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Impact of COVID-19 on the Utility Usage in Residential Buildings Throughout the Midwest

Eva McLaughlin, Angelica Errigo and Salahaldin F Alshatshati*
Department of Mechanical and Aerospace Engineering University of Dayton, Dayton, OH
*Corresponding Author's Email: Alshatshatis1@udayton.edu
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Abstract— The global pandemic impacted all areas of life throughout the world. Everyone, except essential workers, were restricted to their homes for months. Stay at home orders were put into effect, which enforced closures or limitations to all public spaces such as restaurants, libraries, stores, and schools. With these restrictions put in place, the amount of time individuals stayed at home significantly increased. The more time people spent in their homes it is expected that there would be a direct correlation to the utility usage increasing as well. This paper explores the relationship between the utility usage in residential homes and the COVID-19 pandemic. A group of twenty-four students attending the University of Dayton were asked to collect the natural gas, electricity, and water usage from their residential buildings and document them from March of 2019 to March of 2021. These students were living all across the United States, but of the twenty-four households, eighteen were in the Midwest. The Midwest was then focused on since the weather is about the same throughout the region and there were a higher number of test subjects, so the usage was more accurate. This data was then used to determine a correlation, if any, between the restrictions put in place to control the spread of COVID-19 and the natural gas, electricity, and water usage in residential buildings throughout the United States. Through this data, some correlations were found between the pandemic and utilities in these residential buildings. The largest direct correlation found was with electricity usage, while minimal were found with natural gas, and no direct correlations were found between the pandemic and water usage.

Keywords— COVID-19 pandemic, electricity usage, natural gas consumption, utilities, residential buildings

I. INTRODUCTION

The covid-19 pandemic has impacted our economic, the environment and the wellbeing of every individual across the globe. The World Health Organization (WHO) declared this a global emergency due to the severe symptoms, rapid increase in number of cases and growing number of deaths caused by COVID-19 [1]. Due to the pandemic, around 30% of people throughout the

world were forced to go into lockdown [2]. While some countries, such as Sweden, never shutdown their economy and made social distancing a recommendation not a requirement [3, 4]. Other places like the United States took drastic measures as an attempt to contain the spread of COVID-19. On the 16th of March in 2020 several states throughout the US began issuing statements to encourage social distancing and quarantining [5, 6]. This forced many non-essential businesses to close their doors to costumers, forcing them to lose business and struggle to stay open. In densely populated areas, multifamily homes and areas with limited private outdoor space, it was becoming increasingly more difficult to find ways to stay distant from others as an attempt to slow the spread [7]. Due to the economic recession, individuals decreased the priority of investing into renewables and increasing energy efficiency [8], but the environment was still impacted greatly as a result of COVID-19. People were forced to alter their lives and limit the interactions with others, forcing them to stay home and live their lives virtually.

During the pandemic it became essential to stay at home as often as possible, so mass amounts of people began taking online classes, working remotely, having social gatherings through zoom, essentially altering any pre-pandemic in person activity, to an online activity [9]. With the majority of society remaining at home and several patterns changing throughout, as a result of the economic recession the electrical demand began to decrease between 18-25% [10]. A study showed that due to the increase in distance between individuals, single use plastic has become a huge threat to our environment throughout the pandemic [11]. Studies have shown, medical care and energy are equally as important during the pandemic [12]. In China, manufacturing shutdowns reduced overall CO2 emissions to 25% [13]. It is important to analyze usage in the U.S. as well, due to the economic shut down playing a role in demand changes, it is predicted that this economic crisis is going to affect power markets for up to 18 months [14]. There have been noticeable changes in energy use in each sector, these fluctuations were based on the individual industries and the hierarchy of the essential or non-essential business. A study performed in the U.S. showed electricity consumption in residential buildings actually increased by 14% [15]. Increased usage in residential homes is a direct result of people being forced to spend most of their time there[16]. The objective of this paper is to determine the impact of COVID-19 on water, electricity, and natural gas consumption in residential homes. The homes have a wide range of occupants living there and are spread across several different states throughout the U.S.

The paper is structured as follows, in section 2, we discuss the methodology taken to collect the data received and the approach used to interpret this information. In section 3, the data is presented in a concise manner and the correlation between energy consumption in residential homes and the global pandemic is presented. Section 4 of this paper discusses the impacts of the pandemic and the direct effect on the environment.

