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Heterogeneous Effects of Government Energy Assistance Programs: Covid-19 Lockdowns in the Republic of Georgia

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Abstract:
During the Covid-19 pandemic, the governments of many countries adopted measures to support the population during the lockdowns and periods of reduced economic activity. In the Republic of Georgia, in April 2020 the government announced that it would pay the electricity bills of residential customers in April and May 2020, effectively making electricity free, as long as usage would not exceed 200 kWh/month. In August 2020, the government announced that the policy would be in force again in November and December 2020, and January and February 2021. We examine meter readings from the entire country outside of the Tbilisi city limits, finding that the average household increased usage by some 5% above and beyond their normal. This figure however masks considerable heterogeneity in the effects of the policy across urban, rural, and "high mountain" status areas. We examine the possibility that awareness of the policy might decrease with the distance from the capital Tbilisi, but find little evidence of "distance decay" effect. We find that, as suggested by economic theory, in the months when the policy is in place low-volume consumers increase their electricity usage and high-volume consumers decrease it in an effort to make the 200 kWh mark. Assuming that the increase in electricity demand was met with imports and domestic generation by gas-fired power plants, our models predict that in our sample CO2 emissions increased by

2,028 tons during the "free electricity months," despite an actual reduction among the residents of large cities.

JEL: D12; Q41; Q48
Keywords: residential electricity consumption; increasing block rate (IBR) tariffs; salience; free electricity

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1.Introduction

At the beginning of April 2020, the government of the Republic of Georgia announced that it would pay the electricity bills of residential customers directly to the utility on their behalf—as long as electricity consumption was less than or exactly 200 kWh for the month. The policy would apply in April and May 2020, as well as retroactively for March 2020. Effectively, electricity would be free to consumers, as long their consumption levels would stay below or at 200 kWh. This decision was motivated by the desire to help households during the Covid-19 lockdowns—a period of extreme economic uncertainty—and came at a time when the electricity sector was experiencing generation difficulties, because of less abundant rainfall than usual and the upcoming temporary closure of the most important hydro power plant in Georgia for maintenance.

In August 2020, the government announced that the measure would be resumed in November and last until the end of February 2021. Officials at the national energy regulatory commission, GNERC, told us that virtually all of the consumers that contacted GNERC to make sure that they had fully understood the policy and its workings were residents of Tbilisi, the capital.[1] One thus wonders whether somehow people elsewhere were unaware of the policy, and had perhaps failed to respond to it.

The purpose of this paper is to examine *if* and *how* people responded to the free electricity policy in the Republic of Georgia, and identify factors that affect the intensity of such response. Economic theory and common sense suggest that faced with the prospect of free electricity, low-volume consumers would increase their consumption—while trying to stay below the 200 kWh mark. Conversely, high-volume consumers would try to reduce usage to qualify for free electricity. Whether these two opposing responses resulted in an increase or

[1] Sergo Latsabidze, personal communication, November 2022.

decrease in electricity consumption, especially during lockdowns, when people are required to stay at home, is an empirical question, which we tackle in this paper.

We focus on the service territory of one of the two distribution utilities in Georgia—the one that serves the entire nation outside of the Tbilisi city limits. We have a 10% sample of its entire customer base, and conduct our analyses using a longitudinal dataset that follows these consumers every month from January 2017 to September 2021. This period covers revisions in the tariffs, the "emergency" free electricity policy during the pandemic lockdowns, and several months thereafter. Our analyses rely on econometric models with a rich set of fixed effects to account for household and dwelling unobserved characteristics, weather and nationwide trends in electricity usage, and take advantage of the intermittent nature of the free electricity policy.

The free electricity policy results in a 5% increase in electricity consumption during the lockdowns, which is modest when compared to estimates from the US (10% nationwide and 16% in Texas: Cicala, 2020) and Spain (9%, see Bover et al., 2023). This figure however masks considerable heterogeneity across environments.

We formulate and empirically test a number of assumptions about the mechanisms that would result in heterogeneity. Briefly, we find no support for the hypothesis that knowledge of the policy, and hence presumably the responsiveness to it, decreases with the distance from the capital, Tbilisi. We find that rural areas experience a stronger percentage increase in electricity usage, whereas consumption is practically unchanged in urban areas, and even decreases by some 2% in the most urbanized of the urban areas. We had conjectured that the policy should have modest or no impacts in those areas where it represents just a minimal departure from the current situation (Chetty et al., 2009; Sallee, 2014). This would be the case, for example, in areas designated as "high mountain," where normally households receive a 50% discount in price if consumption is less than 200 kWh. Surprisingly, however, households residing in these areas actually exhibit the largest percentage point increase in their usage (almost 12%). We attribute this result to an increase from the very minimalistic baseline consumption, and to the possibility that households increased the use of electric heat.

The remainder of this paper is organized as follows. Section 2 provides background about electricity generation, the residential electricity market, tariffs and policy in Georgia. Section 3 describes the data and section 4 the econometric model(s). Section 5 presents the results and section 6 concludes.

2. Background

2.1. Electricity in the Republic of Georgia

Electricity consumption has increased in Georgia over the last decade, as a result of cryptocurrency processing, higher penetration of air conditioning in the hospitality and commercial sectors, and industrial use (International Energy Agency, 2020). The electricity sector has been partly deregulated in recent years, but the regulator still sets the tariffs at which the two distribution utilities—Telasi for the city of Tbilisi, and Energo-Pro Georgia in the rest of the country—provide electricity to residential customers.

Distribution of electricity is thus very highly concentrated, and so is generation. Most domestic generation is hydroelectricity, which is subject to seasonal fluctuations. During the winter, hydropower must be supplemented with imports (generally of gas-fired electricity from Russia and Azerbaijan) and production from domestic thermal power plants. A very large share of the hydropower is generated at the Enguri power plant (HPP), which is equipped with storage, but is also located in a region controlled by Russia-backed separatists. Moreover, 50% of the electricity produced at the Enguri power plant is given for free to the separatist region.

Less rainfall than usual in 2019 and 2020, and the closure of the Enguri HPP for scheduled maintenance and repairs from January to the end of April 2021, resulted in less hydroelectricity generation during that period. The shortfall was compensated for with additional generation from domestic thermal power plants and a small increase in imports of electricity from neighboring countries.

At the beginning of April 2020, in the early stages of the Covid-19 pandemic and the related lockdowns, the government announced that it would pay the April and May 2020 electricity bills of residential customers directly to the utilities, effectively making electricity free, as long as a household consumed less than 200 kWh a month.[2] This decision was motivated by the government's desire to help families at a time of extreme economic uncertainty and expected increases in residential usage since people had to stay home, as well as the domestic generation difficulties. Later—in August 2020—the government announced that the same free electricity plan would take place in November and December 2020, and January and February 2021.[3]

The measure would no longer stay in place after the end of February 2021, but in March-June 2021 the tariffs would be the ones in place from January 2018 to December 2020, instead of the new ones scheduled from January 2021—but only for consumers in blocks 1 and 2 (see below). Higher-volume consumers—those in block 3—would be facing the new tariff for that

[2] The policy also applied retroactively to March 2020, in that consumers would get credited for their March 2020 bill amount.
[3] National lockdowns took place from March, 21 to May 22, 2020, and then again from November 28, 2020 to February 1, 2021. During the national lockdowns, schools were closed and instruction had to be done online; restaurants, movie theaters, gyms and sports facilities were closed; religious services were cancelled; public transportation was suspended, and government employees were encouraged to work remotely. Only during the winter holidays (from December 24, 2020, to January 2, 2021) were shopping centers open.

block. In sum, electricity was free (as long as consumption stayed below 200 kWh/month) for 4 months in 2020 (April, May, November and December) and 2 months in 2021 (January and February 2021), and scheduled tariff increases were partially postponed (see table A.1 in the Appendix).

