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An Estimate on the Impact of a "City Lockdown" on the Global Energy Demand

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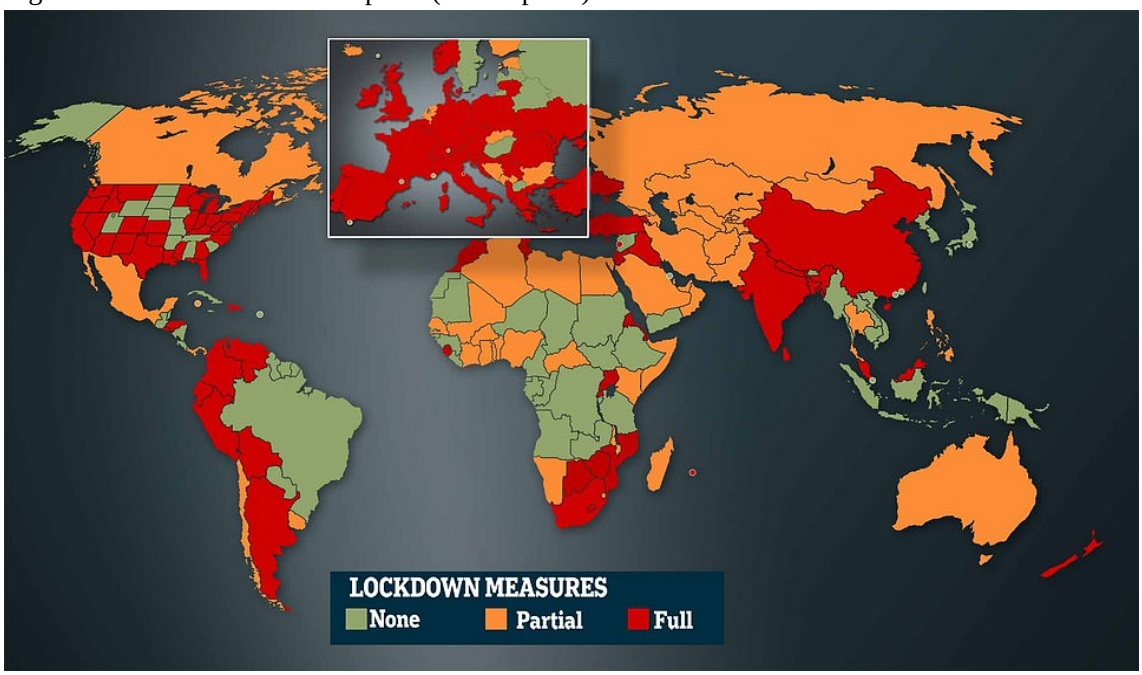
Introduction

The new coronavirus (COVID-19) pandemic is now spreading worldwide. According to the World Health Organization (WHO), 1.28 million people have been infected and 73,000 have died as of April 7. To prevent further contagion, many countries around the world are taking measures including imposing a "city blockade" or "city lockdown" that limits people from leaving their homes or traveling and imposes restrictions on economic activity and the daily lives of citizens mainly in highly-populated cities. A state of emergency was declared also in Japan on April 7 and a large-scale stay-at-home request was issued in seven prefectures, including Tokyo.

Fig. 1 Lockdown measures in place (as of April 2)



Source: Mail online
https://www.dailymail.co.uk/news/article-8181001/3-9-billion-people-currently-called-stay-homes-coronavirus.html
(date accessed: 2020/4/6)
Note) Full: restrictions on movement imposed on all or most residents/hours. Partial: restrictions on movement imposed on some residents/hours.

According to an estimate based on media reports, more than 120 countries are limiting residents from leaving their homes and approximately 4.1 billion people, or more than half of the world's