II. METHODOLOGY

Our approach consists of three sections to conclude the effects COVID-19 had on the electricity use and natural gas usage on residential buildings. First, we conducted a survey on a class of students attending the University of Dayton. When all of the students collected the necessary information, the data was compiled and analyzed.

A group of twenty-four students that attend the University of Dayton were asked to collect two full years of energy usage from their home. Starting in March of 2019 all the way through February of 2021 they logged monthly usage of their natural gas in MMBtu and electricity in kWh. Most of the students.

live on campus in housing owned by the university, limiting the access these students have to their full usage from the residential buildings they live in for the majority of the year. In order to complete the surveys, several of these students documented the usage from their family homes which ranged in several regions throughout the U.S. and the number of occupants in each home ranged from 2 people to 5 people. To best understand the trends in the affects of COVID-19 on utility usage in residential buildings, the data collected was averaged per person in each household. Once each of the students collected the data, all of the information was compiled together. The data was then compared and analyzed into different states, regions and as the US as a whole.

III. DATA AND RESULTS

The utility data from twenty-four households was collected. The households were from different states and regions with varying weather patterns. Most of the households were located in the Midwest, so this region added the more accurate data and was focused on for the analysis. After obtaining all utility data for the eighteen households in the Midwest, an analysis was conducted to determine the changes in utility usage during the pandemic. Since the households have a varying number of residents, the utility for each month was divided by the number of residents per household, to get the average amount of usage for each person in the household. The usage per person was then averaged for the 18 households. This data can be seen in the following graphs for electricity and gas usage.

