CRA Insights

CRA Charles River Associates

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The impact of COVID-19 on electric load: Perspectives on a full pandemic year

This *Insights* follows up on analyses conducted **one**, **two**, and **six** months into the COVID-19 crisis in which we reviewed data illustrating the impact of COVID-19 on electric demand across various market regions. Here, we present analysis of a full year of data—March 2020 through March 2021—and take an expanded approach to reviewing the evolution of electric load patterns throughout the coronavirus pandemic. Examining trends from New York and the UK, we observe that demand destruction was most pronounced early in the pandemic before it showed an uneven recovery across geographies with different economic profiles (i.e., urban versus nonurban areas). This provides insight into indicators to watch during reopening and raises questions about how shifts in consumption patterns may persist post-pandemic. We close by highlighting several areas that we expect to be issues in the electric utility space during reopening and questions that will need to be addressed in the months and years following the pandemic.

Electric Demand after One Year of COVID-19

In this *Insights*, we focus on the impact of the COVID-19 pandemic over its duration and how that impact varies by jurisdiction. In the United States, as of March 2021, economic activity continues to recover from the early days of the pandemic. While quarantines have eased, vaccination programs are progressing, and the recession has technically ended, economic pain remains acute in many US households and industries and general economic conditions remain far from normal. The current situation is similar in the UK after a particularly challenging winter despite higher levels of early success managing the pandemic. Altogether, across both countries, the result is a widely varying set of economic circumstances in terms of business operations, work-from-home dynamics, employment statistics, and social activity.

We examine the ongoing impact on load as well as the trends across the pandemic period. We focus on a set of jurisdictions similar to those discussed in our previous three papers, here presenting data on New York City, New York State, and England and Wales (together). As before, we selected areas that are reasonably well defined geographically and where it is possible to roughly isolate large urban areas from nonurban locales. Likewise, we focus on weather-similar periods when assessing load impacts or observing changes in the relationship between temperature and electric demand. A more sophisticated econometric analysis could account for other variables, but our approach allows us to loosely control for the most significant short-term

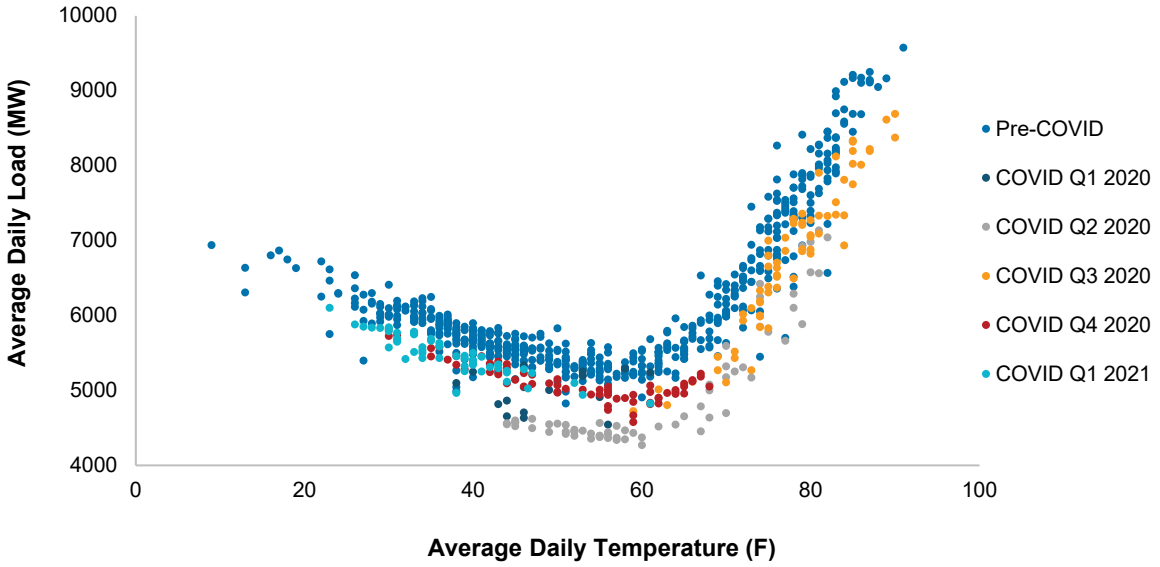
driver of electric load variation while also allowing us to make observations about how this key explanatory relationship has evolved during the pandemic.