In both instances the announcements were made on national television, covered in the newspapers (both in print and online), and posted on the websites of the regulator and Telasi. A Google trends search for the terms “200 kWh,” “Telasi” and “government electricity subsidy” shows enhanced search activity on the part of the general public in early April and in August 2020, at the time of announcements (see Alberini et al., 2023, figure A.1).

2.2 Electricity Tariffs in the Residential Sector in Georgia

In the Republic of Georgia, electricity is supplied to residential customers by two distribution utilities: Telasi, which serves Tbilisi (the capital) and is part-owned by the government, and Energo-Pro Georgia, a private company, which covers the rest of the country. The regulatory commission, GNERC, sets the tariffs to residential customers, which are revised every three years. The tariffs follow a rather unusual increasing block rate scheme: There are a total of three blocks—up to 101 kWh/month, 102-301 kWh/month, and 302 and more kWh/month—but customers whose consumption falls in the second (or third) block pay the second- (third) block rate on their *entire* consumption—not merely on the kilowatt-hours that exceed the cutoff between the first and second block (second and third).

To illustrate, a household that used 101 kWh in November 2022 pays a bill of 0.180422*101=18.22 Georgia Lari (GEL); had it consumed 102 kWh, it would have paid a bill of 0.220542*102=22.42 GEL, and 0.265382*302=80.14 GEL if it had consumed just barely enough to fall in the third consumption tier. One would expect such a stark increase in the bill to motivate customers to pay attention to their consumption and limit it if possible. This scheme has been in place since at least 2005 and presumably consumers are used to it by now.

Alberini et al. (2022) use nationwide data from the Georgia Household Budget survey to construct monthly electricity consumption for households in Georgia, and take advantage of the natural experiment represented by the revisions in the tariffs in 2013, 2015-16, and 2018, and their different timing in different parts of the country, to devise a difference-in-difference study design. Estimates of the price elasticity of demand range from -0.3 to -0.5, depending on the estimation technique and the period, showing that households do respond to the tariffs.

The free electricity policy represents a massive (-100%) tariff change—one that could not possibly go unnoticed. In addition, the 200 kWh limit effectively splits the second consumption tier into two. For comparison, in the previous 10 years Energo Pro Georgia's tariffs had been revised a total of three times: In early 2013, when the rates in blocks 1 and 2 were reduced, whereas the rate in block 3 was kept unchanged; in September 2015, when all rates were raised; and again in January 2018, when they were raised by about 12%. The rates that took effect in January 2018 remained in place until the end of December 2020. New rates were scheduled to start in January 2021, but, as shown in table 1, because of the pandemic and the free electricity policy in January and February 2021, the government decided to continue to apply the 2018 tariffs in blocks 1 and 2 until the end of June 2021. The 2021 tariffs were resumed in all blocks starting in July 2021 (see table A.1 in the Appendix).

3. Hypotheses and Models

3.1. What Effects Do We Expect from the Policy?

During the free electricity months, electricity consumption by residential customers in the capital, Tbilisi, exhibited a striking degree of bunching—namely an unusual spike in the distribution—at or just under 200 kWh, which quickly disappeared every time the policy lapsed and reappeared every time it was reinstated (Alberini et al., 2023).[4] Did the rest of the country, which is served by the privately owned utility Energo Pro Georgia, show a similar response? During the free electricity months, one would expect low-volume consumers to increase consumption, since it is free as long as it stays below or at 200 kWh, and high-volume consumers to strive to make the 200 kWh mark. These responses may be mitigated or enhanced by the fact that people were required to stay at home.

Officials at GNERC report that most of the contacts made by residential customers (by phone or email) to double-check the specifics of the free electricity program came from the Tbilisi area, wondering whether the rest of the country was sufficiently aware of the existence of the policy itself. In the remainder of this paper, we use meter readings from a 10% sample from the entire residential customer base of Energo Pro Georgia, merged with weather and socio-demographics, to empirical test a number of hypotheses about the possible response to the free electricity policy.

Our first hypothesis is that awareness of the policy, and hence the strength of the response to it, is inversely proportional to the distance from Tbilisi. We test this assumption by creating concentric circles around Tbilisi (see figure 1), and fitting regressions (described in section 3.3) where a "free electricity" policy dummy is interacted with an indicator that the customer is a resident of the j-th ring, where j=1, …, 7.[5]

[4] See Borenstein (2009) for a discussion of bunching with increasing block tariffs.
[5] Ring 1 covers the area within 25 km from Tbilisi; ring 2 that between 25 and 50 km; ring 3 that between 50 and 100 km; ring 4 that between 100 and 150 km; ring 4 that from 150 to 200 km; ring 6 that from 200 to 250 km, and ring 7 that between 250 and 300 km.

A second hypothesis is that the response is different in larger than in smaller cities, towns and settlements, presumably on the grounds of faster information diffusion and different stock of housing. A third hypothesis is similar, but posits that any differences follow the urban/rural divide.

Our fourth and final hypothesis is that the strength of the response depends on the strength of the free electricity "treatment" compared to the usual tariffs. We argue that the treatment is the "weakest" for the residents of selected mountain villages, which since 2017 have received subsidies from the government that effectively gives them electricity at half price as long as consumption is within 200 kWh. These consumers experienced the least degree of novelty in terms of the 200 kWh cutoff, suggesting the least degree of consumption adjustment once the policy is put in place or removed.[6] This effect may be compounded with diminished salience (Chetty et al., 2009) and/or insufficient gains for the effort required to change behavior (Sallee, 2014).

3.2. How Do We Measure the Effect of the Free Electricity Policy?

The strength of the response to the policy can be measured in a number of ways. The first is by checking whether any "bunching" is observed at 200 kWh during the free electricity months. Bunching (Borenstein, 2009) is defined as a sharp increase in the frequency of consumption volumes at or in a neighborhood of 200 kWh that was not observed in the periods

[6] Out of 3668 settlements (comprising villages and municipalities) in Georgia, 1582 hold the status of "high mountain settlements." Households residing permanently in these settlements benefit from electricity subsidies provided by the Georgian government. To qualify as a permanent resident in a "high mountain settlement," an individual must meet the following criteria: a) be a citizen of Georgia; b) be registered in a highland settlement; and c) actually reside in a highland settlement for a total of 9 months or more during each calendar year. Starting on January 1, 2017, residential customers in the "high mountain settlements" have been reimbursed 50% of their monthly electricity bills, not to exceed the 100 kWh of electricity consumed. The reimbursement is calculated based on total consumption.

before the policy. We examine histograms of consumption in the appropriate periods, looking for evidence of bunching.

The second is by assessing, regardless of the presence of bunching—whether the policy resulted in a different level of usage from that predicted by usual household consumption and weather. The third is by examining whether usage moved in a different direction and by a different extent for low- and high-volume households. Both of these goals are accomplished by regressing electricity consumption (or its logarithmic transformation) on variables thought to affect it, including a dummy denoting whether the free electricity program is in place, plus interactions of the latter with dummies capturing certain factors. We also fit linear probability models to explain whether the household was able to limit consumption to below 200 kWh as a function of the same variables and factors, as described in the next section.

3.3. Econometric Models

Since we have a panel dataset documenting the monthly electricity consumption of households served by Energo Pro Georgia (see section 4), but no information about the dwelling or the household's sociodemographics, our main regression equation is

$$lnE_{it} = \alpha_{im} + \tau_{rp} + \mathbf{W}_{it}\boldsymbol{\beta} + FREE\_ELEC_{it} \cdot \delta + \varepsilon_{it}, \tag{1}$$

where E denotes the electricity used by household i and month and year t, **W** denotes the weather (heating degree days and cooling degree days, computed using 18° C as the base), and FREE_ELEC is a dummy denoting a month when the free electricity policy is in place. The right-hand side of (1) also includes household-by-month fixed effects and region-by-tariff-period fixed effects to absorb as much unobserved heterogeneity as possible.

