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Towards Informed Policy Making: An Analysis of the Impact of COVID-19 on Electricity Purchases in South Africa

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Abstract: The COVID-19 pandemic created large disruptions in the energy industry as governments all around the world responded by enforcing lockdowns on 54% of the global population to slow down the spread of the virus. This impacts the energy consumption of the residential sector as policies prevented residents from leaving their homes and accelerated the transition towards remote work environments. The impact of lockdown on South Africa's energy sector is unique to other countries due to its extreme inequalities across the affluence divide and ongoing blackouts that affect the entire country. A case study is performed in George, a region in South Africa with a distribution of wealth and energy inequality typical for South Africa. In this paper, the following questions are answered: (i) How has the lockdown period influenced the total energy consumption of a household? and (ii) To what extent has the lockdown affected energy consumption of households based on wealth and demographics? The results of this study showed that implementing the highest stage of lockdown resulted in wealthy communities increasing their overall energy consumption by 5 percentage points and poor communities by 2.5 percentage points. The findings of this study support the use of local data and insight for the unique difference in behavioural change across different communities for optimal decision making in future pandemics or natural disasters.

Keywords: COVID-19 pandemic; impact analysis; electricity usage; prepaid meters; residential buildings; data-driven analysis

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1. Introduction

The WHO has reported over 585 million confirmed cases and nearing 6.5 million deaths, as of August 2022, due to the COVID-19 virus [1]. These numbers increased from 2020 as the global pandemic severely disrupted health systems, national economies, energy policies, etc. [2,3]. Governments all around the world responded by enforcing varying levels of lockdowns on 54% of the global population to slow down the spread of the virus [4,5]. Dingel and Neiman [6] determined that only 37% of jobs in the United States can be performed from home, and the opportunity for remote work declines further in developing countries. The IEA reported that the impact on energy consumption was a 25% reduction for countries in full lockdown and 18% for countries in partial lockdown [4], which highlights the importance of investigating the pandemic repercussions on the energy sector of a country.

The African continent is one of the most energy-deficient regions in the world [7]. The IEA forecasts that more than 700 million people will not have access to energy in 2040, with the majority emanating from sub-Saharan Africa [8]. South Africa's electricity generation is heavily dependent on fossil fuels, and 88% of the total generation is supplied by the burning of coal [9]. Furthermore, the country struggles to meet the demand of the grid and has enforced frequent planned power outages (locally referred to as "load-shedding"), which is expected to continue sporadically for the foreseeable future. The government and Eskom (the country's main electricity supplier) have taken action to supply additional energy from independent power producers and renewable energy sources to address the energy poverty [10].

There is an unequal distribution of electricity across the South African affluence divide, and the urban poor suffer the brunt of it [7,11]. The cause of inequality stems from social, political and economical issues arising from the country's history [7].

However, South Africa suffers from not only energy but also employment scarcity. These moves towards privation in the energy sector are expected to impact unemployment—a factor that is further exacerbated by the coronavirus pandemic. A study with a sample size of 6000 people inquired about COVID-19-related impacts on South African labour markets and found a 19% increase in employees not working or receiving wage [12].

1.1. Impact of COVID-19 on the Energy Sector

The IEA Global Energy Review foresees that global energy usage will decrease by 5%, and some regions will experience as much as 10%. Countries with periods of complete lockdown have had more extreme electricity depressions exceeding 20% [4].

The South African Government declared a lockdown on March 2020 and saw a 28% overall reduction in electricity and a 20% peak demand reduction within the first three weeks [13–16]. Moreover, this substantial depreciation has forced Eskom to increase power tariffs to recoup additional revenue [17].

The pandemic has also decelerated the transition to clean and renewable energy by delaying productivity and long-term goals of serious renewable and sustainable energy projects [18].

Numerous suppliers of clean energy technology have mitigated operating capacity and downsized staff in coordination with new regulations [3]. Solar and wind power projects have been negatively impacted the most, specifically in line with manufacturing facilities and supply chains. Due to the pandemic, 3 GW has been postponed in India, the United States have predicted a 37% decrease in solar capacity, and China, the leading country in solar technology products, has seen a decrease of 25% [19].

The lockdown in South Africa has introduced delays for both commencing energy projects and finishing those already undergoing construction. South Africa is also part of the Southern African Power Pool (SAPP), meaning that a portion of its generated power is shared between neighbouring countries. Consequently, the gradual lifting of lockdown restrictions can result in an intense growth of energy demand and occurrences of load-shedding [20]. Eskom has also declared a force majeure on renewable energy suppliers to satisfy the growing energy demand. This places a high risk of collapsing these companies, diminishing progress of clean energy transition, and increasing the country's energy poverty [20–22].

Energy suppliers need to understand energy usage patterns and the accuracy of modelling the energy demand is growing with uncertainty due to the change in people's behaviour [23]. The volatile and fluctuating nature of energy consumption, productivity and markets in this unique time suggests that alternative methods should replace traditional ones as historical data become increasingly futile [3,23,24].

1.2. Changes in South African Energy Consumption

Gaining insight into South Africa's energy behaviour which is heavily influenced by lockdowns can help manage the situation with energy supply. Given the country's energy discrimination, it is important during observations to differentiate households according to affluence.