In each market region, we provide three types of analyses. First, we look at the relationship between load and temperature as compared to pre-pandemic trends.[1] This allows us to review how the relationship between load and temperature—generally the key short-run determinant of electric demand variation—has deviated from recent historical trends. Next, we compare an early 2020 pandemic week with an early 2021 pandemic week and to weather-similar weeks in 2018 and 2019, which provides insights into shifts in hourly consumption trends. Finally, we review monthly demand impacts by geography, overall, and by sector (residential, commercial, industrial) during the pandemic as compared to historical averages (2018 and 2019), with the goal of shedding additional light on observed trends.

Observations from New York

For New York, we first evaluate the impacts in New York City (defined as the New York Independent System Operator, or "NYISO"—Zone J) as compared to Upstate New York (the NYISO system without Zones J and K). By looking at the correlations between load and temperature (Figure 1), we see in NYC a clear decline in load as a function of temperature in Q1 and Q2 2020, the first full quarters of the Western pandemic response. After Q2 2020, we observe a recovery in electric demand as a function of temperature that reaches what appears to be something of a "new normal" during the later parts of the pandemic response. Despite the rebound, load as a function of weather is still below historical averages.

Figure 1: NYC load and temperature correlations by COVID quarter vs. pre-COVID



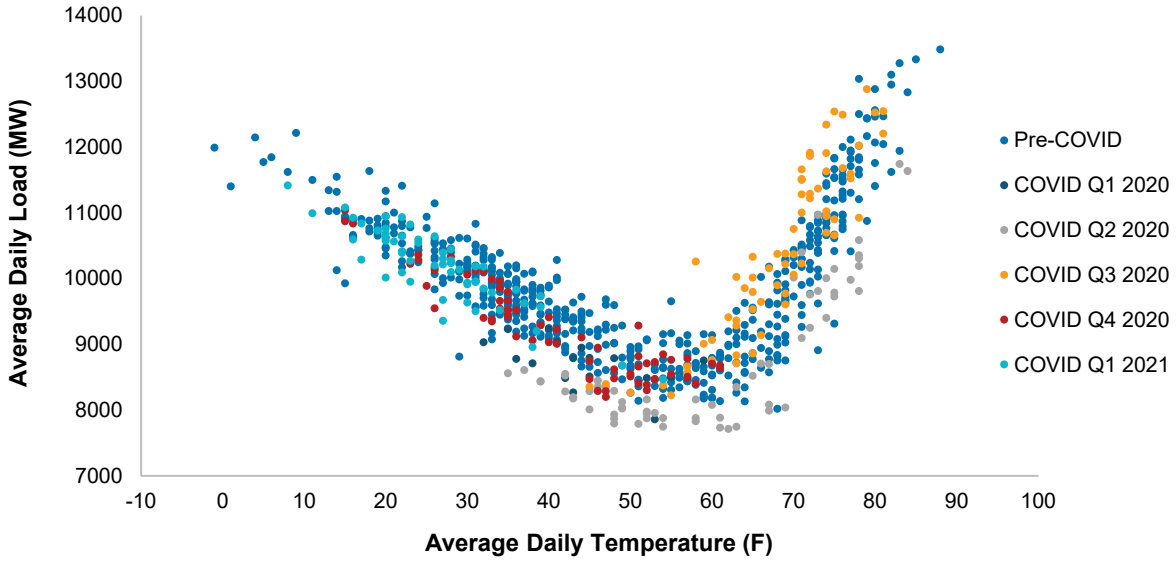
Source: CRA analysis, Energy Velocity

Meanwhile, in Upstate NY (Figure 2), load and temperature correlations between COVID quarters are not as pronounced and evolved differently. During the first two COVID quarters, Q1 and Q2

[1] To limit confounding explanatory variables in our analysis, we present data only for weekdays. Our assumed "start date" for the COVID data period is March 9, 2020. For comparison, the "pre-COVID" data we show is from 2018, 2019, and 2020 through March 9.