The right-hand side of (1) can be amended to include interaction between the free electricity policy dummy and factors thought to modify the basic effect of the policy. For example, we test hypothesis one by replacing the FREE_ELEC dummy with interactions between the FREE_ELEC dummy and location within any one of seven rings around Tbilisi. We test hypothesis two by adding an interaction between the free electricity dummy and living in one of eight municipalities with population greater than 80,000 (or the major cities therein). We test hypothesis three by entering an interaction between FREE_ELEC and rural area, and hypothesis four by entering an interaction between FREE_ELEC and "high mountain status" village.

Equation (1) checks whether consumption has been affected by the presence of the policy, and, if so, in a different way depending on the location. An alternate model replaces ln E with an indicator for whether household i's usage in month and year t was less than or equal to 200 kWh. Taken together, these two regressions should provide exhaustive information as to whether households were reducing or increasing consumption (or both), and by how much, during the free electricity months.

4. The Data

We have monthly meter readings and bills for the entire Energo Pro Georgia customer base in Tbilisi from January 2012 to September 2021. We merged these data (provided by the regulator) with monthly heating degree and cooling degree days, calculated from the weather records provided by the Georgia National Environment Agency using 18° C as the base.

We selected at random 10% of these meters in hopes of mitigating the likely correlation between different units within the same multi-family building or different dwellings in the same neighborhood. We further exclude customers who appear to be engaging in net metering (whom we identify by their negative consumption records), implausible meter readings (e.g., meter readings equal to tens of thousands of kWhs, which suggest meter reading errors), missing meter readings, zero meter readings (which imply uninhabited homes), and meter readings greater than 10,000 kWh/month.

Our analyses and regressions are limited to meter readings between 31 and 1000 kWh a month. Anything less than 31 kWh/month is suggestive of intermittent occupancy or of a structure that is not a home; 1000 kWh falls in the top 1% of monthly residential usage and is thus very rare in the Republic of Georgia. Figure 2 displays the average monthly consumption of households in Georgia from 2012 to September 2021. As expected, consumption is heavily seasonal, with winter peaks and relatively low summer consumption. (Most households in Georgia use natural gas, not electricity, to heat their homes; residents in rural or mountain areas may also use wood. Despite the warm summers, the penetration of air conditioning is relatively low.)

Figure 2 suggests that consumption was growing until about the end of 2016, and was stable thereafter, experiencing seasonal fluctuations around a flat level. We noticed the same trend when we examined each of the 11 administrative regions of Georgia separately—with the only exception of Adjara, which exhibits the opposite trend. For this reason, and to make sure that we correctly identify the response to the free electricity policy, attention in this paper is restricted to the data from January 2017.

Another reason for beginning our usable sample in January 2017 is that in 2017 EPG acquired the Kakheti Electricity Company, thus effectively serving the entire country except for Abkhazia and South Ossetia, separatist regions that the central government has no longer control over, and the city of Tbilisi. Moreover, by 2017 the "high mountain" settlements had been designated and their residents were receiving preferential pricing treatment from the government, which means that by focusing on 2017-2021 we have fewer confounding events to control for.[7]

The panel dataset used in our regressions follows a total of 106,197 meters over time. The length of the longitudinal component of this panel ranges from 1 to 57 months, for an average T=50 months. Figure 3 displays the histogram of monthly consumption from January 2017 to March 2020—when the pandemic started. The distribution is positively skewed and appears to have a modest "vertical wall" (in the parlance of Kleeven and Waseeem, 2013) at 101 kWh, but virtually no other signs of "bunching." Figure 3 shows the distribution of consumption during the free electricity months: Again, any signs of "vertical wall" are minor at best, and there are no signs of "bunching" anywhere else. By the time the free electricity policy is lifted (figure 4) there are absolutely no signs of bunching or any other abnormalities in the histograms.

Perusal of tables 2 and 3 suggests that, prior to the pandemic, average and median consumption were well below 200 kWh. Consumption appears to have increased during the free electricity months, and generally declined thereafter—back to the original level in some regions. The shares of households using less or just about 200 kWh display a more uneven behavior across regions, suggesting that it is possible to increase consumption and yet at the same time the share of bills below 200 kWh.

[7] In preliminary regressions based on equation (1) using the data from January 2012 to September 2021, we found that an implausible large effect of the free electricity policy. We believe that this is due to the long series used, the long-run trends in electricity use, and the adoption of the "high mountain" village energy assistance policy—which are difficult to control for, in spite of the presence of region-by-tariff-period fixed effects.

5. Results

Table 3 displays the results of our main regressions. Overall, controlling for weather, regional patterns and household-by-month effects, consumption appears to have increased by some 5% during the free electricity months. This is the case whether we use all of the observations since the beginning of 2017 or we focus solely on the months of January, February, April, May, November and December (the months when the free electricity policy was eventually in place) since 2017.

This result, however, masks much heterogeneity across places. For starters, Table 4 shows that the effect of the free electricity policy varied with the distance from Tbilisi, but was not monotonic in it, disproving our hypothesis 1. Information may well travel more slowly or incompletely as the distance from the capital increases, but, if so, this "distance decay" does not have the same intensity in all directions.

It is possible that this "distance decay" depends on the education level of the residents. Data from Georgia's Household Budget Survey however suggests that the various regions have similar shares of household members with university-level education, which suggests that the reasons for such non-monotonic response might be rooted in household income, size and age of the dwellings, and appliance stock, which we do not observe in our data.

Table 5, col. (1), suggests that the effect of the free electricity month is very different across urban and rural areas: In the former, electricity usage increases by about 1% during the free electricity months, whereas in the latter it increases by exp(0.0865)-1=0.0904, or 9.04%. Again, this effect remains the same whether we use all months or just those with one instance of the free electricity policy (column (2)).

Columns (3) and (4) report the results of specifications that include the free electricity month dummy and its interactions with dummies denoting, respectively, municipalities with population greater than or equal to 80,000, and the main city within those municipalities. In these municipalities, consumption was virtually unchanged during the free electricity months (0.9% increase), unlike in the rest of the country, where an 8.50% was experienced. In the main cities within those heavily populated municipalities consumers actually reduced their usage by about 2%. The largest proportional increase, however, appears (12.10%) to be the one in the high mountain status areas (column (5)).

In Columns (6) and (7) we include all of the previous interaction terms. In column (6), the coefficient on the free electricity month thus captures the effect of the policy on consumers in smaller towns, suburban areas and municipalities with population below 80,000, which is positive and approximately 3.78%. In rural areas consumption increases by 9.93% in the free electricity months, controlling for the weather, compared to its counterfactual under a regular tariff regime, and in designated mountain status areas by 12.67%, whereas in heavily populated municipalities usage decreases by 1.25%.[8] Column (7) implies an increase of almost 5% in smaller town and suburban areas, an 8.54% increase in rural areas, an 11.72% in mountain status area,[9] and a decline by 2% in the main city in municipalities with population above 80,000.

In table 6 we explore whether the prospect of free electricity appealed differently to high- and low-volume consumers. Indeed, those consumers that used more than 200 kWh in the same month in the previous year, or in the immediately preceding month, *reduced* electricity usage by 1-5% during the free electricity months. By contrast, those who used more than 200 kWh during the same periods increased usage by 7-10%.

[8] It should be borne in mind that mountain status villages are in rural areas, so both the "rural area" dummy and and the mountain status dummy are turned on for the mountain status villages.
[9] "High mountain" status villages are considered as located in rural areas.