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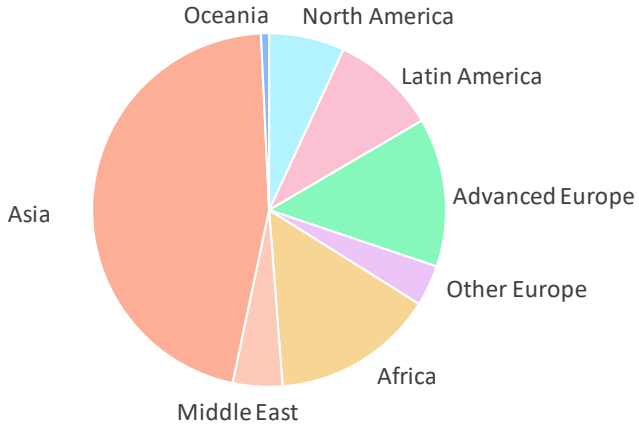
population, are under a city lockdown, though the strength of the policies, such as binding power, varies. About half of the total population under lockdown are concentrated in Asia (Fig. 2). In particular, India has prohibited its entire population of 1.3 billion from leaving their homes, accounting for the majority of the figures for Asia. Meanwhile, in China, the lockdown was lifted in Wuhan, which was where the pandemic started and the first to be locked down, on April 8. In advanced European countries where the contagion is spreading quickly, more than 90% of the population is under lockdown. Further, in the United States, more and more states are imposing lockdowns, covering an estimated three-quarters of the population.

Fig. 2 Ratio of the number of people under lockdown



Clearly, restricting the movement of people and economic and social activities in highly-populated cities where economic activity is concentrated is likely to cause a significant decrease in energy demand. The impact on the international energy market has already been enormous. In particular, in the oil market, the collapse of the joint production cut by oil producers in early March acted as a supply-side shock together with the COVID-19 pandemic as a demand shock, causing oil prices to crash. Going forward, this demand shock will continue to have a massive impact on the international markets for natural gas and LNG, as well as oil. Accordingly, this report estimates the impact on the global energy demand by hypothesizing the decline in activity levels in each country and area under lockdown, based on national energy data from the International Energy Agency (IEA). Note that this estimate adds up the impact of lockdown in different areas and obtains the value per day, which is the equivalent of an "instantaneous wind speed" of the impact of lockdown measures in place. In that respect, it differs in nature from the "Analysis of the Impacts of COVID-19 on the Global Demand for Oil, Natural Gas and LNG (Koyama and Suehiro, IEEJ, March 2020)," which calculated the annual and quarterly impact of COVID-19 on energy demand using a macroeconomic model.

Framework for the calculation

If we look at the countries and cities where a lockdown is already in place, lockdown measures vary considerably in the conditions and strength of restrictions. Many advanced European countries are issuing legally-binding orders to prohibit residents from leaving their homes, imposing fines on offenders in some cases. Meanwhile, in some countries including Japan, the government and municipalities can only request, without legal force, that residents voluntarily refrain from certain activities. Furthermore, in some countries, only the elderly are required to stay at home. Lockdown measures imposed on facilities also vary greatly, from closing all facilities and shops except for the bare minimum (groceries, pharmacies, etc.) to closing just those facilities with a high risk of infection (restaurants, entertainment facilities, religious facilities, etc.) Also, night-time curfews have been imposed in some African countries but their impact on energy demand could be limited.

As discussed above, lockdown measures vary in conditions and strength and it is difficult to incorporate the exact impact in each country and city into the calculation. Therefore, for simplicity of calculation, lockdowns are categorized into two types based on Fig. 1: "Full (restrictions on movement imposed on all or most residents/hours)" and "Partial (restrictions on movement imposed on some residents/hours)."[3] Then, the following assumptions on the impact on energy demand were applied in full to the countries categorized as "Full" and by half to those countries in the "Partial" category.[4]

This estimate focuses on the energy demand in the industrial (including chemical materials), residential, business (commercial), and transport sectors; the demand in areas such as agriculture, forestry, and fishery and international transport are not included. The assumptions on the impact on energy demand in each sector were set as follows by referring to Suehiro and Koyama (2020)[5].

The impact on **energy demand from industry** was estimated by sector. As the supply of daily necessities is critical, we assumed that the final demand for food, medical supplies, and daily consumables (sanitary paper products, detergents, cosmetic products, etc.) will be met. We also assumed that the production of supplies necessary to maintain the minimum necessary services such as energy and water supply, telecommunications and broadcasting, cargo and passenger transport, and retail will continue. In the case there is no demand for goods and services other than the bare minimum above, the rate of decrease in production (i.e. the rate of suspension of operation) in each industry was estimated using the input-output table[6].

The impact on the food sector is estimated to be small with a reduction of around 6–12% and relatively small for the pulp and paper and chemical sectors with around 20–30%. Meanwhile, sectors with a relatively large impact include the construction sector (around 90%) and ceramics, stone, and clay products sector (around 60–80%).

The impact on **residential energy demand** was estimated by purpose of use. Energy demand for the kitchen, and power and lighting are expected to increase as more people stay at home during the daytime due to requests to stay home and telework. The demand for air conditioning was estimated based on the average temperature in April in each country, but we assumed that there is no impact on demand in many countries, though with a few exceptions.