2020, load as a function of temperature fell below pre-COVID levels, but not as significantly as in NYC. After the initial two quarters, however, the correlations appear to largely return to within the historical ranges. We speculate that this may have been driven, at least in part, by differences in the nature of economic activity. In NYC, commercial office work could shift to and maintain the work-from-home paradigm, whereas less urban parts of the state eventually adapted to closer-to-normal operations in Q3 2020 and beyond.[2]

Figure 2: Upstate NY load and temperature correlations by COVID quarter vs. pre-COVID



Source: CRA analysis, Energy Velocity

To compare hourly load during the pandemic months to pre-pandemic trends, we chose weather-similar weeks from the respective periods, as we did in our previous *Insights* pieces. This allows us to review demand patterns with more granularity while qualitatively controlling for the effects of weather. For NYC and Upstate NY, we chose a week in March 2020 (early pandemic) and March 2021 (a year into the pandemic) to compare to weeks from spring 2018 and 2019 (see Figure 3).[3] We observe similar trends here, with demand outside NYC returning closer to historical norms as of March 2021 compared to March 2020 (see Figure 3). Meanwhile, demand in NYC is still well below historical levels later in the pandemic, though it appears to have recovered from the early pandemic. For example, the average electric load the week of March 8, 2021, is 10% above the average load in the week of March 30, 2020, though it is still 6%-7% below the load in weather-similar weeks in 2018 and 2019. The load recovery may be attributed to limited resumption of commercial activity as the COVID-19 virus became better understood and responses evolved to be more targeted, such as when restaurants were able to reopen.[4] We note that load declines are

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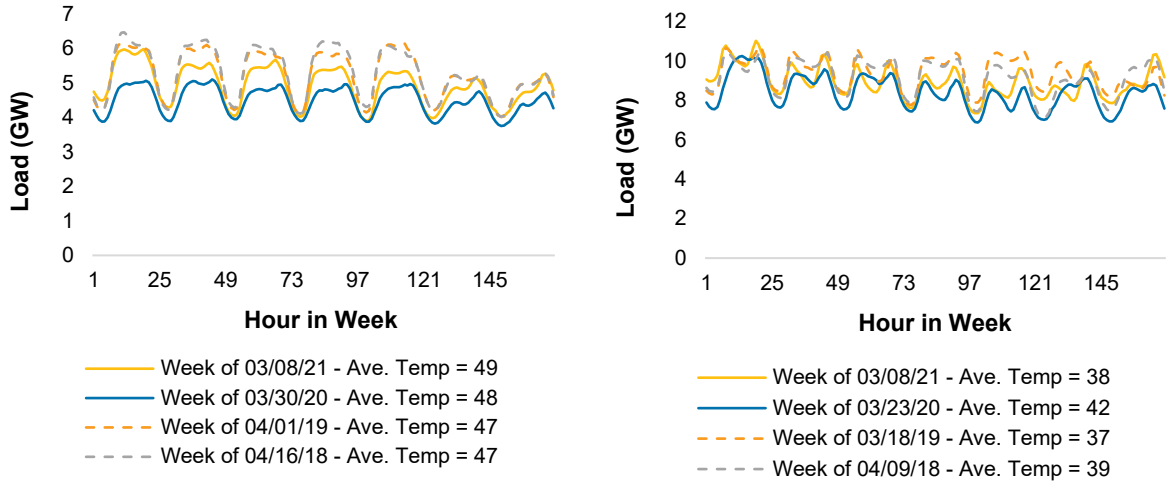
2 We performed similar analyses for Chicago as compared to PJM West and saw that the trends followed those of NYC and Upstate NY, with city loads showing recovery but staying well below historical averages and with areas outside metropolitan cities showing less pronounced declines and greater recovery. For brevity, we have not included those regions in this paper.