These patterns are compatible with either an increase or a decrease in the share of consumers that stayed below 200 kWh. We examine this issue empirically in tables 7 and 8, which report the results of fitting linear probability models where the dependent variable is a dummy denoting that the month's consumption was below or exactly equal to 200 kWh.

In net, as shown in tables 7-8, this results in a tiny increase (0.35 percentage points) in the share of households below or at 200 kWh during the free electricity program's periods; this share however rises (by 1.9 percentage points) among households in urban areas and falls in households in rural areas (by 2.59 percentage points) (see column (2) in table 7). Columns (4) and (5) suggest increases by 2.64 percentage points and 3.35 percentage points, respectively, in larger municipalities and in their main cities. Columns (7) and (8) confirm these findings when all of these interactions are entered in the model.

Panel (B) of table 4 explores the role of distance from the capital Tbilisi in the share of consumers who used less than 200 kWh. The effect on the free electricity policy on the likelihood of consuming less than 200 kWh is again non-monotonic in the distance from Tbilisi, and positive and negative signs for the coefficients alternate without a clear pattern. This suggests that distance may not be a significant factor in household consumption patterns.

Table 8 shows that the share below 200 kWh rises in free electricity months among high-volume consumers, but remains virtually the same or falls only by very little among low-volume consumers. In sum, this is consistent with a behavioral response predicted by economic theory: Low-volume consumers were predicted to increase consumption but stay below 200 kWh, and high-volume consumers to decrease it in order to qualify for free electricity. This behavior is confirmed in the data.

6. Discussion and Conclusions

We have examined household response to a policy that was in place—intermittently for a total of six months—in the Republic of Georgia in 2020 and early 2021, when lockdowns were ordered to help contain the spread of Covid-19. The government paid the electricity bills of residential customers directly to the utilities, as long as consumption for the month was less than or equal to 200 kWh. This effectively made electricity free to consumers below 200 kWh. The program effectively provided support at a time of high economic uncertainty due to the pandemic. For comparison, in other countries, including the United States, direct cash support was provided to households and businesses.

We focus on the service territory of Energo Pro Georgia, which is essentially the entire country outside of the Tbilisi city limits, except for the autonomous regions of Abkhazia and South Ossetia. We found no evidence of "bunching" of the distribution of electricity consumption around the 200 kWh mark during the free electricity months. Yet, there was a meaningful response on the part of the consumers. The average household increased consumption by some 5%, but this figure masks considerable heterogeneity on the part of the consumers. We propose and empirically test a number of hypotheses about possible sources of heterogeneity.

One is that knowledge of the policy is inversely related to the distance from the capital, Tbilisi. We create concentric rings around the capital, but find that the effect of the free electricity policy is not monotonic in the distance from Tbilisi. It is possible that information about and awareness of the policy do not truly decay with the distance from the capital, or that they do but the net effect on electricity consumption does not match such decay, perhaps because of household income and habits, dwelling age and type and stock of appliances.

We suspected households in urban and rural environments to react differently to the policy, but did not have a clear a priori sense for the strength and direction of their responses. Households in urban settings are wealthier, live in smaller homes and use piped natural gas as their mean heating fuel, and may have more electric appliances. Homes are larges in rural areas (on average 154 square meters v 105 in urban areas, according to the 2019-2021 waves of Georgia's Household Budget Survey) but comparable in terms of age of the building. Piped natural gas makes a strong presence in rural areas as well, but income tends to be lower: Absolute poverty is dramatically higher—by 7-10 percentage points, especially in 2020—in rural areas (Geostat, 2023[10]). We find that the households in rural areas increase electricity consumption by more, in percentage terms, than their urban counterparts, who exhibited either a negligible change or even a 2% reduction.

Finally, we had conjectured that the impact of the free electricity policy is likely to be lowest at locales where it poses the least amount of change compared to the existing tariffs. We identify such locales as those villages and areas with "high mountain" status designation, where, even before the pandemic, households already benefited from a 50% discount on the tariffs up to 200 kWh. Contrary to our expectations, the response of household in "high mountain" status areas is actually the strongest, in percentage terms.

A 2015 survey of residents in rural areas and mountain status areas in 12 municipalities indicates that despite the presence of gas lines at some locations, many households continue to

[10] Geostat, the statistical agency of Georgia, considers a household or individual to be living in absolute poverty if they lack the minimum income required to sustain basic living standards over an extended period. Relative poverty is experienced when a person's income falls below a specific percentage of the national median income. According to Geostat, an individual is classified as poor if their consumption falls below 60% of the median consumption of the entire population (see https://www.geostat.ge/en/modules/categories/192/living-conditions).

use wood for cooking and heating, because it is cheaper than gas.[11] Households members live confined to one or two heated rooms during the winter, and the rest of the home is not heated (Lekveishvili, 2015[12, 13]). It is possible and likely that these households chose to use more electricity and less wood during the free electricity months, since the former was, at their usage levels, free (Lekveishvili, 2015). Perusal of the data from the 2019-21 waves of the Household Budget Survey rules out purchases of appliances for these households or any other in our sample during the 2020 pandemic lockdowns.

That the most pronounced electricity usage increases occur in comparatively poor areas bodes well in terms of progressivity of the program (Mastropietro et al., 2020; Berkhouwer et al., 2022; Alberini and Umapathi, 2024). That much of our sample reacted to the policy by increasing consumption has important implications in terms of GHG emissions. Assuming a "worst case scenario," namely that the increased demand was met using imports of natural gas fired electricity or domestically generated natural gas fired electricity, based on column (6) of table 5, our sample alone would be responsible for an additional 2,028 tons of CO_2 emissions (see table 9). The model of column (7) of table 5 however suggests that a net increase in CO_2 emissions masks heterogeneous results across urban and rural environments: As shown in table 10, in the larger cities, residential customers managed to reduce their consumption of electricity by 2%, and hence CO_2 emissions by 196 tons in our sample, despite spending more time at

[11] Likewise, persons living in areas that received a "high mountain" designation experience "natural disasters, unorganized water supply and heating infrastructure, lack of jobs, complicated communications with administrative centers, and low availability of government services" (Georgian Parliament's Research Center, 2020). The main activities of the residents are agriculture and tourism, but incomes are very low, and households spend more than half of their incomes on food. The economic problems in these areas are compounded by a lack of entrepreneurship and skilled labor.

[12] See http://chemilharaguli.com/?p=58050.

[13] Lekveishvili (2015) also writes that in rural and mountain status areas are old and either have never been renovated at all or were renovated a long time ago, but our examination of data from the 2019-2021 waves of the Georgia Household Budget Survey suggests very little difference in the age of homes across urban and rural areas, and, within rural areas, regions with high shares of mountain status villages versus the others.

and/or working from home, which presumably would increase the demand for lighting, and electronics.

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Figure 1. Rings around Tbilisi created to examine the effect of the free electricity policy at different distances from Tbilisi.