In South Africa, it was reported that the number of people using transport has decreased by 37% for public transport and 26% for mobility to work, as of mid-February 2021. This is balanced by a 14% increase in mobility in residential areas [25]. These trends are facilitated by companies ensuring employee safety by denying the ability of people to travel to the workplace and shifting employees towards teleworking [26]. The NIDS

Coronavirus Rapid Mobile Survey (CRAM), a panel survey performed in South Africa, reported that the unemployment rate increased from 43% to 53% between February and April 2020 and signs of improvement only began showing after June 2020 [27]. The CRAM also found that 76% of workers could not work at home at all. Of those that could work from home, 79% were White, and 16% were Black African [28].

This study uses prepaid meter data collected from households in the city of George, South Africa. George's wealth distribution and inequality is similar to many towns and cities in South Africa, it provides a good case study for applying the methods used and models developed. This study uses linear regression and statistical analysis to answer questions based on a residential households purchase history: (i) How has the lockdown period influenced the total energy consumption of a household? and (ii) To what extent has lockdown affected energy consumption of households based on wealth and demographics? Figure 1 shows a timeline during the relevant period for when lockdown stage 1–5 (blue) and load-shedding stage 1–4 (orange) occurred in South Africa, and they are used to assess the findings in this study. An overview is presented on the data used in this case study and the methodology to determine the variation in household energy purchases in Section 2. In Section 3, the models used in this paper are validated and the findings are discussed. Lastly, a conclusion and recommendations for future work is presented in Section 4.

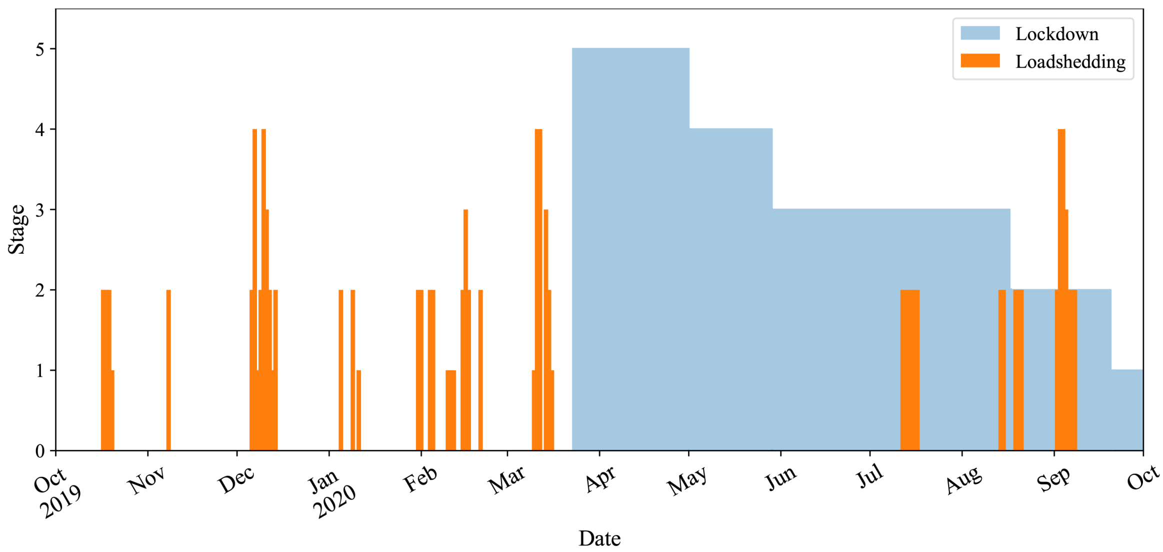


Figure 1. COVID-19 national lockdown and load-shedding timeline where the y-axis indicates the period when lockdown stage 1–5 (blue) and load-shedding stage 1–4 (orange) occurred in South Africa.

2. Method

2.1. Prepaid Meter Data

Household-level prepaid electricity purchase data were used to gather two years of time-stamped purchases up to August 2020 for over 21,000 prepaid meters. Moreover, the sample pool was ensured to be non-domestic indigent, residential households that were active over the observed periods. The purpose of the exclusion of domestic indigent households was to keep the data pure from electricity grants and discounts provided by the George Municipality [29]. The data were divided into two periods: (1) the control period extends over the twelve months prior to October 2019 and represents the baseline for normal activity, and (2) the lockdown period consists of the following twelve months and includes the start of the COVID-19 crisis. Twelve months are used for each period to perform a one-to-one comparison of energy consumption for the months prior to March 2020, and the months proceeding to the declaration of the lockdown. This is used to estimate the incremental trend of electricity purchases due to factors such as inflation and Eskom's power tariff increase and also to determine the impact of factors due to the introduction of the lockdown.

Similarly to the rest of South Africa, George has a wide spectrum of household wealth. According to the Gini Index, a measure of income distribution, the city has a Gini coefficient of 61%, which indicates extreme inequality [30,31]. Fortunately, the data indicate the geographical location of where the prepaid meter is situated and was observed to span over all the considered income levels and population groups.