3 For NYC, we chose the weeks of March 30, 2020, and March 8, 2021, for the pandemic periods, and the weeks of April 16, 2018, and April 1, 2019, for historical weather-similar proxies. Likewise, we chose the following for NYISO (non-NYC + Long Island): March 18, 2019, April 9, 2018, March 23, 2020, and March 8, 2021. All of these weekly observations are within 5 °F, as measured at Albany and LaGuardia airports.

4 Indoor dining in NYC resumed on September 30, 2020, and then closed again on December 11, 2020. It most recently resumed on February 12, 2021 at 25% capacity.

more pronounced during on-peak hours (i.e., business hours), and we also observe a sustained shift in load shape on weekends, which may indicate shifts in discretionary weekend activities (e.g., shopping and eating on-site at restaurants).

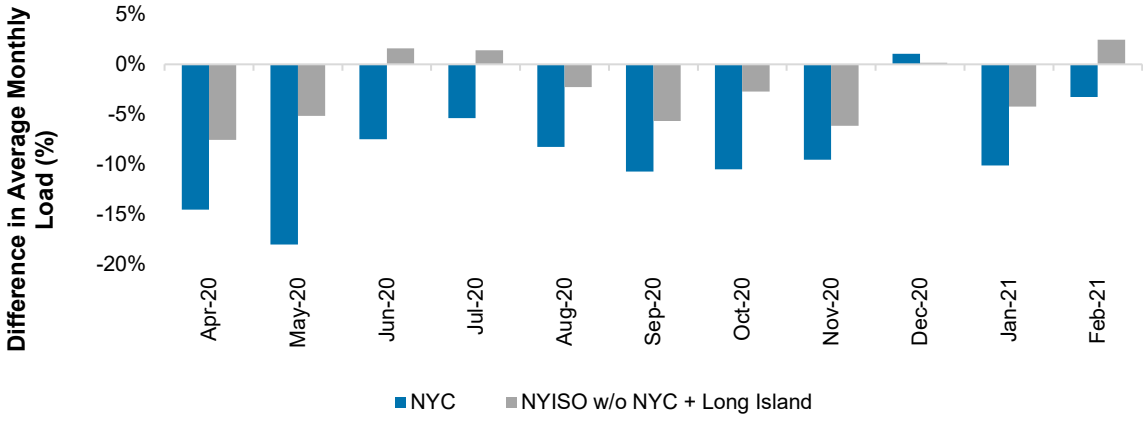
Figure 3: NYC (left) and Upstate NY (right) weekly load, weather-similar weeks



Source: CRA analysis, Energy Velocity

To get a sense of absolute levels of demand destruction by geography, we also review total electric demand changes by month during the pandemic period. While this approach does not include controls for weather, the same observations can be made: NYC's load declines are much more significant than those in Upstate NY (Figure 4). This supports our previous points about the load decline in Upstate being less prominent than in NYC, where restaurants, businesses, and offices shut down to a greater extent and where shifts to working from home were likely to lead to movement of residential electric load out of the metropolitan area. We can also see that load declines were less pronounced in the summer months as compared with historical averages, when air conditioning load drives up demand across both regions.