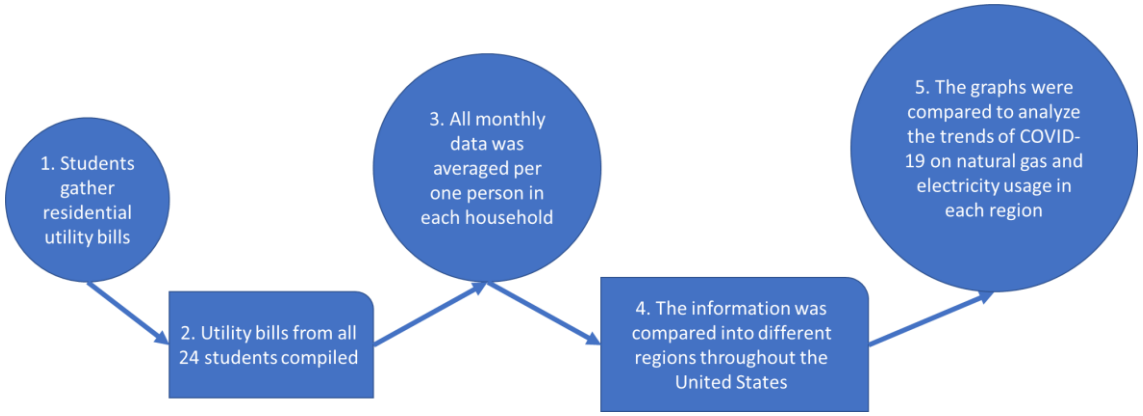

Figure 1: Methodology of data collection

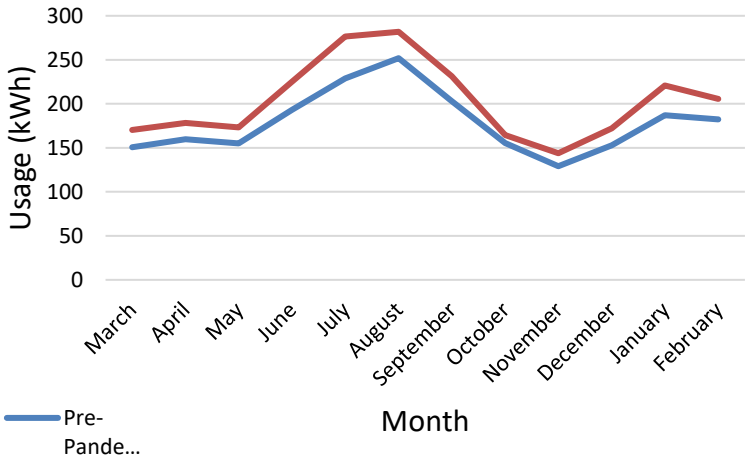

Figure 2: Methodology of data collection

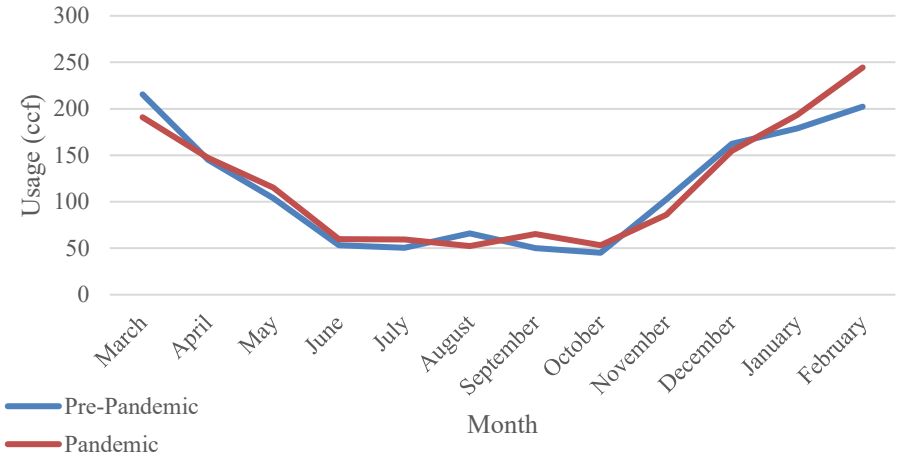

Figure 3: Monthly Natural gas usage

From these graphs, the changes in gas and electricity usage can be seen. For the electricity usage, it can be clearly seen that the average usage per person, in the residential building, during the pandemic is greater than the usage in the year before the pandemic. The gas usage for both years is about the same except for in the winter months. During January and February in the pandemic year, the gas usage begins to increase compared to the previous year. Water usage was collected from all of the students, but not included in this paper because there were no correlations or patterns when comparing the year prior to COVID-19 and the year during the pandemic. The water usage had randomly scattered valleys and peaks throughout the two years which indicated there is more to water usage than can be analyzed in this paper.

IV. Discussion and Conclusion

The COVID-19 pandemic has severely impacted life as we knew it, mainly increasing the amount of time spent at home. Most had to adapt their whole life to work out of the house, attending school remotely, or even grocery shopping online. During the pandemic, most in-person activities became virtual activities from home. It was our assumption that all residential utility data would increase during the pandemic.

The electricity graph shows a noticeable increase in usage during the pandemic year from the previous year. The shape of the electricity usage for each time period is about the same, which indicates the electricity usage followed the same trends on a month to month basis. Electricity is used throughout every household, we need it for lighting, internet connections, air conditioning, power and so much more. Electricity usage for powering our laptops, monitors and connecting to the outside world would have been a large consumer because in today's society they are necessary for those that worked from home. During summer months air conditioning is used to cool homes, with more time being spent at home many had their air conditioning on for longer periods throughout the day and at lower temperature setpoints.

The gas graph has a clear shape with the peaks during the winter months. Natural gas is mostly used for hot water and space heating. In residential houses, hot water is primarily used for showers, laundry, and dishes. Residents would not drastically increase or decrease their shower and laundry usage during the pandemic. Hot water used for cooking and cleaning may increase with more people at home, but in our data, there was no increase due to the data being averaged on a per person basis. The natural gas increase during January and February of the pandemic year could be due to the increase in space heating with more time people spent at home and the need for continuous heat and running hot water throughout the day. Pandemic restrictions weren't implemented until March 2020 so there would not be a large use for space heating. The few differences in usage could be attributed to residents not adjusting their energy usage when they are not home. They may not adjust the temperature in their house when they leave, so the natural gas usage did not change drastically. Other explanations for the increase could be unrelated to the pandemic. The increase could be attributed to a colder winter than the previous year.

Since there could be multiple explanations for changes in utility on a yearly basis, it may be beneficial to gather more data and information from the households, especially related to the gas consumption. The pandemic evenly affected electricity throughout the year, but the gas consumption was about equal to the previous year. The changes in the gas consumption could be explained by variables unrelated to the pandemic like the weather.

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