Coronavirus Pandemic: Opportunities and Challenges for Energy and Low-carbon Transition

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The outbreak of COVID-19 has become the biggest crisis for the world since World War II and there is little doubt that the world has entered a global economic recession. Currently, there are more than 2,160,000 confirmed cases and more than 145,000 deaths across the world (JHU, 2020). The impact of this pandemic is dramatic: cities or countries are in lockdown, factories or stores are shut down, and bars and schools are closed. Coronavirus has led to an astonishing shutdown of economic activity, which would lower energy use, just as every recession did in the history. The 2008 financial crisis and the Great Recession that followed, had a profound effect on the energy sectors in the world, with decreasing the price of crude oil from about $150/bbl. to $35/bbl. in only a few months. Many economists expect that the COVID-19 pandemic would have a much larger effect on economic activity than the 2008 financial crisis. Therefore, it would be important to quantitatively investigate what this pandemic implies for the energy market and low-carbon transition for different regions as well as the whole world.

The typical approach, i.e., input–output (IO) models have been used widely to examine the effect of economic crisis or policies in response to the crisis. For instance, David et al. (1995) used a 10-sector input–output model of the UK to simulate the effects of a variety of policies issues connected with energy use and environmental impacts; and the short-term economic damage of the novel virus outbreak has also been estimated based on such methods (Duan et al., 2020). However, the IO models fail to consider the optimization or adjustments that the economy can reach by its own in response to the crisis. Further, the changes in dynamic interactions among various countries resulting from the crisis are beyond the capability of the I-O model framework. In contrast, computable general equilibrium (CGE) models have the benefits of enabling active adjustments by consumers, producers, or policy makers, and thus they have been used to generate insights into the impacts of economic crises (see, e.g., Burfisher, 2017; Cui et al., 2019). With regarding to the impact of the epidemic, it would be valuable to capture the roles of the supply chains and international trades, given the increasing trends of globalization (Mukhopadhyay and Thomassin, 2009). In this context, we use a dynamic version of the Global Trade Analysis Project (GTAP) model, in this paper, to see how the COVID-19 pandemic has affect the energy transition and carbon emissions across countries, where one is able to see the dynamic effect of this pandemic.

According to the severity of the COVID-19 pandemic, we re-divided the world of the GTAP model into 7 regions, i.e., China, the U.S., European Union (28 countries included, EU_28), Japan, South Korea (SKorea), the Middle East and North Africa (MES), and rest of world (ROW). We consider epidemic shocks for all the regions from both production and consumption sides, and three scenarios are designed, i.e., the Base-case scenario, the Conservative scenario and Pessimistic scenario. Based on the historical economic, energy and carbon emission data, we calibrate the GTAP model and project the critical indicators in 2020; then mpacts of the pandemic are measured by comparing the corresponding results under the epidemic shocks with the 2020 projections.

Under the Base-case scenario, the pandemic will damage the world economy by 2.1%; given the 2.9% projection without epidemic, the real GDP growth of 2020 could be 0.8%, which is largely in line with the estimate of the IHS Markit (Behravesh and Johnson, 2020). As for China and the US, the negative shocks to economy reach 2.6% and 2.4%, which are

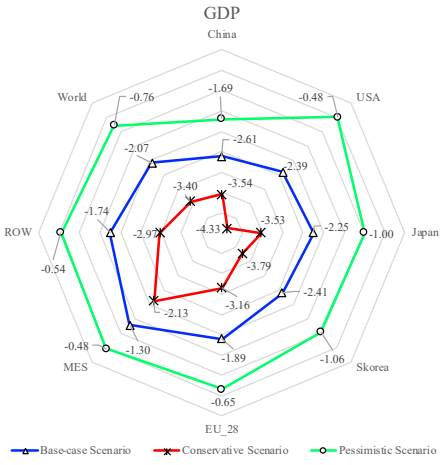

Figure 1. The impact of the COVID-19 pandemic on GDP across regions under different scenarios. These impacts are measured by percentage changes in GDP relative to the 2020 projections without epidemic.

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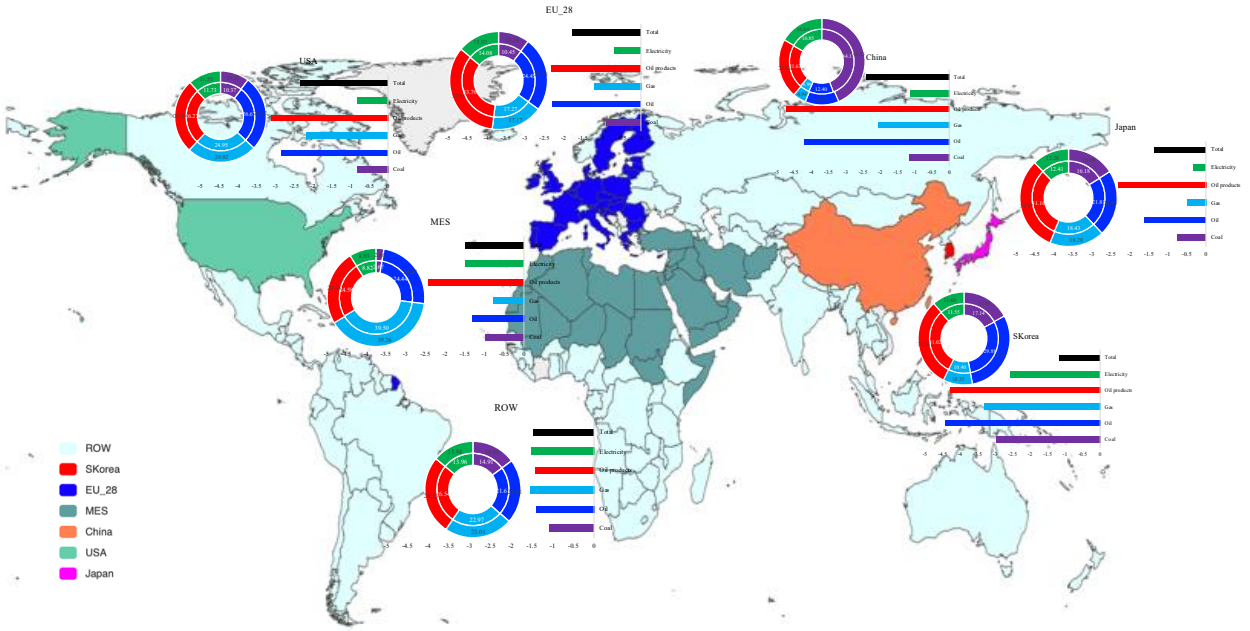