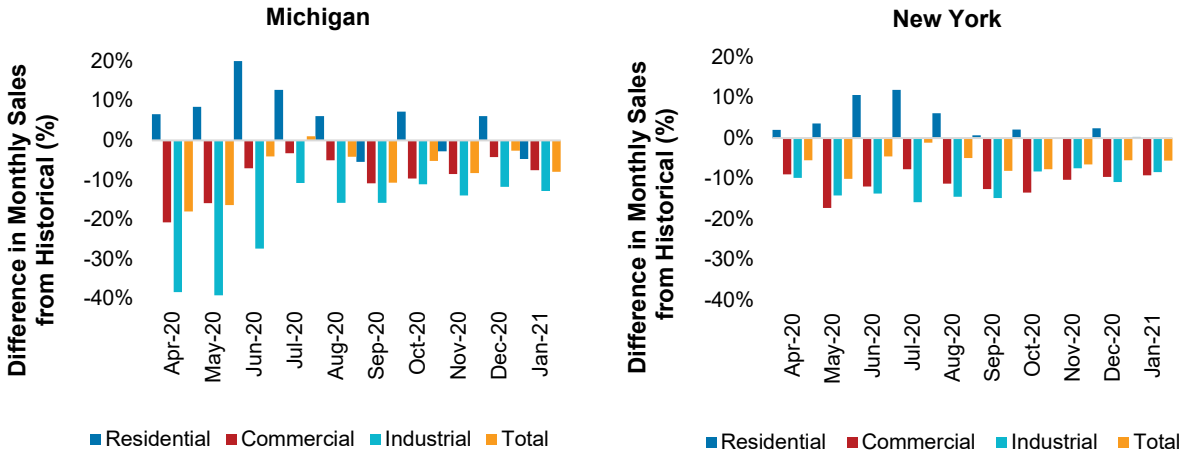
Figure 4: Change in electric load by pandemic month vs. recent historical averages (2018–2019)



Source: CRA analysis, Energy Velocity

We also add to our analysis a limited comparison of the effects of the COVID-19 pandemic across US states with different economic makeups. We chose Michigan to compare to New York because it is more industrially intensive than New York. In both states, residential demand increased in the majority of months, with a similar overall pattern, and especially increased in the summer months, as expected due to cooling load (see Figure 5). Load drops in the commercial sector are relatively more prominent in New York and show some recovery in the last few months of the pandemic. The industrial sector in New York shows a similar trend. In Michigan, however, the industrial sector shows immense drops in load April–June 2020 and recovers significantly beginning in July 2020. Michigan's commercial sector experienced trends that were similar but of lesser magnitude. Overall, however, Michigan appears to have experienced larger levels of load destruction due to COVID-19 than New York.

Figure 5: Change in electricity sales by sector for NY State and MI compared to recent historical averages