We estimated an increase of about 0–30% in air conditioning and a 10–30% increase in the use of lighting equipment and household appliances including TV depending on the country. Kitchen work is expected to increase by around 6% for preparing day-time meals. We assumed no impact on demand for hot water supply, refrigerators, and washing machines as there is no change in their use. Based on these assumptions, we estimated the impact on residential energy demand considering the number of people per household in each country.

The impact on **demand for business-use energy** was estimated by sector and purpose of use. Many offices and shops will close as the bulk of office workers switch to teleworking and more people refrain from going outside unless essential, but supermarkets (food), pharmacies, and hospitals will continue to operate. All schools and entertainment facilities will close, as well as most restaurants.

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3 The strength of the policy (whether it is an order, request, etc.) is not considered. Fig. 1 is as of April 2, but the changes thereafter were incorporated to the extent possible. Lockdowns have ended in China as of April 8. For Japan, the seven cities under a state of emergency are incorporated as "Full" into the estimate.

4 The estimate is based in principle on the energy demand of each country.

5 Suehiro and Koyama, "An Estimate on the Impact of a 'City Lockdown' on Japan's Energy Demand"

6 The input-output table issued by OECD was used. http://www.oecd.org/sti/ind/input-outputtables.htm

The decrease in energy demand for air conditioning, hot water supply, and kitchen work is estimated to be equivalent to the suspension rate in relevant sectors. However, the decline for power and lighting was set considering that they will continue to be used even during a business suspension.

Based on the number of workers in each sector in each country, we estimated the energy demand for each sector and calculated the impact on energy demand for each purpose of use. The results indicated a decrease of around 0–70% for air conditioning depending on the country, 60% for hot water supply, 70% for kitchen work and 50% for power and lighting. We estimated the impact on energy demand based on these assumptions and taking into account the floor space of businesses in each country.

The impact on **energy demand for transportation** was estimated by type of vehicle and means of transportation. Most passenger vehicles and motorcycles will stop being used as people refrain from going out except for essential purposes, but public transportation systems such as buses and railways will remain in operation to a certain extent for minimum transport. Further, freight transportation must continue for the logistics of goods and services to maintain the minimum supply needed for society.

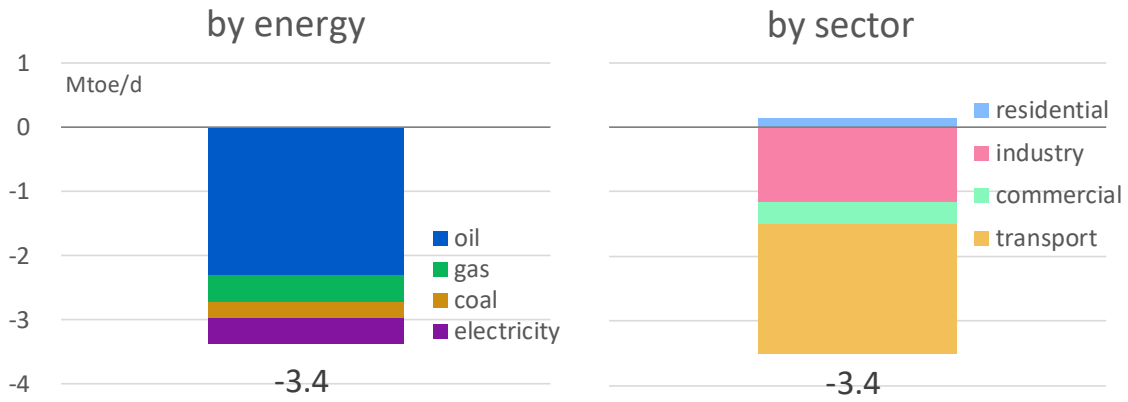
Operation was estimated to decrease by 80% for passenger cars and by 50% for freight vehicles and buses. The rate of operation of domestic airlines, railways, and ships was also estimated to go down by 50% for each. Note that the impacts on international airlines and maritime transport are excluded from this estimate.

Based on the assumptions above, we calculated the impact on energy demand in countries under lockdown. The impact was calculated on a per-day basis, so it would be greater if the lockdown is protracted. Note that the assumptions of impact represent a “Full” city lockdown, and the impact was discounted by 50% for countries under “Partial” lockdown.

