



Effect of Coronavirus Disease 2019 on CO₂ Emission in the World

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ABSTRACT

In order to decrease spreading of Coronavirus disease 2019 (COVID-19) over the world, the activity of many industries has declined, several flights were cancelled and so many people staying home that made drop in fuel consumption in road transport. As industries, transport networks and businesses have closed down, it has brought a sudden drop in carbon emissions. Hence, in this paper, a simple estimation model is developed by using some excel features to assess the reduced CO₂ emissions in March 2020. Then this indicator is calculated for 3 scenarios which are based on this disease situation worldwide and therefore based on different reduction percent of fossil fuels consumption in various sectors over year 2020. In scenario 1, it is assumed the number of infected people increasing but it is before peak region. In this zone, the measures to slow the rate of infection would be similar till end of year. In scenario 2, the infectious growth rate in the world reaches to peak region. Hence, the protective measures would be extended. As a result, industries activities and various kinds of transportations will be probably reduced much more in comparison with scenario 1. In scenario 3, it is assumed the growth rate begins to fall and it is after peak region. In this zone, the intervention and protective measures would be lessened toward scenario 1. So, industries activities and transportations will be likely increased in compare to other scenarios. The results show that CO₂ emissions worldwide in March 2020 has been 7% lower than the monthly average of this parameter in 2019 as consequence of COVID-19. Moreover, carbon emission through 2020 has been estimated to be 34.4, 32.4 and 35.3 Gton based on scenarios 1, 2 and 3, respectively. It is worth to mention that based on these three scenarios, this indicator in 2020 will be approximately the same as 2011, 2008 and 2012.

Keywords: COVID-19; CO₂ emission; Industries; Road transport; Aviation transport.

INTRODUCTION

In early 1700s from the beginning of the industrial revolution, the burning fossil fuel as one of the most important human activities, releases Carbon dioxide to the atmosphere. Especially during the last three decades, CO₂ emission and the average temperature in the world have been growing hugely. The global warming has been introduced as a main issue caused by CO₂ emission that all countries face on, no matter the countries are economically developed or not (Kwon, 2017). Many studies confirm that CO₂ emissions caused by human activities cause directly increases of the global temperature (Boden *et al.*, 2009; Shakun *et al.*, 2012). In other words, according to the Intergovernmental Panel on Climate Change's (IPCC), human's emissions and activities have caused around 100% of the warming observed since 1950 (IPCC, 2013).

The contribution of each of various sources (gas, liquid

(i.e., oil), solid (coal and biomass), flaring, and cement production) on CO₂ emission in different years is shown in Fig. 1. Clearly, Fig. 1 shows that carbon emission was increasing sharply through years and it was dominated by using of solid fuel. Coal-fired power at industrial scales firstly emerged in Europe and North America during the 1700s. It wasn't until the late 1800s that it began to see a growth in emissions from oil and gas production. Another century passed before emissions from flaring and cement production began. However, solid and liquid fuel are still dominating contributions (Ritchie and Roser, 2019).

Based on some researches like (Hansen *et al.*, 1981), from 1960s till the recent time, the global mean temperature has been constantly increased by 0.2°C in each decade. The study directed by IPCC (IPCC, 2007) illustrates that average temperature globally during the last 100 years has been raised by 0.74°C ± 0.18°C from 1906 to 2005. According to this study, temperature changes over the last 25 years (1981–2005), 50 years (1956–2005), 100 years (1906–2005), 150 years (1856–2005) are 0.18°C ± 0.05°C, 0.13°C ± 0.03°C, 0.07°C ± 0.02°C and 0.05°C ± 0.01°C, respectively. To compare, temperature changes within last 25 years are almost four times greater than its changes during the last

