Changes in Electricity Use following COVID-19 Stay-at-home Behavior

Dylan Brewer[a]

1. Motivations underlying the research

The COVID-19 pandemic and associated stay-at-home policies and behaviors have significantly damaged the health and livelihoods of millions of individuals worldwide. Moreover, many energy scholars showed that electricity demand had sharply declined during the early months of 2020, noting that electricity demand could serve as a real-time proxy for overall economic activity. In addition, one of the few "silver linings" expected to come out of the pandemic is a reduction in local and global pollution from a reduced demand for fossil fuels used for transportation and electricity generation. However, as stay-at-home policies expired in areas where the initial outbreak of the virus had subsided, commercial activity resumed to an extent, and individuals and firms had the opportunity to make up for lost economic activity during earlier months. In addition, as households spent more time in quarantine, they had the opportunity to adapt behavior to the home environment, potentially increasing the use of electrical appliances for work in new home offices or acquiring additional electronics for at-home leisure. Any long-run economic losses or environmental health benefits from changes in energy use during the pandemic would have to be from permanently *displaced* consumption of energy rather than *delayed* consumption of energy.

2. A short account of the research performed

Similar to the approach used by the agencies, we estimate benefits and costs by comparing a scenario with the new standards and a scenario that holds the standards fixed at their 2011 levels. We examine the effects of low gasoline prices by comparing benefits and costs under high and low gasoline price scenarios.

This paper provides the first empirical evidence that electricity use increased following the expiry of initial stay-at-home policies and behaviors. To evaluate the longer-term impact of staying at home on electricity consumption, I analyze data on hourly electricity use in the PJM Interconnection of the United States during 2020. The analysis uses a nonparametric matching algorithm to predict electricity consumption for 2020 based on weather patterns and hourly, daily, and monthly seasonality if 2020 consumption resembled consumption from the previous five years. This predicted consumption serves as the counterfactual electricity consumption for a difference-in-predicted-differences estimation that compares the difference between actual electricity consumption and predicted consumption during 2020 before and after the start of the pandemic. This empirical strategy allows me to control for weather patterns, seasonality, and unobserved differences between 2020 and previous years. The results show that during the initial surge of COVID-19 cases and stay-at-home policies from March through May 2020, total electricity use was 2.7-3.8% lower than predicted consumption each month; however, after these policies expired in June 2020, total electricity use increased relative to the predicted baseline and in August was and 3.5% *higher* than predicted consumption.

To understand the mechanisms behind these dynamics, I analyze the relationship between stay-at-home behavior and electricity consumption using cell-phone location data provided by SafeGraph. These data include the median amount of time devices spent at home in each US census block. After matching census blocks to PJM zones, I use the amount of time spent at home as a third difference in the aforementioned difference-in-predicted differences strategy. In addition, I analyze monthly nationwide reported electricity consumption data by sector at the utility level to determine whether residential

a Georgia Institute of Technology, School of Economics, 221 Bobby Dodd Way, Office 224, Atlanta, Georgia 30332, brewer@gatech.edu.

demand or recovering commercial and industrial demand can explain the summer increases in electricity consumption. Finally, I estimate the summer temperature-electricity exposure-response relationship for 2014-2019 versus 2020 to test the hypothesis that cooling more residential homes during the day is more costly than cooling workplaces.

3. Main conclusions and policy implications of the work

Using hourly electricity consumption data in a difference-in-predicted-differences strategy, this article shows that while electricity consumption declined by 3.8, 3.8, and 2.7% in the first three months of the COVID-19 pandemic, electricity use was 3.5% higher in August 2020. Electricity consumption in September through November was roughly normal compared to the predicted baseline, while consumption in December was 3.0% higher than the predicted baseline. Cell-phone location data on stay-at-home behavior show that more time spent at home decreases electricity consumption and that time spent at home substantially decreased after May. Nationwide monthly data on electricity consumption by load class reveals that commercial and industrial consumption was below its expected baseline from March-November 2020, while residential consumption was above its expected baseline, peaking in July. As a whole, the early reductions in electricity consumption were offset by the summer increases, with an overall effect of an increase in electricity consumption of 1.08%. The zone serving electricity to Chicago experienced consistent declines in electricity consumption, while zones covering rural areas saw the largest summer rebounds.

These results have several key policy implications for future pandemics or for a work-from-home environment where households spend substantially more time at home. Increased electricity consumption has important implications for the growing literature examining ``silver linings" of the pandemic. To the extent that electricity generation contributes to local and global air and water pollution, the gains will be smaller than expected due to increased demand for cooling in the summer months. Future work in this area should focus on air and water quality improvements from reduced commuter traffic and should acknowledge that the pandemic did not uniformly decrease electricity consumption. Policies targeting residential electricity consumption will target a larger proportion of load in these scenarios. More residential load means residential energy efficiency has additional value relative to previously, which may increase the payoff of residential energy efficiency programs.