The Short-run and Long-run Effects of Covid-19 on Energy and the Environment

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Abstract:

In this commentary, we explore how the short-run effects of Covid-19 in reducing CO2 and local air pollutant emissions can easily be outweighed by the long-run effects of a slowing of the clean energy innovation. Focusing on the United States, ~~We~~ we show that in the short run, Covid-19 has reduced energy consumption for jet fuel and gasoline dramatically, by 50% and 30% respectively, while overall electricity demand has declined by less than 10%. CO2 emissions have declined by 15~~20~~%, while local air pollutants have declined as well, saving about 200 lives per month. However, if there is a slow recovery and deep impact on long-run innovation in clean energy, the short-run emission reductions will have long-run impacts, including an additional 2,500 MMT CO2 and 40 deaths per month on average from 2020 to 2035. Even pushing back renewable electricity generation investments by one year would outweigh the emission reductions and avoided deaths from March to June~~May~~ of 2020. We emphasize that the policy response will determine how Covid-19 ultimately influences the future path of emissions. A quick stabilization of the economy and action to expedite permitting and invest in clean energy can make all the difference.

Main text:

The Covid-19 pandemic has upended the world. Any time there is a major change in economic activity, there will be implications for the environment. We take a macro-level perspective on the environmental effects of Covid-19 in both the short-run and long-run. In the short run, there has been an emptying of our roads, skies, factories, and commercial office buildings, reducing emissions and clearing the air, but at a dramatic cost to overall well-being and the economy. In the long-run, the implications of Covid-19 are deeply uncertain. We present two illustrative thought-experiments to provide insight into the long-run environmental effects of the pandemic, drawing upon evidence from previous economic shocks. These insights on long-run effects provide ~~useful~~ guidance for policy to mitigate potential long-run negative implications.

In the short run, the reduced emissions from Covid-19 are substantial, but the health benefits from the cleaner air do not come close to outweighing the direct loss in life from the pandemic in the United States. If the threat from the pandemic subsides ~~in a matter of months~~relatively quickly and the economy rebounds, there should be few long-run implications. However, if the struggle against Covid-19 leads to a persistent global recession, there is a real long-run threat to the adoption of clean technology, which could even outweigh any short-run "silver lining" environmental benefits due to both Covid-19 and the recession. Whether this occurs ~~substantially~~ will depend~~s~~ on the ~~nature of the~~ policy response.

Our focus is on the United States, but our main findings could ~~should~~ apply more broadly across much of the developed world, including many European countries. Fundamentally, it is t~~In addition, we emphasize that t~~he *global* response to the pandemic ~~will be crucial for~~that will determine ~~how~~ the long-run effects ~~play out~~.

Short-run Effects

Covid-19 has directly led all of the world's largest economies to come to a near-standstill, with widespread shutdowns ~~around the world~~ and restrictions remaining even when shutdowns have been relaxed. Conferences, gatherings, and travel of all types have been deeply curtailed. Large swaths of the economy ~~have closed~~have been affected. One silver lining in this devastating circumstance is that it has led to reductions in emissions, including greenhouse gas emissions and local air pollutant emissions, due to the decline in the demand for energy.

We explore these reductions by comparing energy consumption in late March to ~~May 20~~June 7, 2020, after the pandemic began~~when all of the shutdowns were in place across the United States~~, to consumption before the shutdowns. ~~We control for seasonal patterns in consumption, climatic conditions, and renewable generation.~~ We predict energy consumption during the shutdowns by ~~estimating~~controlling for the impacts of weather, renewable generation and seasonal patterns~~ in consumption, using pre-shutdown data~~ (~~. See~~ see SM for details).

Figure 1 displays the results. Panel (a) shows that the largest percentage declines in energy consumption are from jet fuel and gasoline, with reductions of 50% and 30% that appear persistent (panel c), in line with estimates of personal vehicle travel.[1] In contrast, most other categories have observed smaller reductions. Use of natural gas in residential and commercial buildings has declined by ~~14~~almost 20%, while overall electricity demand (and demand for coal-fired electricity) has declined by less than 10%. While commercial and industrial electricity use may have been ~~dramatically~~ affected by the shutdowns, some of the decline was offset by increased residential electricity demand from people staying at home, and by June, electricity consumption has largely returned to the trend (panel d).[2]~~[1]~~