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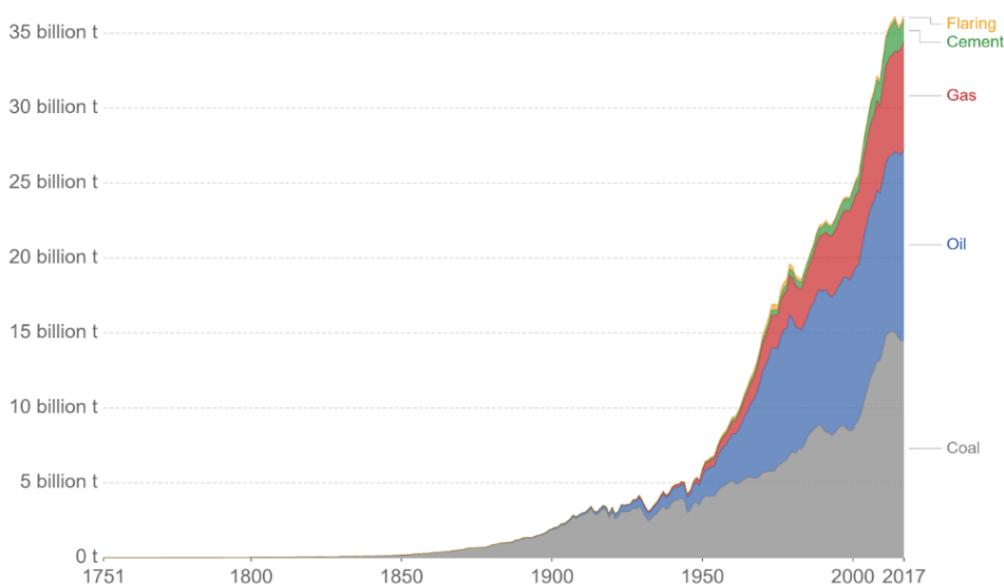


Fig. 1. CO₂ emissions by fuel type in the world.

150 years and average temperature changes over the last 50 years are almost twice larger in comparison to its changes during the last 100 years. Therefore, the global mean temperature increases more rapidly within the shorter period.

It was projected that CO₂ emissions in the world will increase till 2020 and it reaches to around 37 billion ton (Mearns, 2018). However, carbon emissions have decreased through the past months (Jan-April 2020). In recent months, thousands of people have died and hundreds of thousands more have fallen ill from a Coronavirus disease 2019. Hence, to control the spread of this virus, most of travels have been restricted, so many public places were closed, extensive flights were cancelled and so many industries have closed down in the world. As a result of these events, level of pollution and greenhouse gas emissions have fallen across continents (BBC, 2020). Hence firstly in this work, we aim to estimate the amount of reduction in CO₂ emission worldwide through March 2020 and then evaluate the reducing CO₂ emissions through the year 2020, based on 3 scenarios with different reduction percent of fuels consumption.

METHODS

The amount of reduction in CO₂ emission globally through March 2020 can be calculated by using Eq. (1) (Safarian et al., 2018, 2019):

$$\Delta D_{\text{CO}_2} = \sum_j \sum_i \Delta F_{ij} \times \alpha_i \quad (1)$$

$$\Delta F_{ij} = F_{ij} \times r_{ij} \quad (2)$$

Δ_{CO_2} is the amount of CO₂ emission reduction that is caused due to reduce in the consumption of different fuels (*i*) in different sectors (*j*) (GreenCarCongress, 2014; EIA,

