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Commentary

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

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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 clean energy innovation. Focusing on the United States, we show that in the short run, Covid-19 has reduced consumption of jet fuel and gasoline dramatically, by 50% and 30% respectively, while electricity demand has declined by less than 10%. CO₂ emissions have declined by 15%, while local air pollutants have also declined, saving about 200 lives per month. However, there could be a deep impact on long-run innovation in clean energy, leading to an additional 2,500 million metric tons (MMT) CO₂ cumulatively and 40 deaths per month on average from now to 2035. Even pushing back renewable electricity generation investments by one year would outweigh the emission reductions and avoided deaths from March to June of 2020. The policy response will determine how Covid-19 ultimately influences the future path of emissions.

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 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 of life from the pandemic in the United States. If the threat from the pandemic subsides 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 will depend on the policy response.

Our focus is on the United States, but our main findings could apply more broadly across much of the developed world, including many European countries. Fundamentally, it is the *global* response to the pandemic that will determine the long-run effects.

Short-run Effects

Covid-19 has directly led all of the world’s largest economies to come to a near-standstill, with widespread shutdowns 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 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 June 7, 2020, after the pandemic began, to consumption before the shutdowns. We predict energy consumption during the shutdowns by controlling for the impacts of weather, renewable generation, and seasonal patterns (see [Supplemental Information](#) for details).

[Figure 1](#) displays the results. (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 (see C for overall oil consumption over time), 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 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 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 (D).²

(B) illustrates the declines in CO₂ emissions corresponding to the reductions in energy use. The largest reductions are in gasoline, but the natural gas decline leads to nearly as large a reduction in CO₂ emissions as for jet fuel. These reductions imply a roughly 15% total reduction in daily CO₂ 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 CO₂ emissions is in line with the declines laid out in the 2025 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 or do not cover all fuels. While estimates for the United States cover a very wide range, our finding is similar to the 17% global decline in CO₂ emissions for the period through April 2020.³

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, nitrogen oxides (NO_x), volatile organic compounds (VOCs), and particulate matter (PM) emissions (see [Supplemental Information](#) for details). The reductions range from 12% for NO_x 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 small consolations for the over 100,000 confirmed deaths due to Covid-19 before June 2020.

Along with the reduction in driving from the shutdowns has also come a decline in traffic accidents and congestion. For example, the number of crashes over the period of March 13, 2020 to early April are less than half of the previous year, although fatal crashes did not decline by as much, perhaps due to the remaining vehicles being driven longer (see [Supplemental Information](#)).

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 2020⁴ due to the plummeting auto sales overall combined with low gasoline prices. New residential rooftop solar and storage installations have plummeted, as have energy efficiency audits. Even at the utility scale, renewable developments have been slowed. Overall clean energy jobs dropped by almost 600,000 by the end of April.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