Results of the calculation

Based on the assumptions and prerequisites for this estimate, the global final energy demand is estimated to be decreasing by 3.4 Mtoe (Mtoe: million tonnes of oil equivalent) per day due to city lockdown (Fig. 3). This is a 14% decrease from normal times (the daily average demand for 2017). The impact is the greatest in the transportation sector, accounting for about 60% of the overall decrease. By type of fuel, the demand for oil is seeing the greatest impact, accounting for about 70% of the overall decline of fuel demand. There is a very large impact on gasoline and diesel for vehicles as restrictions on going out suppress the movement of people and goods to extremely low levels. Industry sector is seeing the second greatest decline in energy demand while the impact on demand in households and businesses is relatively small. The relatively small impact on electricity demand may be attributable to the Asia region, which has the largest population under lockdown but a relatively low electricity consumption per person.

Fig. 3 Estimated impact of lockdown on the global final energy consumption (by energy and sector)



By region, the impact is greatest in North America and advanced European countries (Fig. 4). The two regions together account for about 60% of the global decline in energy. This indicates that lockdowns in advanced countries with a high rate of car ownership can have an extremely large impact on oil demand. Meanwhile, the decrease in energy demand is relatively small in Asia, which is home to half the population under lockdown, relative to its population, accounting for only about 20% of the global decrease. The reason for the relatively small decrease in Asia may be the low energy consumption per person due to the low rate of ownership of cars and electric appliances, and to the region's manufacturing industry which is still in the development stage (typically India).

On a primary energy basis[7], a global city lockdown lowers the energy demand by 4.1 Mtoe per day (Fig. 5). This is an 11% decrease from normal times. Oil is seeing the greatest impact and is decreasing by 18.1 Mb/d (barrels per day) or 20% from normal times globally. As expected, the bulk of the decrease in oil demand is due to Europe and North America which are under strict city lockdowns and have a high rate of car ownership. The decline in oil demand is 5.7 Mb/d in North America and 5.0 Mb/d in advanced European countries, accounting for 31% and 27% of the total decrease, respectively. In Asia, the decrease in oil demand is 2.8 Mb/d (15%). Meanwhile, the demand for natural gas and coal decreases by 11% and 8%, respectively, from their global consumption in 2017. The impact on these energies including power generation fuel is not as high as that on oil, because the impact on electricity demand is relatively small. The decrease in the overall global demand for gas is 1.1 Bcm/d (1.1 billion cubic meters per day), or about 780,000 tonnes per day in LNG-equivalent[8]. Here again, the greatest decline in demand comes from Europe and North America which are under strict city lockdowns and have a large natural gas consumption. The decrease in natural gas demand in Asia is approximately 90,000 tonnes per day in LNG-equivalent, and the combined decreases in Asia and advanced European countries, which are major net natural gas importers, stands at approximately 290,000 tonnes per day in LNG-equivalent. If the city lockdowns causing this decline continue for 30–60 days, the cumulative decrease in gas demand would be approximately 8.7–17.4 million tonnes in LNG-equivalent and have a serious impact on Russia and other gas-producing countries and the international gas and LNG industries.

Fig. 4 Estimated impact of a city lockdown on the final energy demand of each region

[7] The decrease in electricity demand was converted into generation fuel input based on the average thermal power efficiency in each region.

[8] There are two possibilities regarding the decrease in natural gas demand for the entire world (1.1 billion cubic meters, approx. 780,000 tonnes of LNG-equivalent): decrease in pipeline supply or as demand for LNG. In the actual market, this will depend on the economic efficiency and supply availability of the two sources.