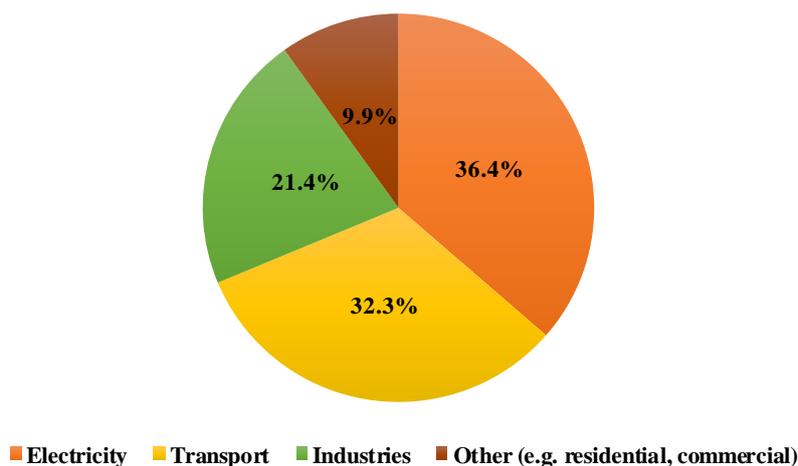
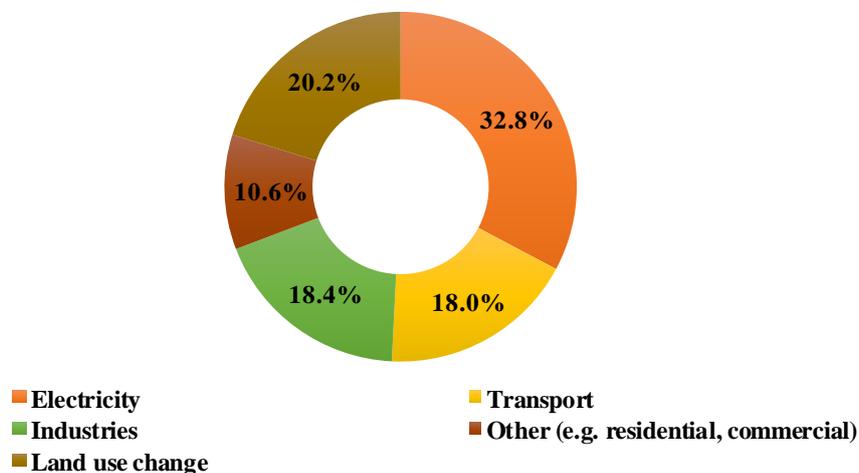
2016; Knoema, 2017; Statista, 2020), (ΔF_{ij}). In fact, decreasing in CO₂ emissions are due to declining in fuels consumption like jet fuel in aviation transport, gasoline and diesel in road transport and liquid fuel, coal, natural gas and electricity in industrial sectors. α_i is also the emission factor of CO₂ per unit consumption of different fuels (EIA, 2019, 2020). ΔF_{ij} is calculated by using Eq. (2) that in which, r_{ij} is reduction percent of various fuels in different sectors. The amount of fuels consumption, their reduction percent during March 2020 and their CO₂ emission factors are shown in Table 1 (GreenCarCongress, 2014; EIA, 2016; Knoema, 2017; EIA, 2019, 2020; RYSRADENERGY, 2020; Statista, 2020).

Actually, in this work, we estimate the reduction of CO₂ emission in the transport sector (aviation and road) and the industrial sector (electricity included) and do not consider the residential, commercial and agricultural sectors due to the below reasons:

1. Carbon dioxide enters the atmosphere through burning fossil fuels (coal, natural gas, and oil), solid waste, trees and other biological materials, and also as a result of certain chemical reactions (e.g., manufacture of cement). However, the largest source of greenhouse gas emissions from human activities in the world is from burning fossil fuels for electricity, heat, and transportation.
2. Fig. 2, shows the global fossil fuel consumption by various sectors in 2017 (EnergyPost, 2019). As it is observed in Fig. 2, around 90% of fossil fuel is consumed in Industrial sector (including industries and power plants) and transport sector (road and aviation transports) and lower than 10% of oil, gas and coal are consumed in other sectors.
3. The global CO₂ emission by various sectors in 2019 is shown in Fig. 3 (Krum, 2019). As it is observed from Fig. 3, the huge amount of CO₂ (approximately 70%) is emitted through the transport (road and aviation transports) and industrial sectors (including industries and power

Table 1. The amount of fuels consumption, their reduction percent during March 2020 and their CO₂ emission factors.