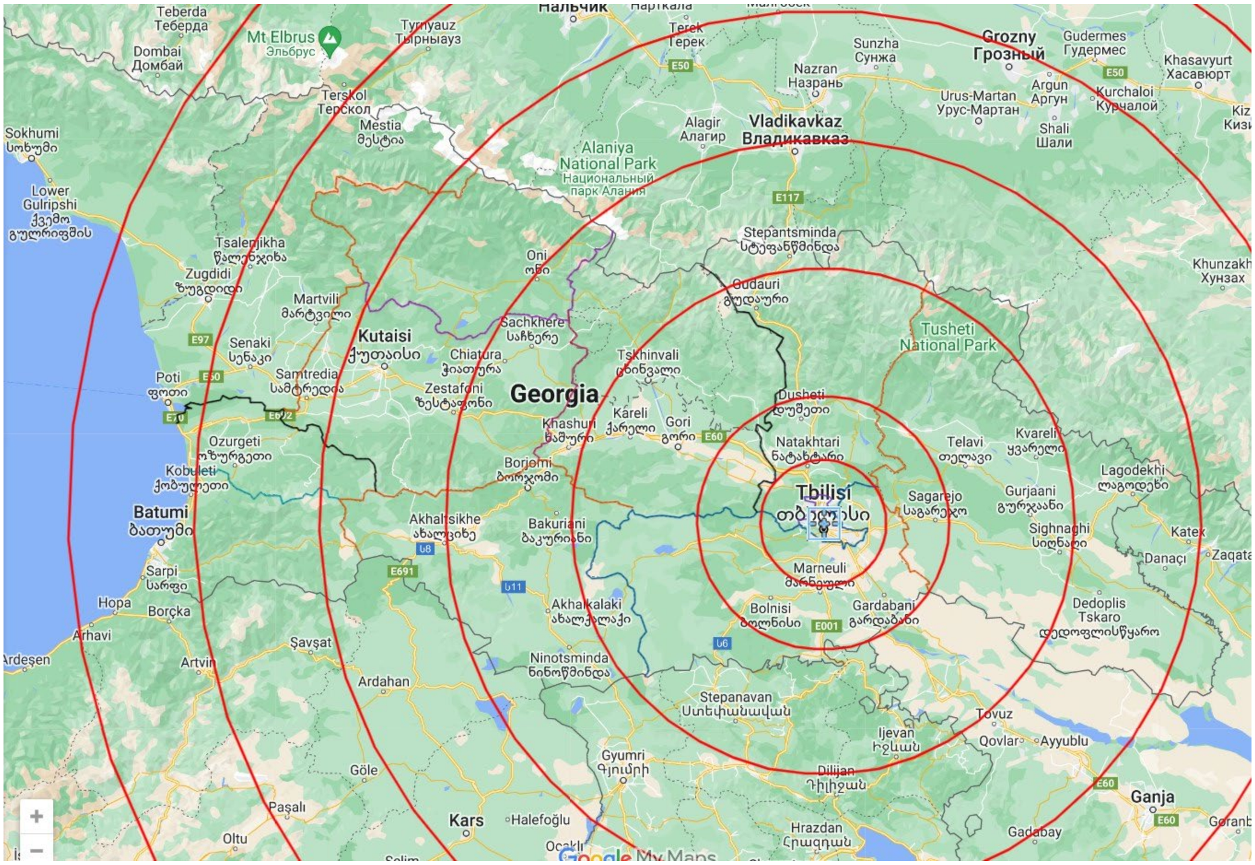

Figure 2. Mean residential electricity consumption in the Energo Pro Georgia service territory (which includes Kakheti as of 2017; it does not include residential customers inside the Tbilisi city limits).

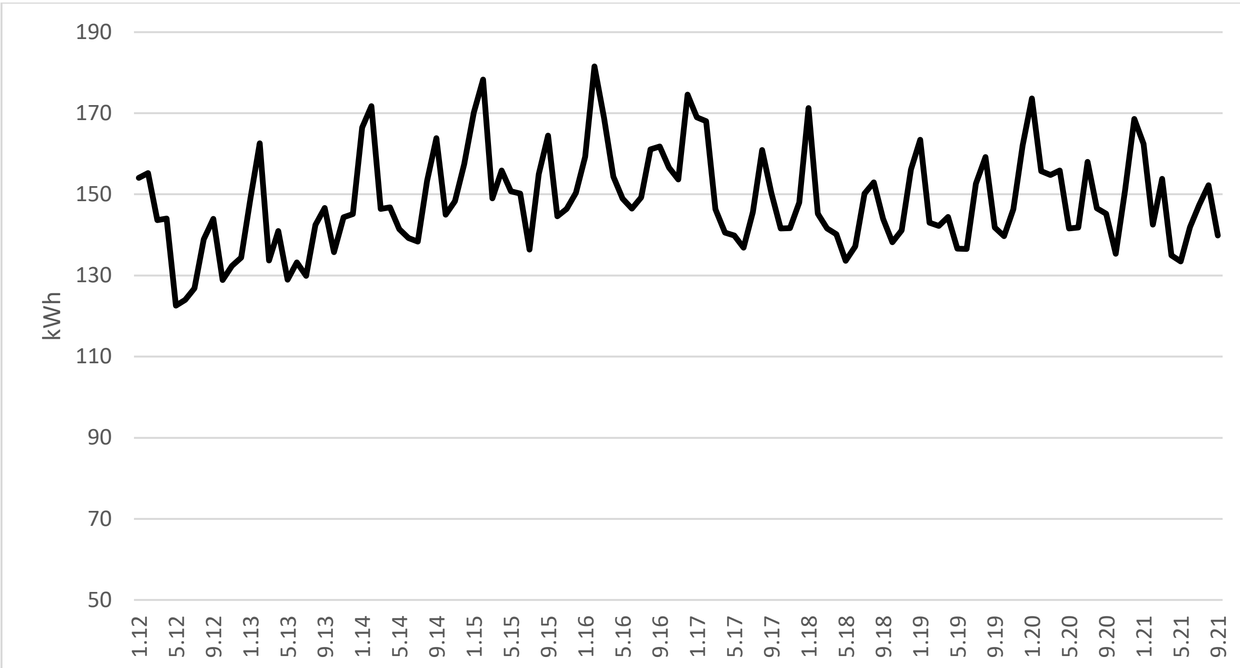

Figure 3.A. Distribution of consumption, January 2017-March 2020.

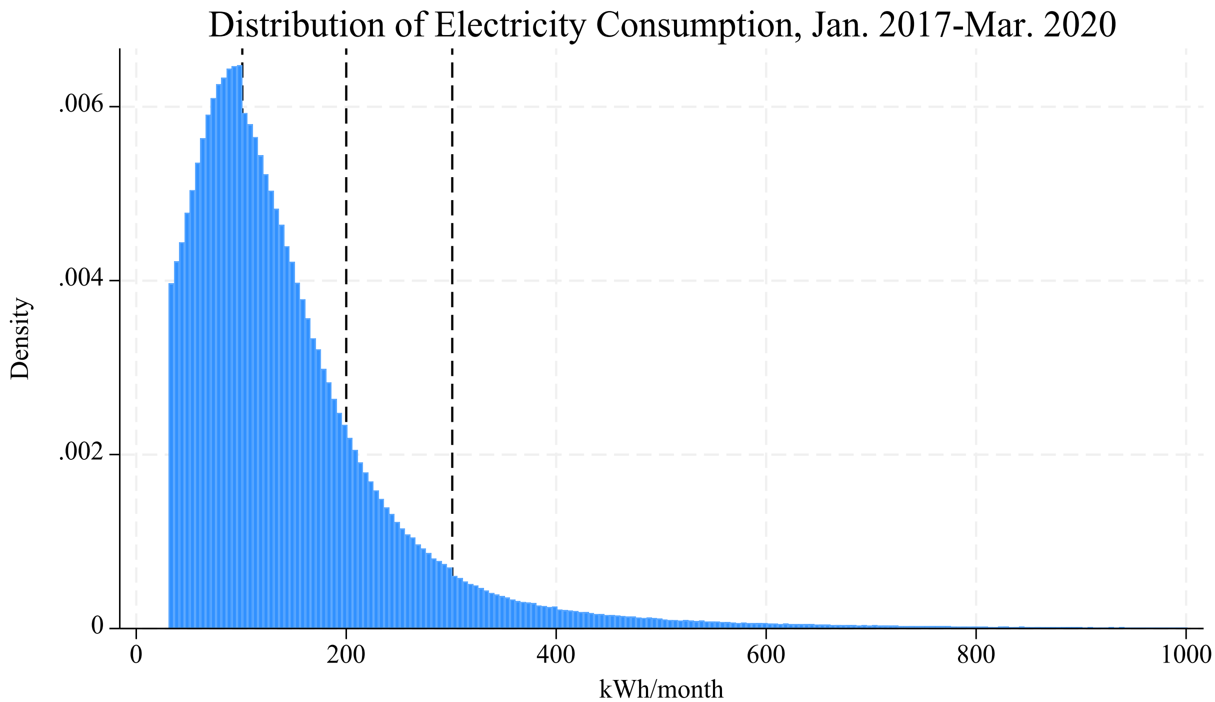

Figure 3.B. Distribution of consumption during the free electricity months.