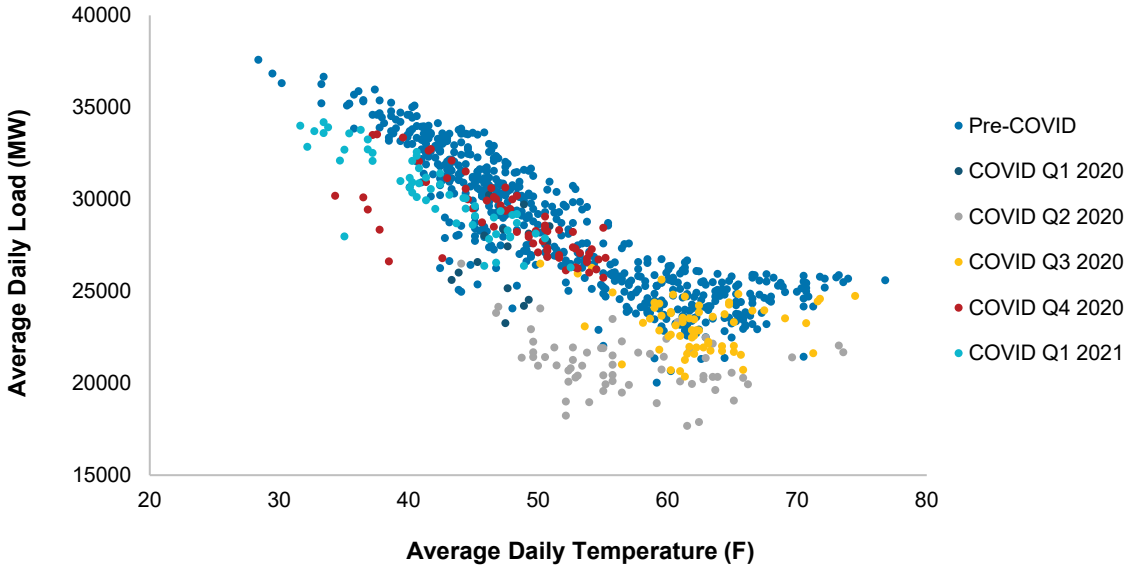


Source: CRA analysis, EIA Monthly Electricity Sales

Observations from England and Wales

In this section, we review the effects of COVID-19 on electric demand in England and Wales. By analyzing the correlation between temperature and load, we observe an initial strong decline in load at the start of the pandemic due to stay-at-home orders and the shutdown of commercial and industrial economic activity (Figure 6). Following the initial pandemic period, load trends recovered significantly in the latter half of 2020 while remaining moderately below pre-pandemic levels or at least exhibiting a demand–temperature relationship on the low end of historical norms.

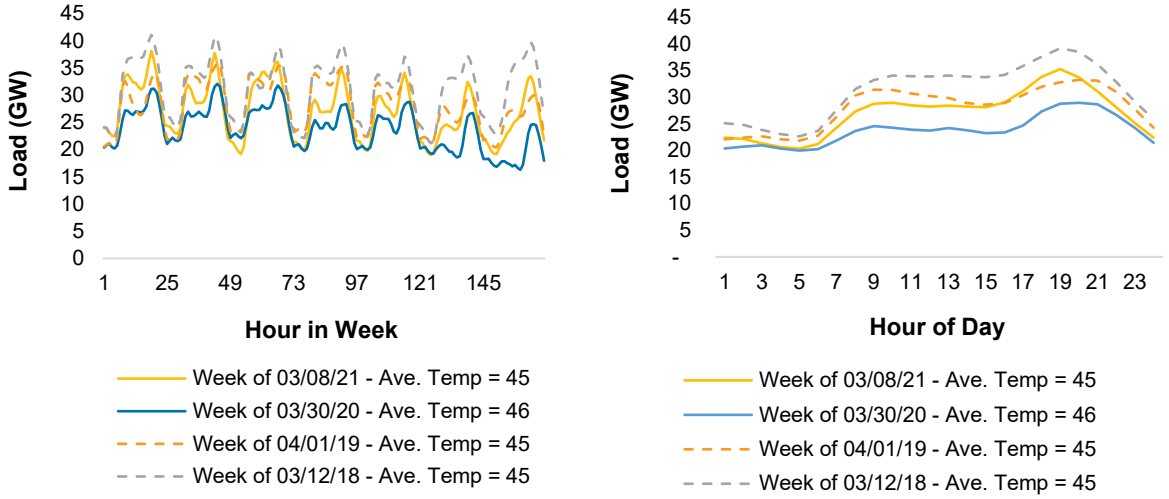
Figure 6: England and Wales load and temperature correlations by COVID quarter vs. pre-COVID



Source: CRA analysis, National Grid

As for our assessment of New York, we examined a week early in the pandemic in 2020 and a similar-temperature week in 2021, a year into the pandemic, and compared with equivalent-temperature years in 2018 and 2019 (see Figure 7). Weekly load patterns show a marked recovery in load one year into the pandemic, with data points moving much closer to historical norms. Average load in 2021 is only 4% lower than levels seen in 2019, a stark contrast to the 16% drop-off we saw between our 2019 and 2020 temperature-controlled weeks. This recovery likely represents an uptick in residential demand as more of the labor force has now adjusted to working from home effectively, substituting efficient office heating and lighting for less efficient domestic substitutes. And some industrial and commercial activities, having introduced pandemic protocols allowing their employees to operate safely in work environments, were able to resume. Most interestingly, we actually see a much steeper evening peak in demand in the UK in our 2021 week, with a smoother morning peak. This may represent more relaxed starting hours for jobs in the morning, in the absence of the need to commute, while the sharper evening peak indicates a greater mass of people who would not ordinarily be at home switching on electrical appliances in the evening in lieu of other pre-pandemic nighttime activities.