The impact of energy consumption on areas representing the various inequality groups are addressed by defining indicators to classify the prepaid meters accordingly. Information provided by the prepaid meter data as well as census data is used to determine suitable classifications of prepaid meters into suitable annual household income brackets and population groups [32,33]. Demographic information enabled us to classify meters into three population groups that forms the majority of the South Africa's population: White, Coloured and Black African households. Furthermore, an indicator of measurable wealth is defined which classifies prepaid meters into four distinct levels of average annual household income. The wealth indicator is represented by I, and the corresponding income levels are defined as follows:

- I_1: R29 400;
- I_2: R57 300;
- I_3: R115 100;
- I_4: R230 700.

2.2. Regression Model

Simply comparing electricity usage during lockdown to usage prior to lockdown could potentially deliver biased results, since these models fail to account for other changing circumstances. Most notably, the differences in usage could be due to seasonality (demand-driven) or load-shedding from the national provider (supply-driven). Since information on load-shedding is accessible, the model can explicitly control for its effect. Moreover, sufficient prepaid meter data are available to be able to control for seasonal effects.

The data were aggregated to a monthly level (for 24 months) for each region of the 30 neighbourhoods identified in the data. The outcome represents the logarithmic average of the monthly units used per day per household in the corresponding neighbourhood. Firstly, the effects that lockdown had across the neighbourhoods of different income levels were determined. A linear regression model was calculated for the simplest specification which determines the effects of the different stages of lockdown on the energy usage according to various income levels, defined as follows:

$$Y_{it}^{1} = f(wealth_i, lockdown_t) \quad (1)$$

where subscripts i and t refer to the wealth indicator and month of the year, respectively. Since the hard lockdown occurred in winter, when electricity usage is at its highest, it became a concern that the model might overestimate the impact of COVID-19. Seasonal effects are accounted for by adding dummy variables for each month to the specification, and the model is modified as follows:

$$Y_{it}^{2} = f(wealth_i, lockdown_t, month_t) \quad (2)$$

Lastly, the model must account for the rolling blackouts since they occurred during the lockdown and impacted the neighbourhood's energy consumption. Load-shedding is accounted for in the specification, and the model is modified as follows:

$$Y_{it}^{3} = f(wealth_i, lockdown_t, month_t, load - shedding_t) \quad (3)$$

2.3. Unit Purchase Trends and Shifts

The trends and shifts in purchase quantities is determined for the households when transitioning from the month in the control period to the respective month in the lockdown period. Firstly, $x_{i,n}$ is defined as the total amount spent on units for prepaid meter i during the nth month. The total amount spent by prepaid meter i over the entire period is calculated as follows:

$$X_i = \sum_{n=1}^{24} x_{i,n} \tag{4}$$

where $n \leq 12$ is the control period, and $n > 12$ is the lockdown period. Next, M is defined as a series of a distinct number of bins to group the expenditure amounts into quantities m. M is used to determine the number of prepaid meters that purchase amounts that correspond to each bin and is calculated as follows:

$$Z_{m,n} = \sum_{i=1}^{I} z_{i,n} \tag{5}$$

where $Z_{m,n}$ is the number of prepaid meters that purchased an amount corresponding to bin m during month n, $z_{i,n}$ is an indicator that is equal to 1 if $x_{i,n} \in m$ or zero otherwise, and I is the total number of prepaid meters. From analysing the data, it was determined that M would consist of three bins to categorise the purchase quantities, as follows:

$$M_0 \; : \; x_{i,n} = 0 \tag{6}$$

$$M_1 \; : \; 0 < x_{i,n} < 1000 \tag{7}$$

$$M_2 \; : \; 1000 < x_{i,n} \tag{8}$$

The final step is determining a metric that compares the amount of prepaid meters that make purchases in bins M_0, M_1, and M_2 from a month in the control period to that in the lockdown period. The difference is calculated as a percentage, and the formula for the case M_0 is as follows:

$$\%\Delta n(M_0) = \frac{Z_{M_0,n} - Z_{M_0,n+12}}{\sum_{m=0}^{2} Z_{M_m,n}} \times 100 \tag{9}$$

where the denominator represents the total number of prepaid meters. However, this metric includes changes due to factors other than the behaviour changes due to lockdown. Therefore, a baseline value $\%\Delta N$, which takes all the months in a year into consideration (sum of $\%\Delta n$ over 12 months), is determined to compare how the changes for a specific month differ from the average change for the whole year.

3. Results

3.1. Unit Purchases

Table 1 shows the results of linear regression of units purchased for the three linear regression models defined in Section 2. The results in the table represent a 1% level of significance, and the standard error is shown in parenthesis. These results show how unit purchases were affected as a result of lockdown stages for the different income levels (row 1–4), seasonality for each month (row 5–15), and load-shedding stages on the different income levels (row 16–19).

The first column shows that increasing the lockdown stage increased the amount of units purchased by 1.6 percentage points (8 percentage points for stage 5) for I_1, which increased to 2.2 percentage points (11 percentage points for stage 5) for I_4. This shows that lockdown increased unit purchases for all income levels, where the impact is slightly greater for wealthier neighbourhoods.

Table 1. Linear regression results.