Figures 2. Cross-regional shocks of the COVID-19 outbreak on energy consumption under the base case. The world map portrays the region divisions of this work, and the bars show the impacts of the outbreak on consumption of different energy technologies and the total (percentage changes relative to no outbreak case). The doughnut charts give the changes in energy structure without (the outside doughnut) and with (the inside doughnut) the shocks of the COVID-19 outbreak.

greatly consistent with the estimates under the global pandemic case of Bloomberg Economics (Orlik et al., 2020). Under the Pessimistic scenario, the damages for these two countries may further approach to 3.5% and 4.3%, respectively, relative to baselines of no virus outbreak. The pandemic are also major blows to the EU and Japan's economy, with the corresponding impacts to be -1.9% and -2.3%, respectively under the base case (Figure 1).

We find that the COVID-19 pandemic will lead to a significant reduction in energy consumption for all the regions/countries in 2020 (Figure 2), especially for China and the U.S, the corresponding declines could be 2.4% and 2.3%, respectively. The industries of oil and oil products are the most affected energy sectors in all the regions, particularly for China and South Korea, in which the consumption of oil and oil products may decrease by up to 4.7% and 4.3% in 2020 under the base case. When turning to the U.S. and the EU, the negative shocks of the epidemic to their consumption of oil decline to 3.1% and 2.3%, versus 2.8% and 2.3% for the consumption of and oil products. In contrast, the pandemic plays a limited role in energy structures, which implies that the influence of the epidemic on energy system should be short term. At the same time, we can observe a relatively weaker impact of the COVID-19 outbreak on renewables, as shown in Figure 2, and such negative effects in China and the US are only around 1%. However, it is still difficult to determine the epidemic is an opportunity or challenge for future energy transition from fossil fuels to renewable. On one hand, the relatively weaker impacts of the pandemic on renewables may due to their minor roles in current energy structure, and this could not

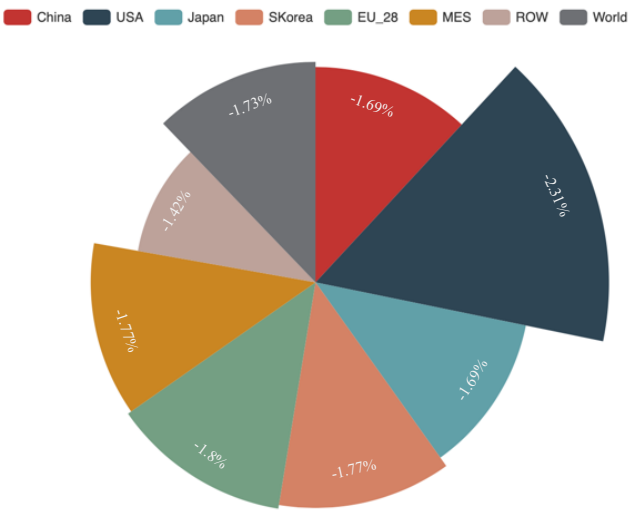

Figure 3. The impact of the COVID-19 outbreak on carbon emissions across regions under the Base-case scenario. These impacts are represented by percentage changes in carbon emissions relative to the 2020 projection.

lead to the conclusion that the epidemic is beneficial to the development of renewables. On the other hand, the big blows to global oil market do provide an opportunity for energy restructuring and the potential large-scale substitution of renewables for conventional energy.

The pandemic pauses the key of carbon emission increase. According to the chair of the Global Carbon Project, the world may usher in its first dip in carbon

emissions since the 2008 financial crisis, with the expected fall to be over 5% (Stone, 2020). Actually, we are not so optimistic about the fall, despite the observable carbon emissions in China and the whole world do dramatically decrease in the first quarter, and this situation should be changed in the coming quarters. As depicted in Figure 3, the world's total carbon emissions in 2020 under the base case may reduce by 1.7%, versus 2.3% and 1.7% for the US and China. It is of little probability that the COVID-19 pandemic will benefit the worsening climate change situation, since the short-term drop in CO_2 emissions play a negligible role in the cumulative carbon contents and atmospheric CO_2 concentration; mostly importantly, the lessons from the 2008 financial crisis show that the emission will retaliatorily rebound after the drop. However, the carbon fall associated with the outbreak do enhance the causality between human activities and carbon emissions.

In conclusion, the coronavirus pandemic will trigger a recession to the global economy, and the economic downturn for the US and China are extremely stressed this year. The COVID-19 epidemic may not shock the current energy structure, but does have a dramatically negative impact on the total energy consumption at both global and country scales, especially for the consumption of oil and oil products. As a result, the increasing trend of the world's total carbon emissions in the past decade ceases. However, this short-term fall in CO_2 emissions associated with the pandemic may not change the increasingly strict situation of global warming, which relies on long-term decrease in carbon emissions and substantial low-carbon energy transition.

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