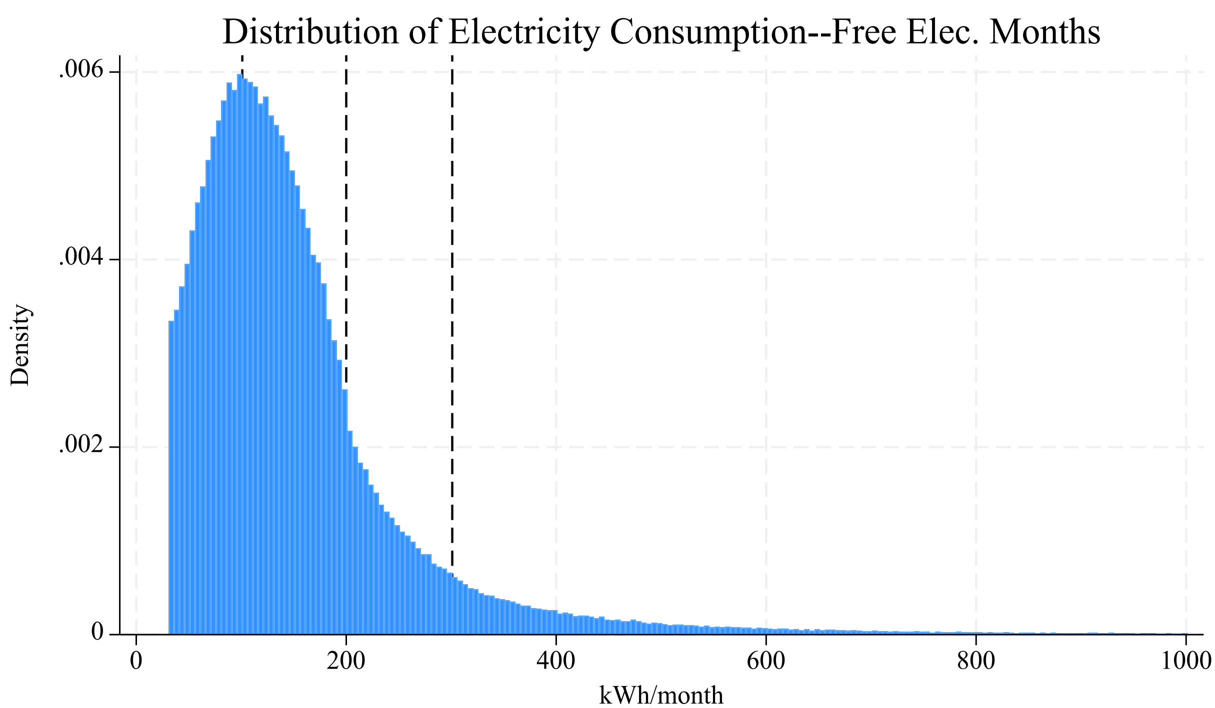

Figure 4. Distribution of consumption, during and after the pandemic lockdowns, excluding the free electricity months.

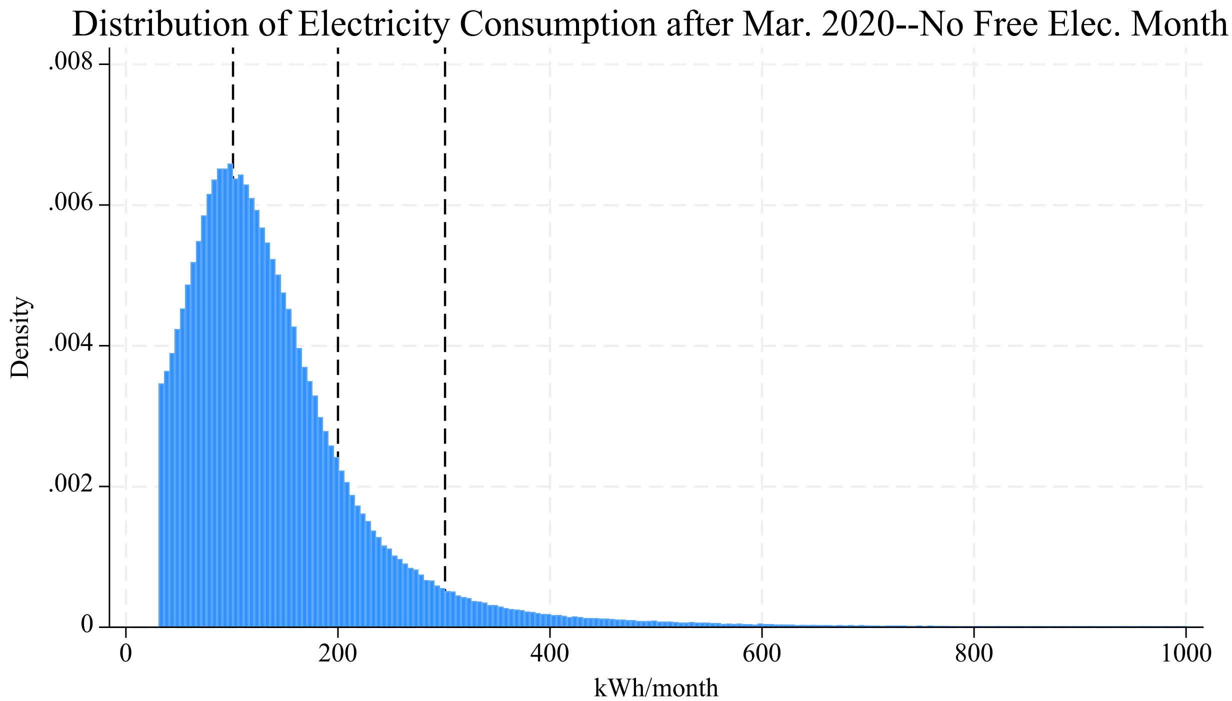

Table 1. Descriptive statistics of consumption in kWh/month by region. The sample covers Jan. 2017 to Sept. 2021, and excludes observations below 31 and above 1000 kWh per month.

	pre-pandemic		free elec months		Since the pandemic, but not free elec months	
	mean	median	mean	median	mean	median
Adjara	196.37	159	185.21	151	177.60	147
Guria	136.98	114	141.72	123	137.74	118
Imereti	138.52	114	144.32	124	137.24	117
Kakheti	124.28	102	138.15	114	128.05	110
Kvemo Kartli	143.48	118	149.87	126	142.18	120
Mtskheta-Mtianet	145.53	114	163.09	128	151.37	120
Racha-Lechkhumi-	132.42	105	154.83	123	144.31	117
Samegrelo-Zemo S	153.26	124	155.81	130	148.08	125
Samtskhe-Javakhe	151.81	127	164.23	142	147.49	126
Shida Kartli	135.08	113	144.13	124	134.05	116
Tbilisi	186.28	150	199.76	159	178.39	143
Total	148.44	120	153.68	129	145.05	122

Table 2. Share of households with monthly consumption less than or equal to 200 kWh. The sample covers Jan. 2017 to Sept. 2021, and excludes observations below 31 and above 1000 kWh per month.

less200	pre-pandemic	free elec months	Since the pandemic, but not free elec months
Adjara	0.6502	0.7085	0.7128
Guria	0.8435	0.8511	0.8521
Imereti	0.8293	0.8333	0.8448
Kakheti	0.8767	0.8462	0.8790
Kvemo Kartli	0.8175	0.8134	0.8307
Mtskheta-Mtianet	0.8077	0.7622	0.7977
Racha-Lechkhumi-	0.8353	0.7903	0.8024
Samegrelo-Zemo S	0.7811	0.8004	0.8092
Samtskhe-Javakhe	0.7750	0.7455	0.8002
Shida Kartli	0.8409	0.8317	0.8596
Tbilisi	0.6693	0.6447	0.7018
Total	0.798549	0.80155	0.819769

Table 3. Model of log consumption. Estimation results, based on Jan. 2017-Sept. 2021, excluding observations below 31 and above 1000 kWh per month.