Panel (b) illustrates the declines in CO_2 emissions corresponding to the reductions in energy use. The largest reductions are in gasoline but the ~~decline in~~ natural gas~~ consumption~~ decline leads~~s~~ to nearly as large a reduction in CO_2 emissions as for jet fuel. These reductions imply a roughly 15~~20~~% total reduction in daily CO_2 emissions, which will be the largest annual percentage decline for the United States in recorded history, should this drop continue. For context, the decline in CO_2 emissions is not much larger than the declines laid out in the ~~United States~~U.S. Nationally Determined Contributions under the Paris Agreement, but the sources of the decrease are entirely different than would be expected under an optimal emissions reduction strategy focusing on both behavioral and structural changes to the energy system. Other estimates tend to focus on the world rather than the United States~~, and tend not to use an econometric~~~~for the United States~~~~ methodology~~ or do not cover all fuels. While estimates for the United States cover a very wide range,~~ although~~ our finding is ~~not far~~similar to~~ from~~ the 17% global decline in CO_2 emissions for the period through April 2020.[3]~~[2]~~

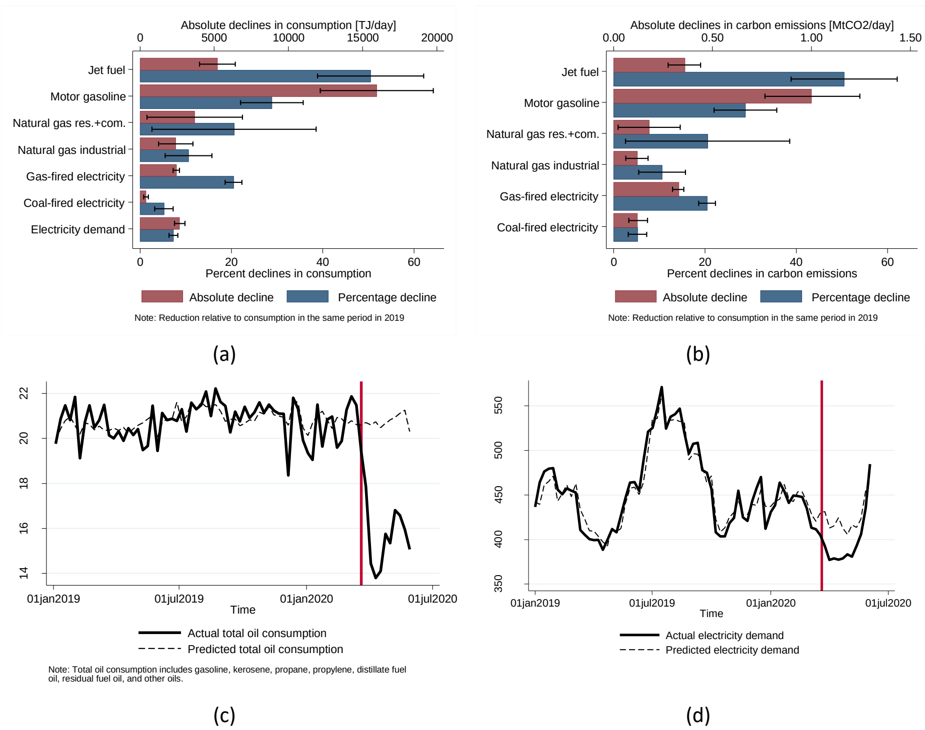

Figure 1. Short run reductions in energy use and emissions due to Covid-19 in the United States

The reductions in energy demand are also reducing emissions of local air pollutants that affect near-term human health. We calculate the reductions in SO2, NOx, VOC, and PM emissions (see SM for details). The reductions range from ~~16~~12% for NOx to 1% for PM. We estimate that the shutdowns save about 200 lives per month, primarily driven by the lower PM emissions from transportation. Of course, these are a small consolation for the over ~~55~~ 100 ~~thousand~~,000 confirmed deaths due to Covid-19 ~~in March and April~~ before June 2020. ~~But it is notable that there is a documented correlation between Covid-19 deaths and NO_2 concentrations.[3]~~

Along with the reduction in driving from the shutdowns has also come a decline in traffic accidents and congestion. For example, the number of ~~average~~ crashes over the period March 13, 2020 to early April are~~is~~ less than half of ~~what it was in~~ the previous year, ~~with the ratio falling by 2% per day after March 13,~~ although fatal crashes did not decline by as much, perhaps due to the remaining vehicles being driven longer (see SM ~~for more details~~).

There is also a more subtle impact due to the shutdowns: most investment in the low-carbon transition has come to a halt. Global electric vehicle sales are projected to decline by 43% in 2020[4], due to the plummeting auto sales overall combined with low gasoline prices. ~~Nearly all~~New residential rooftop solar

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and storage installations ~~are on hold~~have plummeted, as ~~are nearly all~~have energy efficiency audits. Even at the utility-scale, renewable developments have been slowed~~ or on hold~~. Overall clean energy jobs dropped by ~~over ~~almost 600~~106~~,000 by the end of April~~in March~~.[5] While these are short-run impacts, they may have long-run effects.