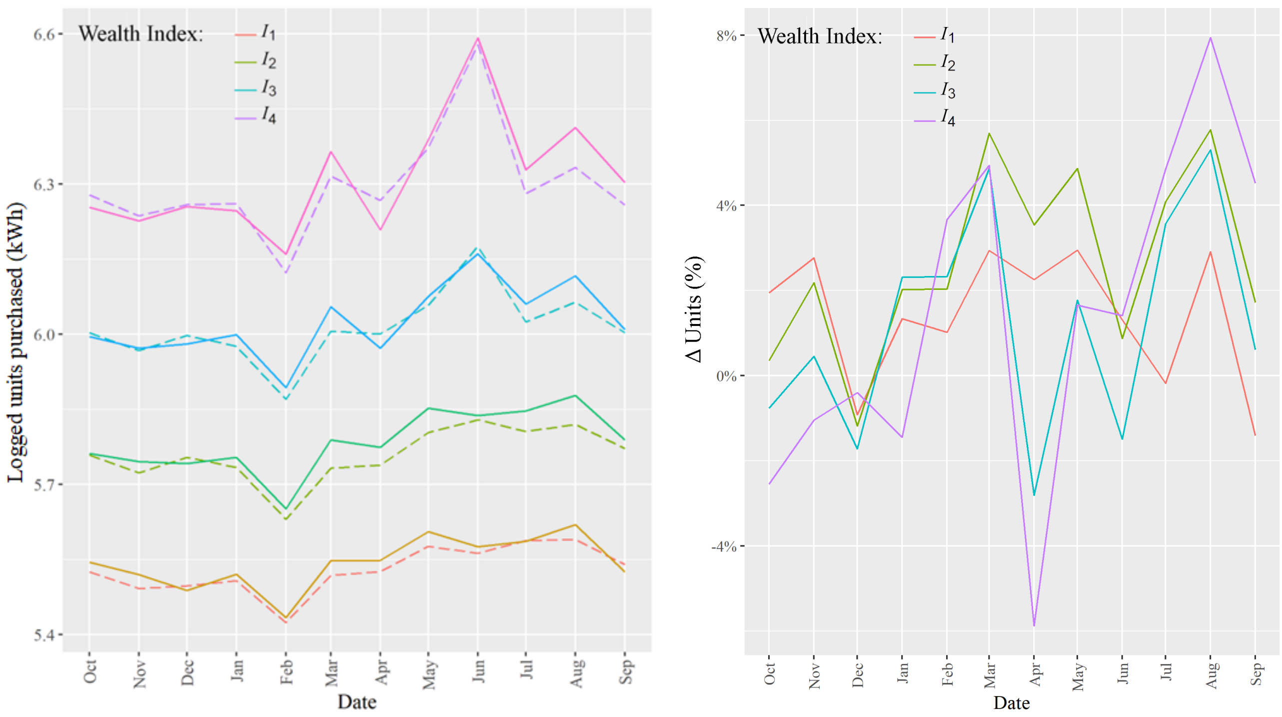
	Y_{it}^1 Units Purchased	Y_{it}^2 Units Purchased	Y_{it}^3 Units Purchased
LockdownStage × I_1	0.016 ***	0.005 ***	0.005 ***
	(0.002)	(0.001)	(0.001)
LockdownStage × I_2	0.020 ***	0.009 ***	0.009 ***
	(0.004)	(0.002)	(0.002)
LockdownStage × I_3	0.015 ***	0.003	0.004
	(0.004)	(0.002)	(0.002)
LockdownStage × I_4	0.022 ***	0.010 ***	0.010 ***
	(0.005)	(0.003)	(0.003)
Month = February		−0.049 **	−0.014
		(0.024)	(0.041)
Month = May		0.028 ***	0.035 ***
		(0.007)	(0.010)
Month = April		0.019	0.027 *
		(0.012)	(0.014)
Month = May		0.074 ***	0.071 ***
		(0.007)	(0.007)
Month = June		0.120 ***	0.129 ***
		(0.011)	(0.014)
Month = July		0.062 ***	0.062 ***
		(0.007)	(0.007)
Month = August		0.092 ***	0.091 ***
		(0.007)	(0.007)
Month = September		0.037 ***	0.048 ***
		(0.011)	(0.016)
Month = October		0.019 ***	0.018 ***
		(0.007)	(0.007)
Month = November		0.007	0.016
		(0.011)	(0.014)
Month = December		−0.012 *	−0.008
		(0.007)	(0.008)
Days in Month		0.017 *	0.028 **
		(0.009)	(0.014)
LoadshedStage × I_1			−0.013
			(0.016)
LoadshedStage × I_2			−0.014
			(0.019)
LoadshedStage × I_3			−0.018
			(0.019)
LoadshedStage × I_4			−0.029
			(0.022)
Constant	5.854 ***	5.302 ***	4.964 ***
	(0.012)	(0.286)	(0.430)
N	744	744	744
R^2	0.964	0.988	0.988

Note: Standard errors shown in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The second column shows the significance of each month on unit purchases when the model controls seasonality. It can be seen that the significance increases for the winter months that occur in the middle of the year, where the cold weather in June contributed to a 12.0 percentage point increase in unit purchases. For this model, it was found that the effect of an increase in lockdown stage only increased units usage by between 0.5 and 1.0 percentage points for I_1 and I_4, respectively.

