and global contributions of air pollution to risk of death from COVID-19, Cardiovascular Research (2020) 116(14):2247-2253.

[25] Shan J., Ni Y., Dong W., Xu JH., Pan L., Li HY., The effect of short-term exposureto ambient NO(2) on lung function and fractional exhaled nitric oxide in33 chronic obstructive pulmonary disease patients, Chinese Journal of Preventive Medicine (2017)51(6):527-532.

[26] Khan S.A.R., Yu Zh., Belhadi A., Mardani A., Investigating the effects of renewable energy on interna- tional trade and environmental quality, Journal of Environmental Management (2020) 272:111089.

[27] Impact of on the Biofuels industry and implications for corn and soybean markets. *Purdue University,* 13 April 2020.

[28] https://markets.businessinsider.com/ (accessed on 18 October 2020).

[29] IEA (2020), *Renewable energy market update*, IEA, Paris https://www.iea.org/reports/renewable-energy-market-update

[30] Cooperation for clean air must be at the heart of a green recovery from the Covid-19 crisis, available at https://www.unece.org/ (accessed on 26 August 2020).

[31] Munawer M.E., Human health and environmental impacts of coal combustion and post-combustion wastes, Journal of Sustainable Mining (2018)17(2):87-96.

[32] M Palash S., Kalam M.A., Masjuki H.H., Masum B.M., Rizwanul Fattah I.M., Mofijur M., Impacts of biodiesel combustion on NOx emissions and their reduction approaches, Renewable Sustainable Energy Reviews (2013) 23:473-490.

[33] Fattah I.M.R., Masjuki H.H., Liaquat A.M., Ramli R., Kalam M.A., Riazuddin V.L., Impact of various biodiesel fuels obtained from edible and non-edible oils on engine exhaust gas and noise emissions, Renewable Sustainable Energy Reviews (2013) 18:552-567.

[34] Mofijur M., Atabani A.E., Masjuki H.H., Kalam M.A., Masum B.M., A study on the effects of promising edible and non-edible biodiesel feedstocks on engine performance and emissions production: a comparative evaluation, Renewable Sustainable Energy Reviews (2013)23:391-404.

[35] Ashraful A.M., Masjuki H.H., Kalam M.A., Rizwanul Fattah I.M., Imtenan S., Shahir S.A., Mobarak H.M., Production and comparison of fuel properties, engine performance, and emission characteristics of biodiesel from various non-edible vegetable oils: a review, Energy Conversion and Management (2014) 80:202-228.

[36] Huang Y., Mok W.-c., Yam Y.-s., Zhou J. L., Surawski, N. C., Organ, B., Chan, E. F. C., Mofijur, M., Mahlia T. M. I., Ong H. C.. Evaluating in-use vehicle emissions using air quality monitoring stations and on-road remote sensing system, Science of The Total Environment (2020) 740:139686.

[37] Measuring air pollution in a post-COVID-19 world (2020, September 18) retrieved 5 December 2020 from https://phys.org/news/2020-09-air-pollution-post-covid-world.html

[38] Air pollution goes down as Europe takes hard measures to combat Coronavirus, available at: https://www.eea.europa.eu/ (accessed on 23 November 2020).

[39] Zhou L., Li F., Wu S., Zhou M., School's out, but class's on", the largest online

education in the World Today: Taking China's practical exploration during the COVID-19 epidemic prevention and control as an example, Best Evidence of Chinese Education (2020) 4(2):501–519.

[40] Watts, JKommenda, N. (2020). Coronavirus pandemic leading to huge drop in air pollution (pp. 2–5). The Guardian. Retrieved April 20, 2020, (https://www.theguardian.com/environment/2020/mar/23/coronavirus-pandemic-leading-to-huge-drop-in-air-pollution)

[41] Shadidi B., Yusaf T., Haji Agha Alizadeh H., Ghobadian B, Experimental investigation of the tractor engine performance using diesohol fuel, Applied Energy (2014) 114:874-879.

[42] Shadidi, B., Haji Agha Alizade H., Najafi Gh., Performance and exergy analysis of a diesel engine run on petrodiesel and biodiesel blends containing mixed CeO_2 and MoO_3 nanocatalyst, Biofuels (2020): 1779976.

[43] IEA (2020), the impact of the Covid-19 crisis on clean energy progress, IEA, Paris https://www.iea.org/articles/the-impact-of-the-covid-19-crisis-on-clean-energy-progress (accessed on 11 Jun 2020).

[44] IEA (2020), *Global Energy Review 2020*, IEA, Paris https://www.iea.org/reports/global-energy-review-2020 (accessed on April 2020).

[45] IEA, Change in global primary energy demand, 1900 to 2020e, IEA, Paris https://www.iea.org/data-and-statistics/charts/change-in-global-primary-energy-demand-1900-to-2020e (accessed on 15 Jun 2020).

[46] EA, Annual change in global energy-related CO2 emissions, 1900-2020, IEA, Paris https://www.iea.org/data-and-statistics/charts/annual-change-in-global-energy-related-co2-emissions-1900-2020 (accessed on 30 April 2020).