

Poster Abstract: Impact of COVID19 lockdown on household energy consumption on two Indian cities

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ABSTRACT

COVID-19 has severely impacted millions of lives around the world. In this note, we explore the impact of COVID-19 on the electricity consumption of 93 households across two tier-2 cities in India. Given the work from home restrictions, we would expect electricity consumption to increase as people spend more time at home. Contrary to the expectations, we found that electricity consumption decreased during the lockdown as compared to previous years. On further follow-up with households, we found several reasons for decreased usage: i) inability to get air conditioners serviced due to movement restriction, ii) advisories on minimising AC usage, and iii) reducing energy to compensate for reduced income.

CCS CONCEPTS

• Information systems; • Software and its engineering;

KEYWORDS

deployment, energy consumption, covid19

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1 INTRODUCTION

Covid-19 pandemic has influenced all facets of life. While factories and shops remained shut for a long time during a full or partial lockdown, most people were locked up in their houses. The former led to a sharp drop in electricity demand from the commercial and industrial sector; however, the change in residential electricity use remains uncertain. A recent study [2] reported a 30 per cent rise in electricity use during day time and 7 per cent fall during night time among households in the United Kingdom. Reasons described range

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from a surge in working from home to unstructured daily routines during the lockdown. Another study [4] described lockdown as “a month of Sunday” wherein people across multiple countries have shown a consistent delay in day to day activities.

In this note, we discuss the impact of COVID-19 on the electricity consumption of 93 households in two tier-2 Indian cities, Bareilly and Mathura. We had instrumented smart meters these two cities in the middle of 2019. The COVID-19 interventions came as a natural “experiment”. We study the smart meter data of these households in the context of a nation-wide lockdown that was followed by three more waves of lockdown with varying restrictions.

Our analysis shows that despite comparable or higher temperatures this year concerning 2019, the consumption in these households reduced. We followed up with these households and found that despite spending all their time at home, the consumption was lower due to various reasons described in section 3.

2 DEPLOYMENT

For this study, we use data from single-phase smart meters installed in 93 urban households in Mathura and Bareilly districts of Uttar Pradesh (UP) state in India. For sampling the households, we used two criteria rule - the number of rooms and appliance inventory as these variables are strongly associated with household electricity demand and socio-economic status. All the sampled households have grid electricity connections and use lights and fans. However, the ownership of medium to high-power appliances varies: more than 75% of the sampled households have a television and a refrigerator, but only 45% have coolers and 37% have air conditioners (ACs). Our smart meters are programmed to capture 8 consumption and supply parameters at every 3-minute interval: active and apparent energy consumption, and minimum, maximum, and average values for voltage and current. Further deployment details available in [1].

3 IMPACT OF LOCKDOWN ON DOMESTIC ELECTRICITY USE

On 25th March, the Government of India imposed a nationwide lockdown to contain the spread of COVID-19 virus. This first lockdown was followed by three more waves of lockdown with varying restrictions on movement and economic activities. While the domestic electricity consumption in countries like UK increased during the lockdown [2], little evidence exists on how household electricity use varied in India.

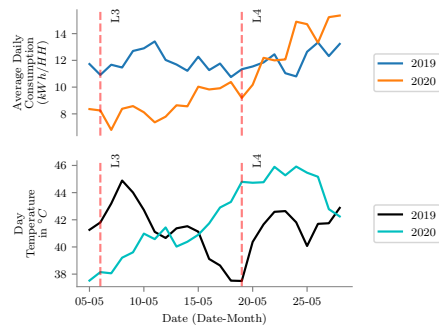


Figure 1: Household electricity use during the later half of third lockdown was lower than previous year, despite similar or higher temperatures. L3 represents third lockdown, L4 represents fourth lockdown

We first compared the actual electricity use of 20 sample households (for which data is available from May 2019) during May this year and last year. We find that average daily consumption during May 2020 (10 units/household) is 17% lower than that in May 2019 (12.5 units/household), despite a slightly higher mean monthly temperature. Further analysis reveals that household electricity use was lower during the first three weeks of May 2020 (i.e. during lockdown 3), but exceeded the past consumption levels post 23 May (Figure 1). These trends may be partly explained by relatively lower temperatures during the first week of May 2020, as shown in Figure 1. However, during the second and third week of May, average temperatures were higher in 2020; despite this, consumption was lower than previous year. Lower consumption cannot be attributed to power cuts, which were fewer during May 2020 (43.5 minutes/day/HH) as compared to May 2019 (72.5 minutes/day/HH).

We also observe that the relative drop in electricity use was highest amongst households owning air-conditioner (AC). Using year-on-year assessment, we observe that the decline in electricity use during 1 May - 20 May is steepest for families that own ACs (36%). Families with coolers and those without AC/coolers display a smaller drop in demand at 23% and 18%, respectively. Figure 2 shows the average weekly load curve for the sample households grouped by appliance ownership. We observe maximum deviation during night hours (8 pm – 6 am), particularly for AC households, suggesting lower AC use this year. Through a separate assessment, we find that nearly 80% of the sample households with ACs did not use it until 15 May 2020.

To investigate the reasons behind lower electricity consumption, we interviewed 20 households from our sample - 12 from Mathura and 8 from Bareilly. Many of these households own AC. Inability to get the AC repaired or serviced during the lockdown, and adherence to public advisories against the use of ACs and coolers to prevent the spread of corona were the key reasons behind limited electricity use during the concerned period. Some households lowered their consumption to save money due to affected income levels. “We are surviving off our saved money, so we are trying to save every bit we can”, said one of the respondents when asked whether decreased income has affected their electricity use. Some households also cited perceived lower temperatures as the main reason, while a few reported reasons like use of new inverter AC

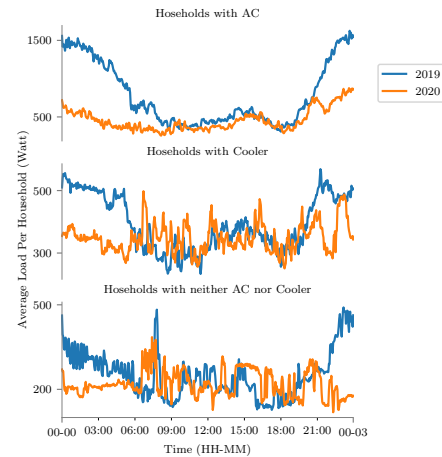


Figure 2: Weekly average load curves of households show maximum drop in electricity use in households having ACs

and institutional quarantine upon a family member testing positive. Some households reported using electricity as per their need.

As our sample is too small to generalise to a larger population, we also analysed data obtained from BSES, a utility that supplies power to 4.08 million households in the National Capital Territory of Delhi and accounts for 75% of the total domestic consumers in Delhi. We found that during the month of May, 65.8% BSES consumers used 0-400 units, up from 60.4% in May 2019. Thus, 5.4% of BSES consumers or 0.24 million households used less electricity than previous year, despite comparable temperatures. Average monthly temperature in Delhi during May 2019 and 2020 was 32°C and 31.8°C, respectively. Similar observations are made in [5].

4 FUTURE WORK AND CONCLUSIONS

During the pandemic-induced lockdowns, electricity consumption in homes increased in certain countries. In this note, we analysed smart meter data from households in two tier-2 Indian cities, Mathura and Bareilly and found contrary insights. The smart meter data and our followups show that many people reduced electricity consumption due advisories, logistical challenges or to compensate for reduced earnings. In the future, we plan to analyse our data using interrupted time-series analysis [3] and bound the impact of the lockdown on daily lives controlling for known factors such as temperature.

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