The third column shows slightly higher estimates of unit purchases when load-shedding is accounted for. Load-shedding had a large negative impact on all four wealth groups. The model suggests that if load-shedding goes from stage 0 to stage 1, unit purchases among the rich and poor, without considering the effects of lockdown and seasonality, will decrease by 2.9 percentage points and 1.3 percentage points, respectively. When the model controls seasonality and load-shedding, increasing the lockdown stage increased the number of units purchased by 0.5 percentage (2.5 percentage points for stage 5) points for I_1, which increased to 1 percentage points (5 percentage points for stage 5) for I_4.

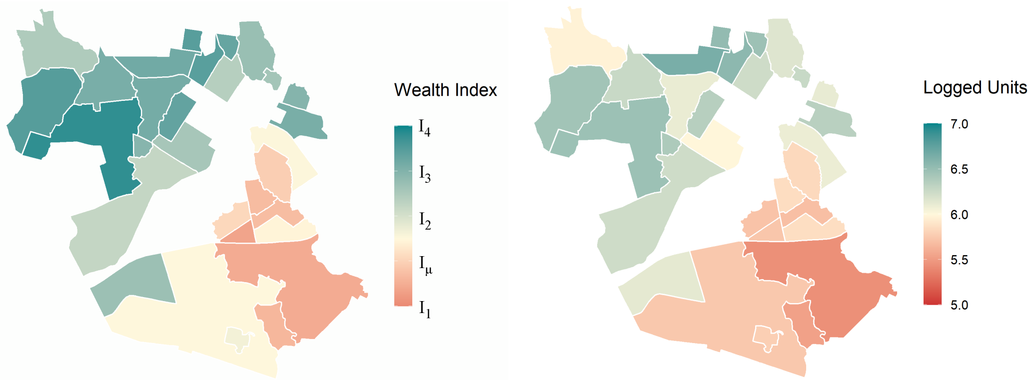
Figure 2a shows plots of the exponential average unit purchased by each wealth group for each month from October 2018 to September 2019 (dashed line) and from October 2019 to September 2020 (solid line). The units purchased are exponentially transformed to show an equal difference between the wealth groups so that it can be similarly compared to the plots in Figure 2b, which show the percentage change in units purchased for the respective wealth groups. For wealth indicators I_3 and I_4, it can be seen that the amount of units purchased shows a spike in February and March, followed by a significant drop in April. The same effect is observed for the poorer wealth groups; however, it is a lot more insignificant.



(**a**) (**b**)

Figure 2. Plots of (**a**) the exponential average units purchased and (**b**) the percentage change in average units purchased for each wealth group per month from October 2018 to September 2019 (dashed line) and from October 2019 to September 2020 (solid line).

Figure 3a shows a map of George and compares the distribution of wealth groups in various neighbourhoods, where I_μ indicates the average household income of South Africa. The distribution shows that there is a clear divide between rich and poor neighbourhoods. Figure 3b shows the average units purchased per month for the corresponding neighbourhoods. Comparing the two figures, it is observed that the wealth index of a neighbourhood has a direct correlation with the amount of units purchased.

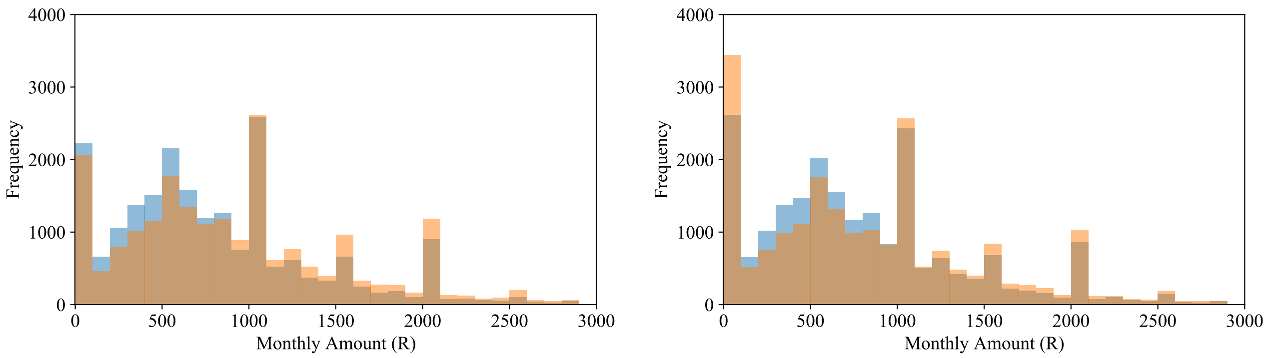


(**a**) (**b**)

Figure 3. Map of George that compares (**a**) the distribution of wealth groups in various neighbourhoods, where I_μ indicates the average household income of South Africa, and (**b**) the average logged units purchased per month for the corresponding neighbourhoods. The blank space represents "no data".