	All	Jan, Feb, Apr, May, Nov, Dec only
Free electricity month (dummy)	0.0552*** (0.0006)	0.0532*** (0.0007)
N	4,287,931	2,063,476
R^2	0.74	0.73

Note: Standard errors clustered at the household level in parentheses. The model includes HDD, CDD, and their squares, household-by-month and region-by-tariff-period fixed effects.
*=significant at the 10% level; **=significant at the 5% level; ***=significant at the 1% level.

Table 4. Effect of distance on electricity consumption during the free electricity months. Based on Jan. 2017-Sept. 2021, excluding observations below 31 and above 1000 kWh per month.

	Log-Log model Dependent var: ln(consumption)		Linear Probability Model Dependent var: less 200 kWh used	
	All	Jan, Feb, Apr, May, Nov, Dec	All	Jan, Feb, Apr, May, Nov, Dec
Free electricity month × circle1 (dummy)	0.0113*** (0.0019)	0.0078*** (0.0021)	0.0087*** (0.0023)	0.0091*** (0.0023)
Free electricity month × circle2 (dummy)	0.0823*** (0.0018)	0.07929*** (0.0019)	-0.0050*** (0.0020)	-0.0040* (0.0021)
Free electricity month × circle3 (dummy)	0.0790*** (0.0015)	0.0765*** (0.0017)	-0.0090** (0.0016)	-0.0062*** (0.0016)
Free electricity month × circle4 (dummy)	0.0989*** (0.0020)	0.0980*** (0.0021)	-0.0159*** (0.0021)	-0.0154*** (0.0021)
Free electricity month × circle5 (dummy)	0.0474*** (0.0015)	0.0462*** (0.0016)	0.0078*** (0.0017)	0.0063*** (0.0017)
Free electricity month × circle6 (dummy)	0.0866*** (0.0017)	0.0847*** (0.0018)	-0.0034* (0.0019)	-0.0037* (0.0019)
Free electricity month × circle7 (dummy)	0.0059*** (0.0014)	0.0066*** (0.0015)	0.0270*** (0.0018)	0.0259*** (0.0018)
R^2	0.74	0.73	0.61	0.61
N	4,287,931	2,063,476	4,287,931	2,063,476

Note: Standard errors clustered at the household level in parentheses. The model includes HDD, CDD, and their squares, household-by-month and region-by-tariff-period fixed effects.
*=significant at the 10% level; **=significant at the 5% level; ***=significant at the 1% level.

Table 5. Effect of free electricity policy by location. Based on Jan. 2017-Sept. 2021, excluding observations below 31 and above 1000 kWh per month.

	(1) All	(2) Jan, Feb, Apr, May, Nov, Dec	(3) All	(4) All	(5) All	(6) All	(7) All
Free elec month	0.0099*** (0.0010)	0.0091*** (0.0011)	0.0816*** (0.0012)	0.0777*** (0.0011)	0.0496*** (0.0007)	0.0371*** (0.0021)	0.0466*** (0.0025)
Free elec month × rural	0.0766*** (0.0012)	0.0753*** (0.0013)				0.0575*** (0.0024)	0.0354*** (0.0029)
Free elec month × large municip			-0.0728*** (0.0022)			-0.0497*** (0.0024)	
Free elec month × large city				-0.0978*** (0.0026)			-0.0666*** (0.0035)
Free electricity month × mountain status					0.0647*** (0.0022)	0.0247*** (0.0038)	0.0352*** (0.0038)
N	4,287,931	2,063,476	4,287,931	4,287,931	4,287,931	4,287,931	4,287,931
R^2	0.74	0.75	0.74	0.72	0.74	0.74	0.74

Note: Standard errors clustered at the household level in parentheses. The model includes HDD, CDD, and their squares, household-by-month and region-by-tariff-period fixed effects.
*=significant at the 10% level; **=significant at the 5% level; ***=significant at the 1% level.

Table 6. Effect of free electricity policy for high- and low-volume consumers. Based on Jan. 2017-Sept. 2021, excluding observations below 31 and above 1000 kWh per month.

	Customers who used > 200kWh the same month the previous year	Customers who used > 200 kWh the same month the previous year (only Jan, Feb, Apr, May, Nov, Dec)	Customers who used > 200 kWh the previous month	Customers who used > 200 kWh the previous month (only Jan, Feb, Apr, May, Nov, Dec)	Customers who used ≤ 200 kWh the same month the previous year	Customers who used ≤ 200 kWh the same month the previous year (only Jan, Feb, Apr, May, Nov, Dec)	Customers who used ≤ 200 kWh the previous month	Customers who used ≤ 200 kWh the previous month (only Jan, Feb, Apr, May, Nov, Dec)
Free elec. month	-0.0554*** (0.0017)	-0.0474*** (0.0020)	-0.0125*** (0.0015)	-0.0092*** (0.0017)	0.0907*** (0.0007)	0.0845*** (0.0008)	0.0692*** (0.0007)	0.0655*** (0.0008)
N	622,398	313,336	702,017	354,670	2,781,397	1,320,644	3,362,778	1,594,319
R^2	0.60	0.59	0.65	0.63	0.70	0.69	0.68	0.67

Note: Standard errors clustered at the household level in parentheses. The model includes HDD, CDD, and their squares, household-by-month and region-by-tariff-period fixed effects.
*=significant at the 10% level; **=significant at the 5% level; ***=significant at the 1% level.

Table 7. Linear probability models. Dependent variable: Household used less than or exactly 200 kWh during the billing period. Effect of free electricity month by location, based on Jan. 2017-Sept. 2021, excluding observations below 31 and above 1000 kWh per month.

	All	Jan, Feb, Apr, May, Nov, Dec	All	All	All	All	All	All
Free elec. month	0.0035*** (0.0007)	0.0039*** (0.0007)	0.0198*** (0.0012)	-0.0060*** (0.0009)	-0.0042*** (0.0008)	0.0071 (0.0007)	0.0113*** (0.0015)	0.0088*** (0.0018)
Free elec. month × rural			-0.0275*** (0.0016)				-0.0188*** (0.0017)	-0.0122*** (0.0021)
Free elec month × large municip				0.0264*** (0.0016)			0.0162*** (0.0017)	
Free elec month × large city					0.0335*** (0.0019(			0.0205*** (0.0025)
Free elec × mountain status						-0.0414*** (0.0027)	-0.0283*** (0.0027)	-0.0318*** (0.0027)
N	4,287,931	2,063,476	4,287,931	4,287,931	4,287,931	4,287,931	4,287,931	4,287,931

Note: Standard errors clustered at the household level in parentheses. The model includes HDD, CDD, and their squares, household-by-month and region-by-tariff-period fixed effects.
*=significant at the 10% level; **=significant at the 5% level; ***=significant at the 1% level.