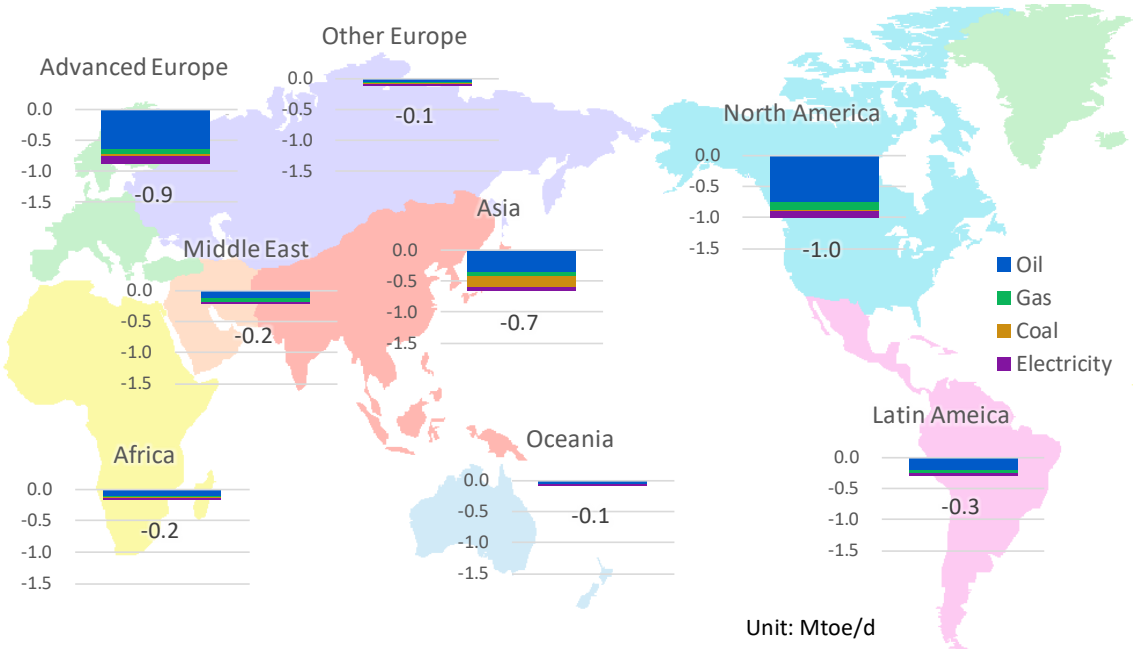
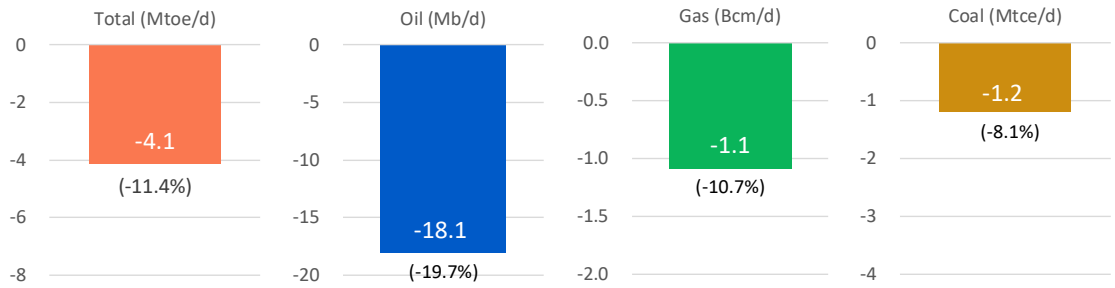


Fig. 5 Estimated impact of a city lockdown on the global primary energy demand



Note: The percentage in parentheses is the change from normal times (the average demand per day in 2017). The use of traditional biomass is excluded.

Conclusion

The daily energy demand will see a significant drop as a result of city lockdowns. Based on this estimate, the demand for oil, mainly for transportation in particular, will decrease by as much as 20%. The longer the city lockdowns continue, the harder total demand will be hit. This massive decline in demand, if it continues or worsens, will inevitably exacerbate the supply glut in the international energy market. Since the beginning of April, the world has been keenly watching moves to reinstitute the joint production cut by oil producers. However, unless the producers can agree on drastic cuts, oil prices will be subject to powerful downward pressure. Some consider that even if a production cut is agreed, the decline in oil demand is so large, as indicated by this estimate, that a supply glut cannot be avoided completely. Nevertheless, a production cut, if achieved, could delay the time when oil stocks exceed the total stockpiling capacities of countries and start flooding the market, and buy time to ramp up capacity to hold stock. At the very least, the market will start to face powerful downward pressure if oil producers fail to agree to cut production.

This estimate was obtained through calculations based on hypotheses set up for various forms of city lockdowns. The results should be viewed with caution as the availability of detailed data on each country and area is limited to a certain degree. It should also be noted that the slowdown in the global economy will also affect economic and social activities in countries not under lockdown, but such countries are not included in this estimate. Furthermore, the decline in energy demand associated with

COVID-19 is being caused not only by city lockdowns but also by declines in macroeconomic activity. Thus, the actual decrease may exceed that caused just by city lockdowns considered in the present estimate. While recognizing these issues, we hope that the results presented here will be a useful reference to all those involved in the international energy market.

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