Long-run Effects

While the short-run effects of Covid-19 are already clear, the long-run effects are highly uncertain. How the pandemic influences emissions and health outcomes in the long run depends on how long it takes to bring the pandemic under control and whether the pandemic leads to a persistent economic contraction. To develop insight in the presence of such deep uncertainty, we consider two illustrative "thought-experiments"~~ or scenarios~~ that roughly bound what might happen, while emphasizing that the true outcome may fall in between these scenarios or, while unlikely, could be even more extreme than either. ~~A key distinction between these two scenarios is whether demand for products and services is deferred or destroyed by the pandemic.~~

The first thought-experiment considers a best-case scenario, where the world develops treatments and effective low-cost strategies to control Covid-19, so that the economy can be progressively re-opened within a matter of several months, and entirely reopened by the end of 2020. While there would be thousands of deaths~~ from the pandemic~~, the worst projections of millions of lives lost were averted in this scenario. ~~In this case~~Thus, Covid-19 would be a relatively short-lived shock to the world economy. Most demand for products and services will be deferred rather than destroyed, so when the entire economy is safely reopened, there will be a massive rebound in economic activity, likely even surpassing the activity prior to the outbreak.

The implications of Covid-19 will thus only be a ~~small, ~~temporary reduction in emissions~~, as the economy returns to business-as-usual~~. The trends prior to the pandemic will continue after a brief lapse, including investments in green technologies. For example, wind and solar capacity were increasing rapidly prior to Covid-19—an increase of 10.5% in 2019[6], and in this scenario new installations will pick up where they left off. Energy efficiency investments will continue as if the pandemic~~brief interlude~~ had never happened. Overall energy-using habits will return to the pre-existing trend after a rebound, leaving policymakers largely~~ right back~~ where they were prior to Covid-19, albeit with more budgetary challenges.

We view our second thought-experiment as more likely. In this scenario, the consequences of Covid-19 are far-reaching, with many more deaths, deeper disruptions to supply chains, and a persistent global recession. This could come about if there are continued flare-ups requiring backpedaling on re-opening of the economy~~shutdowns prove necessary for many months because of the lack of success in containing the virus~~ and would be exacerbated if developing a successful vaccine in a timely manner proves impossible. ~~Should the public health challenges spill over into longer economic challenges~~In this scenario, ~~the ~~substantial demand for goods and services will be~~ more likely to be~~ destroyed, rather than deferred, and real production will be reduced.

In this case, there will be a direct effect and an indirect effect. The direct effect is the short-run emissions reductions due to Covid-19 and the ~~subsequent ~~associated recession. We can examine the effects of the Great Recession beginning in 2008 for some guidance on the effects of recession. Between 2008 and 2013, U.S. energy-related CO2 emissions fell by nearly 10%.[7]

The indirect effect is due to changes in behavior and investment. Should shutdowns continue for an extended period of time, workers and employers may be sufficiently comfortable with remote working that even after the threat has passed, this option may continue to be popular. This would ~~likely~~ reduce travel but increase likely building energy use. Home energy use would increase, while commercial building use would remain largely unchanged if office space is used in a similar manner by the remaining employees, implying a modest net effect. However, one cannot rule out more substantial changes in commercial building use if telecommuting becomes widespread. Another behavioral response might be if individuals remain fearful of taking public transportation even after the pandemic is under control, and switch to driving instead. But this will likely be a ~~we see this effect again as a likely~~ modest effect in the United States, as only about 5% of commuters take public transport.[8]

The more important long-run indirect effect of Covid-19 in this case is likely to be on energy sector investment. The most marginal firms, including new firms that have yet to show a profit, are those most likely to liquidate. This could include~~s~~ coal mining firms due to the decreased demand for electricity and the declining profitability of coal-fired generation, but it also includes firms developing low-carbon technologies. In a recession, with financing drying up, and low wholesale electricity prices due to reduced electricity demand, renewables investments will decline. This will affect ~~both~~ rooftop solar, ~~and~~ utility-scale solar, and energy efficiency investments~~. It would also affect energy efficiency investments by firms and households~~.[9] The transition to a cleaner vehicle fleet would also be affected. The short-run decline in electric vehicle sales would persist, but perhaps more importantly, cash-strapped automakers will be hard-pressed to continue investing as much in new vehicle technologies to improve efficiency and there will be a reduced~~continued effects on the~~ roll out of charging infrastructure.