Table 8. Linear probability models. Dependent variable: Household used less than or exactly 200 kWh during the billing period. Effect of free electricity month for high- and low-volume consumers, based on Jan. 2017-Sept. 2021, excluding observations below 31 and above 1000 kWh per month.

	Customers who used > 200 kWh the same month the previous year	Customers who used > 200 kWh the same month the previous year (only Jan, Feb, Apr, May, Nov, Dec)	Customers who used > 200 kWh the previous month	Customers who used > 200 kWh the previous month (only Jan, Feb, Apr, May, Nov, Dec)	Customers who used ≤ 200 kWh the same month the previous year	Customers who used ≤ 200 kWh the same month the previous year (only Jan, Feb, Apr, May, Nov, Dec)	Customers who used ≤ 200 kWh the previous month	Customers who used ≤ 200 kWh the previous month (only Jan, Feb, Apr, May, Nov, Dec)
Free electricity month	0.0703*** (0.0025)	0.0611*** (0.0026)	0.0175*** (0.0017)	0.0131*** (0.0018)	-0.0213*** (0.0007)	-0.0177*** (0.0007)	0.0039*** (0.0005)	0.0052*** (0.0005)
N	622,398	313,336	702,017	354,670	2,781,397	1,320,644	3,362,778	1,594,319

Note: Standard errors clustered at the household level in parentheses. The model includes HDD, CDD, and their squares, household-by-month and region-by-tariff-period fixed effects.
*=significant at the 10% level; **=significant at the 5% level; ***=significant at the 1% level.

Table 9. Predicted electricity usage with and without the free electricity policy during the free electricity months based on the model of column (6) in table 5. Total by municipality.

only free elec months	kWh with free elec	kWh if no free elec	change in emissions during free elec months (tons)	% change in elec usage
Abasha	550324.6	507596.6	23.45766	8.42%
Akhalkalaki/Nino	1899586	1688054	116.1312	12.53%
Akhaltsikhe	1466333	1352030	62.75233	8.45%
Akhmeta	667611.9	613335.4	29.79778	8.85%
Ambrolauri	389133.7	348467.2	22.32595	11.67%
Aspindza	274706	249725	13.7146	10.00%
Baghdati	547471.7	504061.7	23.8321	8.61%
Batumi	6822736	6857900	-19.3049	-0.51%
Bolnisi	1119079	1032738	47.40113	8.36%
Borjomi	847293.5	782543	35.54798	8.27%
Chiatura	916479.6	849502.5	36.77042	7.88%
Chkhorotsqu	490068.6	452223.3	20.7771	8.37%
Chokhatauri	458903.3	420379.2	21.14976	9.16%
Dedoplistsqaro	503353.1	467068.6	19.92018	7.77%
Dmanisi	332517.2	300483.1	17.58671	10.66%
Dusheti	845934.1	773235.6	39.91147	9.40%
Gardabani	718634.2	702656.6	8.771732	2.27%
Gori	3204227	3062812	77.63708	4.62%
Gurjaani	1274352	1170728	56.88948	8.85%
Kaspi	1199904	1110237	49.22758	8.08%
Kazbegi	154364.5	137334.4	9.34954	12.40%
Kharagauli	449784.1	412443.4	20.50004	9.05%
Khashuri	2300742	2162946	75.6497	6.37%
Khelvachauri	1600886	1478539	67.16872	8.27%
Khobi	729764.8	670201.1	32.70045	8.89%
Khoni	666948.4	622053.7	24.6472	7.22%
Khulo	409637.1	366668	23.59002	11.72%
Kobuleti	1988833	1842766	80.19068	7.93%
Kutaisi	4846643	4908159	-33.7723	-1.25%
Kvareli	730066.5	664140	36.19367	9.93%

only free elec months	kWh with free elec	kWh if no free elec	change in emissions during free elec months (tons)	% change in elec usage
Lagodekhi	980034.6	900212.9	43.82207	8.87%
Lanchkhuti	744555.2	685975	32.16051	8.54%
Marneuli	2716491	2637301	43.47524	3.00%
Martvili	751023.2	686180	35.59892	9.45%
Mestia	41573.29	39033.28	1.394466	6.51%
Mtskheta	1673598	1538138	74.36735	8.81%
Oni	189580.7	174210.4	8.438262	8.82%
Ozurgeti	1683730	1557206	69.4616	8.13%
Poti	1534031	1478145	30.68153	3.78%
Rustavi	5018058	5040161	-12.1345	-0.44%
Sachkhere	740836.5	682472.3	32.04197	8.55%
Sagarejo	1049172	967852.4	44.64454	8.40%
Samtredia	1296313	1219090	42.39513	6.33%
Senaki	1009171	951149.9	31.85377	6.10%
Shuakhevi-Keda	560031.5	497124.9	34.53576	12.65%
Signagi	744992.9	677718.5	36.93366	9.93%
Tbilisi	1114511	1069586	24.66355	4.20%
Telavi	1690142	1575627	62.8686	7.27%
Terjola	858329	787343.8	38.97088	9.02%
Tetritsqaro	421736.5	384934.5	20.2043	9.56%
Tianeti	258997.1	234517.3	13.43938	10.44%
Tkibuli	741469.8	675389.3	36.2782	9.78%
Tsageri	478132.7	427422.8	27.83977	11.86%
Tsalenjikha	708905.3	655992.5	29.04913	8.07%
Tsalka	532185.8	478402.6	29.52698	11.24%
Tsqaltubo	1413670	1309842	57.00141	7.93%
Vani	532515.3	489493.5	23.61899	8.79%
Zestaponi	1360454	1270889	49.17138	7.05%
Zugdidi	3017423	2971081	25.44159	1.56%
Total	**7.23E+07**	**6.86E+07**	**2028.259**	**8.07%**

Table 10. Predicted electricity usage with and without the free electricity policy during the free electricity months based on model of col. (7) in table 5. Total by city.

	kWh with free elec	kWh if no free elec	change in emissions during free elec months (tons)	% change in elec usage
Batumi	6016132	6137986	-66.8979	-1.99%
Gardabani	1191928	1216070	-13.2539	-1.99%
Gori	1599.701	1575.714	0.013169	1.52%
Kutaisi	4834802	4932729	-53.7618	-1.99%
Marneuli	601566	613750.5	-6.68926	-1.99%
Rustavi	3403999	3472945	-37.8516	-1.99%
Tbilisi	130346.2	132986.3	-1.44942	-1.99%
Zugdidi	1512830	1543472	-16.8223	-1.99%
Total	**1.77E+07**	**1.81E+07**	**-196.713**	

Appendix.

Table A.1. Electricity tariffs to residential customers in the Republic of Georgia, 2010-2021.

	up to 101 kWh	101-200 kWh	201-301 kWh	301+ kWh
from Jan 2010 to Dec 2012	0.134756	0.160008	0.160008	0.177
from Jan 2013 to Mar 2013	0.099356	0.124608	0.124608	0.177
from Apr 2013 to Aug 2015	0.094754	0.124608	0.124608	0.177
from Sept 2015 to Dec 2017	0.1298	0.16992	0.16992	0.21476
from Jan 2018 to Mar 2020	0.145494	0.185614	0.185614	0.230454
from Apr 2020 to May 2020	0	0	0.185614	0.230454
from June 2020 to Oct 2020	0.145494	0.185614	0.185614	0.230454
from Nov 2020 to Feb 2021	0	0	0.185614	0.265382
from Mar 2021 to June 2021	0.145494	0.185614	0.185614	0.230454
from Jul 2021 to Oct 2021	0.180422	0.220542	0.220542	0.265382

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