3.2. Household Expenditures

Figure 4a,b shows histograms of the monetary amount purchased for March and April during the control period (blue) and the lockdown period (orange) with the bins in M using R100 intervals for all of the data. The trend for the purchased amounts is expected to increase from the previous year to the next due to inflation and power tariffs, and this is conveyed by the shift from users purchasing below R1000 to purchasing more than this amount. The results for all the months show similar trends to March, with the exception of April showing an abnormal spike in the number of purchase amounts below R100, or better described as not purchasing electricity for the month.



(**a**) March (**b**) April

Figure 4. Histograms of the total household monthly amount purchased for electricity per prepaid meter for the control period (blue) and the lockdown period (orange). The overlap of histograms are shown in brown. Note: the behavioural analysis was performed using electricity units, and the monetary unit is reported here for reference only.

Table 2 shows the percentage change in the number of users purchasing monthly amounts within bins M_0, M_1, and M_2 for March and April using Equation (9) and for the overall year by using the same equation over all the months. By looking at the results over the whole year using *all* the data, there is a small change in the number of households not purchasing units for the month. There is also a 6.4% decrease in users purchasing less than R1000, which contributes to the 5.9% increase in users purchasing more than R1000. By looking at the April columns, there is a significant increase of 4.1% in users purchasing less than R100 that is explained by the equally significant shift in purchases of

9.6% in March to above R1000. This increase is 3.7% higher than the yearly average and is equivalent to the 3.7% increase in April's number of zero purchases from the yearly average.

By looking at the results according to the the different population groups in Table 2, it can be seen that the shift from M_0 to M_1 is higher for White households and the least for Black African households, and the significant observations noticed in all of the data are less apparent. Furthermore, a similar trend is observed when the data are separated according to the various wealth indicators, with the exception of the wealth index I_4.

Table 2. Table of the percentage change from the control to lockdown period in the number of meters with purchases within M_0, M_1, and M_2 for March, April, and for the whole year. The rows represent a further separation of the results into the corresponding population groups and wealth indicators of the households.

	Δ% March			**Δ% April**			**Δ% Year**		
	M_0	M_1	M_2	M_0	M_1	M_2	M_0	M_1	M_2
All	−0.4	−9.2	9.6	4.1	−9.1	5.0	0.4	−6.4	5.9
Population groups:									
White	−1.1	−9.4	10.5	4.6	−9.5	4.9	0.0	−6.7	6.7
Color	0.2	−9.6	9.4	3.7	−9.6	6.0	0.8	−7.0	6.2
Black	−0.1	−6.1	6.2	3.3	−5.9	2.6	0.7	−4.5	3.9
Wealth Index:									
I_4	−1.4	−7.8	9.2	1.9	−5.7	3.7	−0.9	−5.1	6.0
I_3	−0.7	−10.2	10.9	5.0	−10.8	5.8	0.4	−7.4	7
I_2	−0.5	−9.3	9.8	4.3	−10.5	6.1	0.7	−6.9	6.2
I_1	0.7	−7.5	6.9	3.1	−6.6	3.4	0.9	−5.5	4.5

3.3. Discussion of Results

The regression results table in Section 3.1 clearly show that the effects of implementing lockdown stages in George affected all neighbourhoods of different wealth groups, where stage 5 lockdown results in a 2.5 percentage point increase in poor neighbourhoods and a 5 percentage point increase in rich neighbourhoods. Load-shedding also had little impact on the purchases of each wealth group. This can be explained by the fact that load-shedding is implemented for the whole country and equally affects the various areas. Moreover, Figure 2 shows that there is a significant increase in unit purchases when hard lockdown was first implemented in March 2020. This suggests that lockdown caused people to panic and purchase more units in fear of lockdown. A geographical view of George in Figure 3 indicates that the affluent divide between rich and poor neighbourhoods are respectively situated in the the northern and southern halves of the region. It also shows how the greatest impact on unit purchases, positive or negative, occur in the wealthier neighbourhoods and that the poorer communities are affected less.

The results in Section 3.2 shows that more households spent over R1000 on unit purchases in all of the lockdown months than those prior to them. However, an interesting finding is observed by comparing the change in how much households spent in March and April. For all of the households in March, there was a 3.7% increase above the 5.9% annual increase in the number of households that spent over R1000 on electricity. This resulted in a 3.7% increase above the 0.4% annual increase in the number of households that spent less than R100 on electricity. Furthermore, this finding was more significant for both the wealthiest areas and White neighbourhoods and less significant for poorest areas and Black neighbourhoods. This confirms that the start of lockdown induced panic for residential households due to the purchase surplus in March and deficit in April.

The results show that the household electricity usage increased due to lockdown regulations. These regulations prevented people from working, and many of those that could work were forced to work remotely. Moreover, the vast majority of workers that could work from home are White [28]. This explains why the electricity usage in residential households increased overall in response to lockdown levels, and wealthier, White neighbourhoods showed a bigger impact as they tend to have more electricity-consuming devices, consume more electricity in general, and are more likely to work remotely from home.

Although the results are not extreme, it is important to understand the financial impact of increased household electricity usage due to lockdowns. These findings provide insight and a better understanding of how the COVID-19 pandemic impacted the electricity demand and purchases in different affluent neighbourhoods in South Africa. Using local data as well as examining the compliance of people to stay at home in different communities enables policymakers to make better predictions of the behavioural change in electricity usage in the various areas of the country in the event of the COVID-19 pandemic or other unforeseen natural disasters.