	Fuels	Recent consumption	Unit	Reduction percent (r_{ij})	CO ₂ emission factors (α_i)	Unit
Aviation Transport	Jet fuel	13.14	Mton month ⁻¹	20	3.16	kgCO ₂ /kg _{fuel}
Road Transport	Gasoline	3.75	Quadrillion Btu month ⁻¹	10	157.2	LbCO ₂ /MBtu
	Diesel	1.25	Quadrillion Btu month ⁻¹	10	161.3	LbCO ₂ /MBtu
Industries	Liquid fuel	5.2	Quadrillion Btu month ⁻¹	10	161.3	LbCO ₂ /MBtu
	Coal	5.3	Quadrillion Btu month ⁻¹	10	228	LbCO ₂ /MBtu
	Natural gas	4.6	Quadrillion Btu month ⁻¹	10	117	LbCO ₂ /MBtu
	Electricity	3.05	Quadrillion Btu month ⁻¹	10	0.99	LbCO ₂ /MBtu

**Fig. 2.** Global fossil fuel consumption by sectors in 2017.**Fig. 3.** Global CO₂ emission by sectors in 2019.

plants). Only 10% of CO₂ emission is due to fossil fuel burning in residential and commercial sectors and 20% CO₂ releasing to the atmosphere is because of land use of change (e.g. agriculture, forestry and any other land use change).

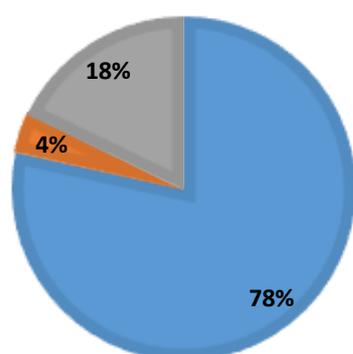
- It was mentioned in the first and the second points that the fossil fuel consumption and CO₂ emission through the residential, commercial and agricultural sectors are much less than transport and industrial sectors. Moreover based on the news, the huge reduction of fossil fuel

consumption (as a result of Coronavirus disease 2019) happened in industries, power plants and transportation. For example, the streets of Wuhan, China, are deserted after authorities implemented a strict lockdown. In Italy, the most extensive travel restrictions are in place since World War Two. In London, the normally bustling pubs, bars and theatres have been closed and people have been told to stay in their homes. Worldwide, flights are being cancelled or turning around in mid-air, as the aviation industry buckles. Those who are able to do so are holed

Table 3. Drop in CO₂ emissions from different parts.

	Fuels	ΔCO_2 (Mton month ⁻¹)
Aviation transport	Jet fuel	8,30
Road Transport	Gasoline	29,48
	Diesel	10,08
	Total	39,56
Industries	Liquid fuel	41,94
	Coal	60,52
	Natural gas	26,96
	Electricity	44,37
	Total	173,78
Total		221,64

■ Industries ■ Aviation transport ■ Road Transport

**Fig. 5.** Contributions in CO₂ emission reduction.

is made by industrial sector through decrease in fossil fuels especially coal used over the world, following with road transport and aviation transport.

This carbon reduction has been caused because of Coronavirus disease 2019. It seems that this disease is unstoppable. The virus that has had a fatal impact on people's lives, it is also threatening the industries and transportation over the world. The COVID-19 pandemic effected so much restrictions on public gatherings and on many organized activities and businesses. So it made that many of people staying at home and doing less in terms of social interactions and exercise. Since February 2020, many things have changed and will keep constantly changing due to the coronavirus disease 2019 and its impacts on the transport and industries. There were so much limited export loads and the extra delays of port operations due to the raising of limited transport and lack of transshipment operators and warehousemen. In fact, that the number of goods imported is limited with the shortened routes the transport companies carry out, it will be possible that industries activities and trade level play down as a result of the COVID-19 outbreak. All these changes have also led to some unexpected consequences. As industries, transport networks and businesses have degraded, it has brought a sudden drop in CO₂ emissions.