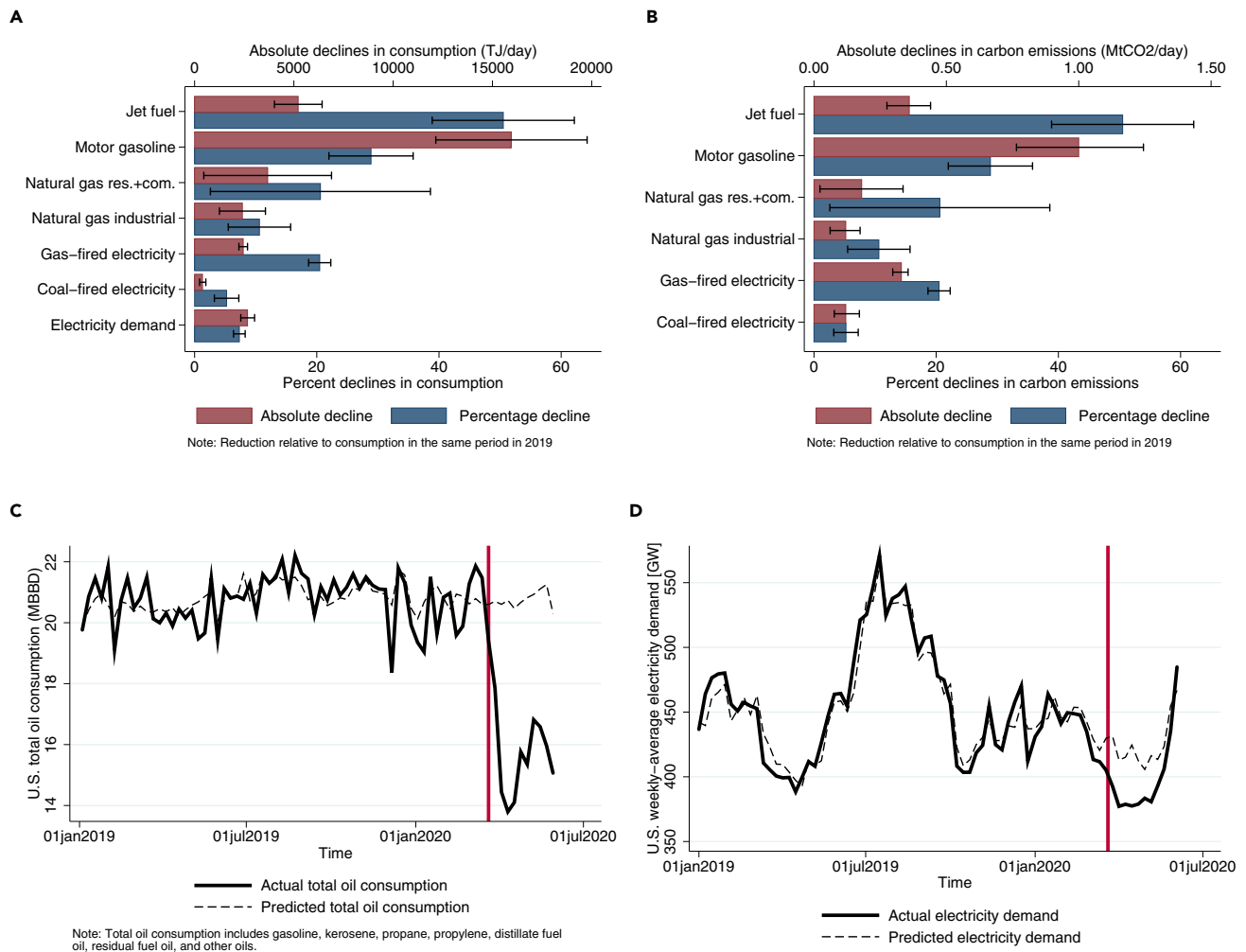


Figure 1. Declines in Energy Consumption and Emissions Due to Covid-19

Short-run reductions in energy use (terajoule [TJ]/day) and emissions (metric tons CO₂/day) due to Covid-19 in the United States. Note: 99% confidence intervals shown in (A) and (B).

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” 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.

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 reopened within a matter of several months and entirely reopened by the end of 2020. While there would be thousands of deaths, the worst projections of millions of lives lost were averted in this scenario. 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.

Thus, the implications of Covid-19 will only be temporary reductions in emissions. 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 had never happened. Overall energy-using habits will return to the preexisting trend after a rebound, leaving policymakers largely where they were prior to Covid-19, albeit with more budgetary challenges.

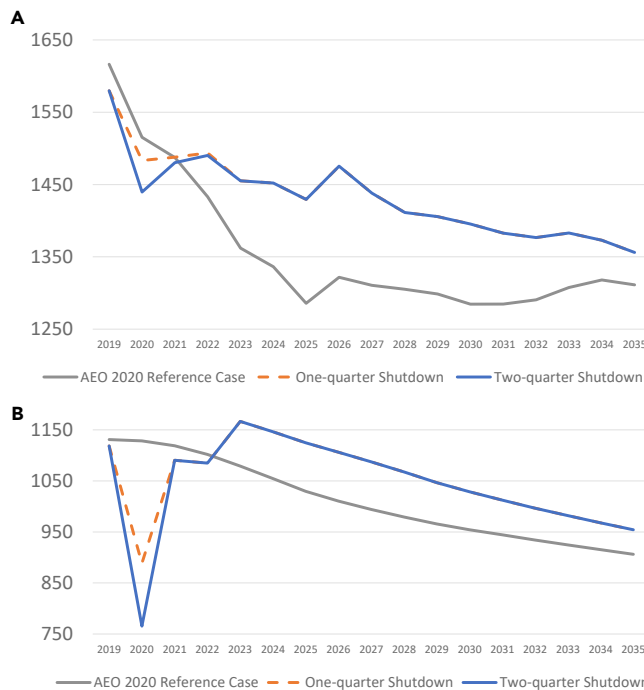


Figure 2. Illustrative Scenario of the Long-run Effects of Covid-19

Trajectory of CO₂ emissions (MtCO₂ per year) from (A) electricity generation and (B) light-duty vehicles in the United States because of short-run reductions of energy use and delayed investments in clean energy technologies and vehicle fuel economy.

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 and would be exacerbated if developing a successful vaccine in a timely manner proves impossible. In this scenario, substantial demand for goods and services will 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 reduction due to Covid-19 and the 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 become sufficiently comfortable with remote working that even after the threat has passed, this option continues to be popular. This would reduce travel but likely increase 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 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 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 rooftop solar, utility-scale solar, and energy efficiency investments.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 diminished rollout of charging infrastructure.

To explore the implications of a more severe scenario, we perform an illustrative modeling exercise on how long-run emissions would be affected (see [Supplemental Information](#)). Figure 2 displays the average trajectory of CO₂ emissions from electricity generation and light-duty vehicles. For comparison, we also show what the short-run reduction would look like if it extended over either one or two quarters. 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 CO₂ 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 vehicle fuel economy alone could lead to an additional 2,500 MMT of CO₂ cumulatively 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 renewables investment (see [Supplemental Information](#)).

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 June of 2020. 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 increases are not preordained. The government policy response is crucial.¹⁰ And there 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. 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 in the United States, it is unlikely that clean technol-

ogy and infrastructure will be at the heart of any stimulus package in the near future even if that possibility cannot be ruled out. The American Recovery and Reinvestment Act stimulus package in 2009 allocated sums toward clean energy investment, and similar investments are in the policy debate.¹¹ Even a modest allocation toward new technologies may pay dividends in the future in terms of clean air, clean jobs, and national security.¹² But simply stabilizing the economy would be 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.

Data and Code Availability

The data and code reported in this paper have been deposited in Github, https://github.com/MartenOvaere/energy_longruneffects_covid19_Joule.

SUPPLEMENTAL INFORMATION

Supplemental Information can be found online at <https://doi.org/10.1016/j.joule.2020.06.010>.

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