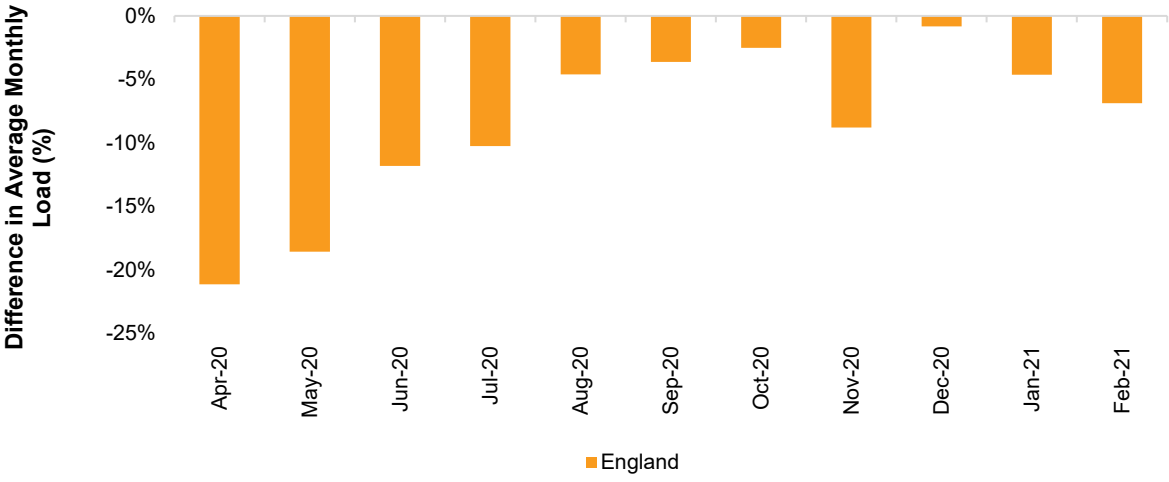
Figure 7: England and Wales weekly load and average hourly load by week



Source: CRA analysis, National Grid

Figure 8 shows average load differences for each month of the pandemic compared to average load in those months over 2018–2019. This paints a clear picture of the UK government's response to the coronavirus pandemic. While initial restrictions were very strict, causing the cessation of much of the region's economic activity, restrictions were slowly relaxed through the summer months, with pubs, restaurants, and cinemas allowed to reopen. This, coupled with milder weather, led to a load bounce back during that period. Another strict national lockdown was imposed in November, causing load to again fall markedly below historical averages. A winter cold snap combined with business familiarity with COVID-19 protocols meant that load drop-offs after the second national lockdown did not mirror those seen in the initial stages of the pandemic.

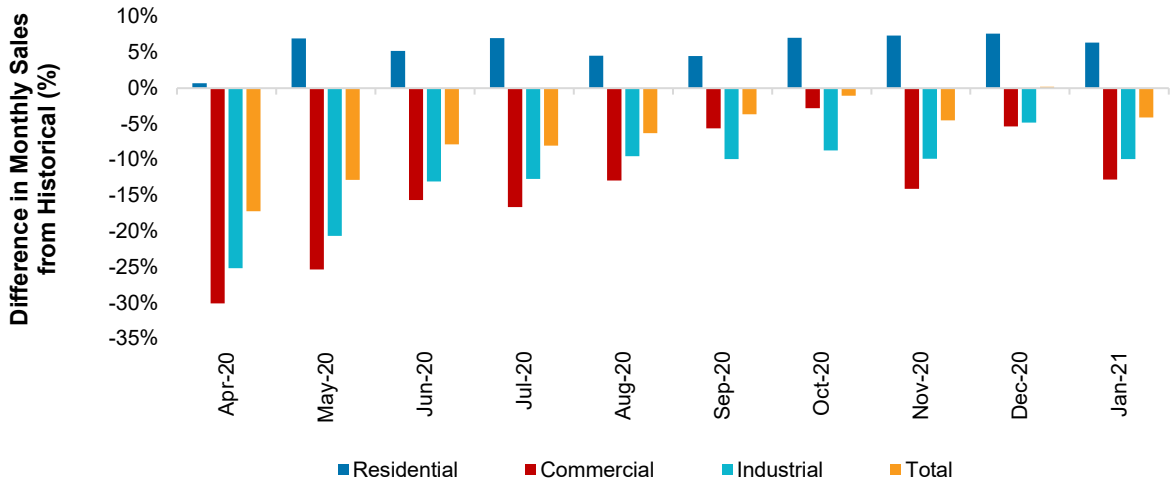
Figure 8: Average load differences during pandemic as compared to recent historical averages (2018–2019), England and Wales