According to scenarios 1, 2 and 3, CO₂ emissions through 2020 is estimated to be decreased around 2,438, 4,395 and 1,440 Mton; these values are around 6.6, 11.9 and 3.9% reduction in comparison to 2019, respectively. It is worth to

say that based on these scenarios, CO₂ emissions in 2020 will be approximately the same as 2011, 2008 and 2012.

Although, the CO₂ emission in 2020 for scenarios 1, 2 and 3 has been estimated similar to 2011, 2008 and 2012, the share of carbon emissions in different sectors are not the same. The CO₂ emission contributions in 2011, 2008 and 2012 were gathered in Table 4 (Ritchie and Roser, 2019). As is clear, approximately 70%, 20% and 10% of CO₂ emission are corresponding to industrial sector (industries and electricity production), transport sector and other (residential, commercial and public services), respectively.

In addition, the CO₂ emission shares by various sectors in 2020 for three scenarios were shown in Fig. 6. In the first scenario, the CO₂ emission in industrial and transport sectors are 14.3% and 6% less than its shares in 2011. In the second scenario, this indicator is about 17.2% and 7.8% lower in comparison its values in 2008. In the final scenario, the CO₂ emission in industrial and transport sectors is 11.8% and 5.8% less than its values in 2012.

CONCLUSIONS

In this paper, firstly the reduced CO₂ emissions worldwide in March 2020 is estimated. This carbon reduction is due to closing down of industries, transport networks and businesses as consequence of COVID-19. Then this indicator is calculated for 3 scenarios which are based on different reduction percent of various fuels over year 2020. The results show that CO₂ emissions worldwide in March 2020 has been 7% lower than the monthly average of this parameter in 2019 and the largest contribution of this reduction is made by industrial sector through decrease in fossil fuels especially coal used over the world. Moreover, carbon emission through 2020 has been estimated to be 34.4, 32.4 and 35.3 Gton based on scenarios 1, 2 and 3, respectively. It is worth to mention that based on these three scenarios, this indicator in 2020 will be approximately the same as 2011, 2008 and 2012.

Table 4. CO₂ emission contributions.

Sectors	2011	2008	2012
Industrial	69,55	67,84	69,26
Transport	19,75	20,44	20,13
Other	10,71	11,72	10,61

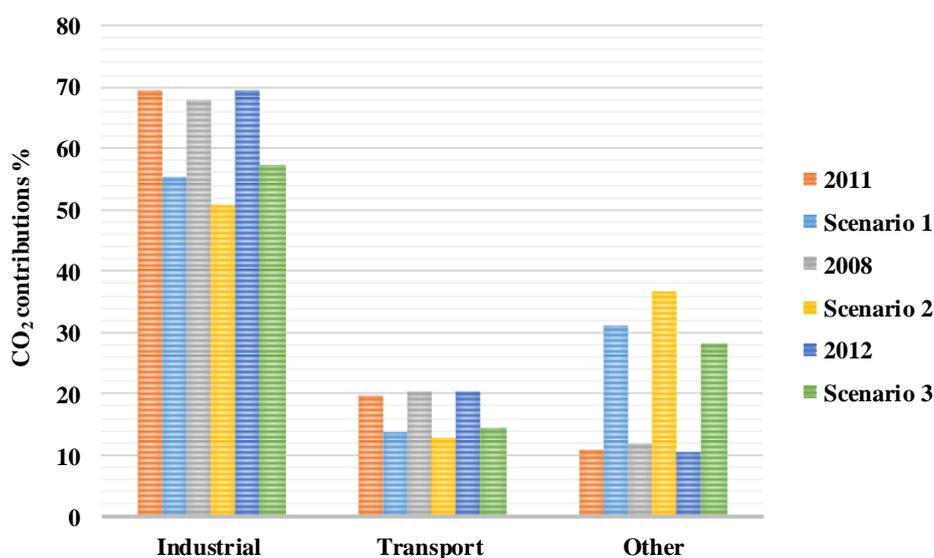


Fig. 6. Contributions in CO₂ emission for various years and for three scenarios.

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DISCLAIMER

There is not any companies or specific commercial products.

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