To explore the implications of a more severe scenario, we perform an illustrative modeling exercise on how the long-run emissions would be affected (see SM ~~for details~~). We find that under plausible assumptions on how the pandemic could delay investments in clean energy technologies and vehicle fuel economy, the long-run impact on CO_2 and local air pollutant emissions could easily outweigh the short-run reductions. After netting out the short-run reduction in economic activity due to the pandemic, we calculate that delays in investments in renewables and ~~electric vehicles~~vehicle fuel economy alone could lead to an additional 2,500 MMT of CO2 from 2020 to 2035. The additional local air pollutants could lead to 40 deaths per month on average or 7,500 deaths from 2020 to 2035. In our simulations, we assume no *permanent* changes to consumption from the pandemic. But we calculate that if there are such changes, they would need to be large—at least 4% of total energy-related emissions—to compensate for the delayed investment. Similarly, coal retirements would have to more than double from pre-pandemic forecasts to offset the delayed investment (see SM). ~~Similarly, we need to retire twice as much coal capacity by 2023 than anticipated to offset the delay in renewable investment.~~

Our findings suggest that even just pushing back all renewable electricity generation investments by one year would outweigh the emissions reductions and avoided deaths from March to~~and~~ June~~April~~ of 2020 ~~(see SM for details)~~. However, the energy policy response to Covid-19 is the wild card that can change everything.

Implications for Policy

Even if the world does face our second thought experiment, long-run emission~~s~~ increases ~~from a slowing of the adoption of new technology is~~are not pre-ordained. The government policy response is crucial.[9 10] And t~~T~~here is a real reason to be concerned. Government budgets are going to be stretched thin in paying for the costs of Covid-19, making it[more difficult to invest in clean energy and public transportation.

Commented [OM1]: Looking at my estimates, the short-term effect of lower electricity demand on coal-fired electricity generation is very small (-40 TWh/year compared to -250 TWh/year for gas), so unless COVID leads to long-term increases in anti-coal regulation or higher relative coal prices, I don't expect the effect on coal to be extremely large in the longer term – especially if we expect sluggish renewable investment.

Commented [OM2]: R1 and R3: add a bit more!

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Lt energy effect + right before caveat something about coal

Commented [OM4]: EVs are not being modeled

Furthermore, if the economy remains in a persistent recession, there may be intense pressure to relax climate change mitigation targets. But there is also an opportunity.

Many nations around the world, including those in the EU, UK, Japan, and South Korea are considering stimulus packages explicitly focusing on clean energy. But ~~I~~in the United States, it is unlikely to us that clean technology and infrastructure will be at the heart of any stimulus package in the near future, ~~but it~~even if that possibility cannot be ruled out. The ARRA stimulus package in 2009 allocated sums towards clean energy investment ~~that are dwarfed by the sums in the packages today~~and similar investments are in the policy debate.~~[10]~~ [11] Even a modest allocation towards new technologies may pay dividends in the future in terms of clean air, clean jobs and national security.[12] ~~As our discussion also showed,~~But simply stabilizing the economy ~~we~~could be ~~very~~ valuable for putting the trends toward clean energy back on track.

At the state level, there may be more room for policy action. If financing dries up for new investment in renewables, state green banks can help bridge the gap. States can also expedite permitting, while of course retaining environmental and other safeguards. Covid-19 may also remind voters and policymakers that collective action and listening to scientists matters, leading to greater efforts on policy to reduce emissions, possibly even including carbon pricing. The research community could start new endeavors analyzing potential policy options to help bring us out of the malaise of Covid-19. These developments would be a true "silver lining" to the Covid-19 crisis.

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~~Ogen, Y. (2020). Assessing Nitrogen Oxide (NO_2) Levels as a Contributing Factor to Coronavirus (COVID-19) Fatality, *Science of the Total Environment*, 726: 138605~~

~~3.~~4. WoodMac (2020) Global Electric Vehicle Sales to Drop 43% in 2020. April 8, 2020. https://www.woodmac.com/press-releases/global-electric-vehicle-sales-to-drop-43-in-2020/

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~~5.~~6. EIA (2020a). Electric Power Monthly. Available at: https://www.eia.gov/electricity/monthly/

Commented [OM5]: R2: U.S. government stimulus package has national security benefits

Commented [OM6]: R2: Adding this? https://www.utilitydive.com/news/treasury-department-offers-wind-industry-coronavirus-lifeline-with-proposed/577720/

And other extensions, as shown on p.16 of https://webstore.iea.org/download/direct/2999

Commented [OM7]: R2: Stimulus packages in other regions:

Could refer to table on p. 74 of https://www.iea.org/reports/world-energy-investment-2020 for summary of proposed stimulus packages.

Or this table (where the money has gone): https://www.bloomberg.com/features/2020-green-stimulus-clean-energy-future/ The governments of the world's 50 largest economies have committed nearly $12 trillion to the coronavirus recovery. Of that, only about $18 billion has been targeted at post-carbon economic priorities such as developing renewable energy or incentivizing clean industry.

Europe redoubles its commitment to the Green Deal in a €750 billion ($826 billion) recovery package (including a carbon border tax!) https://ec.europa.eu/commission/presscorner/detail/en/ip_20_940

~~6.~~7. EIA (2020b). Monthly Energy Review. Available at: https://www.eia.gov/totalenergy/data/browser/

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