Source: CRA analysis, National Grid

As in the New York analysis, we present a breakdown of electricity consumption by sector across the United Kingdom[5] relative to historical averages in 2018 and 2019 (see Figure 9). We observe that residential increases in consumption have somewhat offset decreased load from industry and commercial activities, which themselves have seen much recovery over the course of the pandemic as business has adjusted to the new normal. The second national lockdown in November saw another steep fall, relative to previous months, especially in commercial sectors as hospitality businesses were forced to close. We can also see that industry was slightly more resilient due to the already-defined COVID-19 working protocols put in place after the first national lockdown. On the whole, however, despite recovery from the early depths of the pandemic, industry and commercial impacts have been severe and aggregate demand destruction persists.

Figure 9: Change in UK electric consumption by sector compared to recent historical averages



Source: CRA analysis, UK Department for Business, Energy and Industrial Strategy

Additional observations

This series of *Insights* has now explored the impact of the COVID-19 pandemic on electric load across one full year of policy, economic, and social response aimed at addressing and containing the COVID-19 pandemic. In the market areas reviewed here, the effects on electricity demand have evolved with business patterns, government policy, and personal behavior during this challenging year. We observe a pronounced recovery in demand through March 2021 as the worst of the pandemic is hopefully behind in the US and the UK. However, the nature and timing of the recovery in electric demand patterns is inconsistent, with non-urban areas appearing to return to load patterns that more closely resemble historical normal more quickly and fully than in large urban cores. As with our prior *Insights*, we acknowledge the high-level nature of our observations and note that additional analysis could more precisely assess the effects of the COVID-19 response by jurisdiction and across time.

[5] Note: These data cover all countries in the UK (England, Wales, Scotland, and Northern Ireland), rather than just England and Wales. Scotland and Northern Ireland make up a small portion of total consumption in the UK, and restrictions have been similar enough across regions that the trend we see here is representative of the picture in England and Wales.

With significant progress being made in the rollout of vaccines and reopening prospects appearing increasingly promising in the coming months, we will be watching a range of electric utility issues as they unfold post-pandemic. With regard to our observations in this series of *Insights*, we will be tracking how commercial loads recover as office work and social life resume, including which pandemic trends (e.g., working from home, shifts to e-commerce, etc.) persist and which fade. It seems unlikely that post-pandemic life will return entirely to the pre-pandemic "normal," but it remains to be seen whether permanent changes will be marginal or significant.

We also expect a range of cascading effects on electricity sector stakeholders in the post-COVID-19 world. One set will involve recovery from the direct impacts of the pandemic, including the impact of decreased demand—be it transient or permanent—and responsive policies, such as disconnection moratoriums. Utilities may need to recover lost revenue and cope with cost-recovery shortfalls, which may drive an increase in rate cases and other filings. Utility forecasting and planning exercises may need to adapt to shifting load patterns across both time (e.g., load shifting to reflect persistence of working from home) and space (e.g., load shifting out of cities). Regulatory mechanisms and wholesale market rules that rely on historical proxies may need to be adjusted to avoid being skewed by an anomalous year of data. As for secondary effects, the pandemic and associated economic impacts seem to have accelerated a number of trends, including a shift toward renewable and alternative technologies and retirement of aging fossil fuel infrastructure. This trend is likely to be spurred onward in the United States by progressive energy and environmental policies of the Biden administration. We will continue to offer comment as these processes unfold and work with our clients to resolve related problems as they arise.

About CRA's Energy Practice

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