4. Conclusions

In this paper, an analysis is performed to determine how enforcing a hard lockdown due to the COVID-19 global pandemic impacted the energy consumption of a developing country since it was first implemented in March 2020. A case study is performed in George, a region in South Africa with a significantly high distribution of wealth and energy inequality, and the changes in the residential sector's energy usage behaviour patterns were determined. The results of the analysis indicate that the total energy consumption was influenced by the lockdown and that panic lead to residents purchasing excessive amounts of electricity in March. This is mainly attributed to policies that prevented residents from leaving their homes, such as the transition of staff to working remotely. Moreover, this trend was more noticeable in wealthier communities and neighbourhoods that are considered White inhabited. The study shows that enforcing a stage 5 lockdown resulted in the wealthiest communities increasing their overall energy consumption by 5 percentage points and the poorest communities by 2.5 percentage points.

The findings in this paper also showed that the number of households that spent over R1000 on electricity increased significantly in March 2020 when the lockdown was enforced, as well as contributing to numerous households not buying electricity for the following month. The impact is less significant for poorer areas and Black neighbourhoods. These findings are supported by the number of workers that can work from home in different areas, as well as compliance of people with lockdown rules.

South African policymakers can make better predictions for the change in electricity purchases for different areas by using local data. In future work, these findings can aid in optimal decision making in response to electricity demand in the event of an unforeseen pandemic or natural disaster.

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Nomenclature

$\%\Delta n$	Annual percentage difference in prepaid meter purchases from control to lockdown period
I_x	Indicator of specific wealth group x
M_m	Total number of prepaid meters within expenditure bracket m

X_i Total prepaid meter expenditure for household i
Y_{it} Linear regression model
$Z_{m,n}$ Total number of prepaid meters for expenditure bracket m and month n

References

1. World Health Organization. WHO Coronavirus Disease (COVID-19) Dashboard. 2021. Available online: https://covid19.who.int/ (accessed on 16 February 2021).
2. Ruan, G.; Wu, J.; Zhong, H.; Xia, Q.; Xie, L. Quantitative assessment of U.S. bulk power systems and market operations during the COVID-19 pandemic. *Appl. Energy* **2021**, *286*, 116354. [CrossRef]
3. Sovacool, B.K.; Furszyfer Del Rio, D.; Griffiths, S. Contextualizing the COVID-19 pandemic for a carbon-constrained world: Insights for sustainability transitions, energy justice, and research methodology. *Energy Res. Soc. Sci.* **2020**, *68*, 101701. [CrossRef] [PubMed]
4. International Energy Agency. IEA Global Energy Review 2020. 2020. Available online: https://www.iea.org/reports/global-energy-review-2020 (accessed on 16 February 2021).
5. Kaplan, J. At Least 20% of the Global Population Is on Coronavirus Lockdown—Here Are Their Rules. 2020 Available online: https://www.businessinsider.co.za/countries-on-lockdown-coronavirus-italy-2020-3-4 (accessed on 6 March 2021).
6. Dingel, J.I.; Neiman, B. How many jobs can be done at home? *J. Public Econ.* **2020**, *189*, 104235. [CrossRef] [PubMed]
7. Smit, S.; Musango, J.K.; Brent, A.C. Understanding electricity legitimacy dynamics in an urban informal settlement in South Africa: A Community Based System Dynamics approach. *Energy Sustain. Dev.* **2019**, *49*, 39–52. [CrossRef]
8. IEA. World Energy Outlook 2018. 2021. Available online: https://www.iea.org/news/preview-of-world-energy-outlook-2018 (accessed on 18 February 2021).
9. Mathu, K. Cleaning South Africa's Coal Supply Chain. *J. Bus. Divers.* **2017**, *17*, 116–126. [CrossRef]
10. McKane, J. Ramaphosa Announces Plan to Save Eskom and Stop Load-Shedding. 2021. Available online: https://mybroadband.co.za/news/energy/386264-ramaphosa-announces-plan-to-save-eskom-and-stop-load-shedding.html (accessed on 17 February 2021).
11. Jaglin, S.; Dubresson, A. *ESKOM: Electricity and Technopolitics in South Africa*; Juta and Company (Pty) Ltd.: Cape Town, South Africa, 2016.
12. Ranchhod, V.; Daniels, R.C. *Labour Market Dynamics in South Africa in the Time of COVID-19: Evidence from Wave 1 of the NIDS-CRAM Survey*; SALDRU: Cape Town, South Africa, 2020.
13. The Presidency. President Cyril Ramaphosa: Escalation of Measures to Combat Coronavirus COVID-19 Pandemic. 2020. Available online: https://www.gov.za/speeches/president-cyril-ramaphosa-escalation-measures-combat-coronavirus-covid-19-pandemic-23-mar (accessed on 20 October 2020).
14. The Presidency. President Cyril Ramaphosa: South Africa's Response to Coronavirus COVID-19 Pandemic. 2020. Available online: https://www.gov.za/speeches/president-cyril-ramaphosa-south-africas-response-coronavirus-covid-19-pandemic-23-apr-2020 (accessed on 20 October 2020).
15. The Presidency. President Cyril Ramaphosa: UN High-Level Event on Development Financing in Age of Coronavirus COVID-19. 2020. Available online: https://www.gov.za/speeches/president-cyril-ramaphosa-un-high-level-event-development-financing-age-coronavirus-covid (accessed on 20 October 2020).
16. Andrade, J.V.; Salles, R.S.; Silva, M.N.; Bonatto, B.D. Falling consumption and demand for electricity in South Africa-a blessing and a curse. In Proceedings of the 2020 IEEE PES/IAS PowerAfrica, Nairobi, Kenya, 25–28 August 2020; pp. 1–5.
17. Khumalo, S. Eskom Could Increase Tariffs by up to 10.95% after Regulator's Decision. 2021. Available online: https://www.news24.com/fin24/economy/eskom/eskom-could-increase-tariffs-by-up-to-1095-after-regulators-decision-20210128#:~:text=Eskom%20could%20increase%20tariffs%20by%20up%20to%2010.95%25%20after%20regulator's%20decision,-28%20Jan&text=An%20electricity%20pylon.&text=In%20an%20announcement%20on%20Thursday,the%202021%2F22%20financial%20year (accessed on 29 January 2021).
18. Hosseini, S.E. An outlook on the global development of renewable and sustainable energy at the time of COVID-19. *Energy Res. Soc. Sci.* **2020**, *68*, 101633. [CrossRef] [PubMed]
19. IRENA. Post-COVID Recovery: An Agenda for Resilience, Development and Equality. 2020. Available online: https://irena.org/publications/2020/Jun/Post-COVID-Recovery (accessed on 16 February 2021).
20. Southern African Research and Documentation Centre. SADC Energy Sector Braces for COVID-19 Impact. 2020. Available online: https://www.sardc.net/en/southern-african-news-features/sadc-energy-sector-braces-for-covid-19-impact/ (accessed on 16 February 2021).
21. The Conversation. Power Shortages Will Remain a Big Challenge in a Post-COVID-19 South Africa. 2021. Available online: https://theconversation.com/power-shortages-will-remain-a-big-challenge-in-a-post-covid-19-south-africa-134589 (accessed on 16 February 2021).
22. Akrofi, M.M.; Antwi, S.H. COVID-19 energy sector responses in Africa: A review of preliminary government interventions. *Energy Res. Soc. Sci.* **2020**, *68*, 101681. [CrossRef] [PubMed]

23. Norouzi, N.; de Rubens, G.Z.; Choubanpishehzafar, S.; Enevoldsen, P. When pandemics impact economies and climate change: Exploring the impacts of COVID-19 on oil and electricity demand in China. *Energy Res. Soc. Sci.* **2020**, *68*, 101654. [CrossRef] [PubMed]
24. Bakirtas, T.; Karbuz, S.; Bildirici, M. An econometric analysis of electricity demand in Turkey. *METU Stud. Dev.* **2000**, *27*, 23.
25. Google. COVID-19 Community Mobility Reports. 2021. Available online: https://www.google.com/covid19/mobility/ (accessed on 17 February 2021).
26. Belzunegui-Eraso, A.; Erro-Garcés, A. Teleworking in the Context of the COVID-19 Crisis. *Sustainability* **2020**, *12*, 3662. [CrossRef]
27. Spaull, N.; Daniels, R.S.; Ardington, C.; Branson, N.; Breet, E.; Bridgman, G.; Brophy, T.; Burger, R.; Burger, R.; Casale, D.; et al. Synthesis Report, NIDS-CRAM Wave 3. 2021. Available online: https://cramsurvey.org/reports/#wave-3 (accessed on 23 February 2021).
28. Spaull, N.; Oyenubi, A.; Kerr, A.; Maughan-Brown, B.; Ardington, C.; Christian, C.; Shepherd, D.; Casale, D.; Espi, G.; Wills, G.; et al. Synthesis Report, NIDS-CRAM Wave 2. 2021. Available online: https://cramsurvey.org/reports/#wave-2 (accessed on 23 February 2021).
29. George Municipality. George Municipality Final Budget 2020/21 to 2022/23. 2021. Available online: https://documentportal.george.gov.za/storage/twenty-twenty-budgets/July2020/zoT1pxxttTkzcIoKcanQ.pdf (accessed on 26 February 2021).
30. George Municipality. Socio-Economic Profile 2018. 2021. Available online: https://www.westerncape.gov.za/provincial-treasury/files/atoms/files/WC044%20George%202018%20Socio-economic%20Profile%20%28SEP-LG%29%20F%20.pdf (accessed on 26 February 2021).
31. Investopedia. Gini Index Definition. 2021. Available online: https://www.investopedia.com/terms/g/gini-index.asp (accessed on 26 February 2021).
32. Wazimap. South African Community Survey 2011. 2021. Available online: https://wazimap.co.za/profiles/municipality-WC044-george/ (accessed on 26 February 2021).
33. Wazimap. South African Community Survey 2016. 2021. Available online: https://wazimap.co.za/profiles/municipality-WC044-george/ (accessed on 26 February 2021).