Utility disconnection protections and the incidence of energy insecurity in the United States

Trevor Memmott (corresponding author)
PhD Candidate
O'Neill School of Public and Environmental Affairs
Indiana University
tmemmott@iu.edu

Sanya Carley
O'Neill Professor
O'Neill School of Public and Environmental Affairs
Indiana University
scarley@indiana.edu

Michelle Graff
Assistant Professor
Maxine Goodman Levin School of Urban Affairs
Cleveland State University
m.graff66@csuohio.edu

David M. Konisky
Lynton K. Caldwell Professor
O'Neill School of Public and Environmental Affairs
Indiana University
dkonisky@indiana.edu

Summary
Energy insecurity—the inability to secure one's energy needs—impacts millions of Americans each year. A particularly severe instance of energy insecurity is when a utility disconnects a household from service, which affects its ability to refrigerate perishable food, purchase medicine, or maintain adequate temperatures. Governments can protect vulnerable populations from disconnections through policies, such as shutoff moratoria or seasonal protections that limit disconnections during extreme weather months. We take advantage of the temporary disconnection moratoria that states implemented during the COVID-19 pandemic to assess the efficacy of state protections on rates of disconnection, spending across other essential needs, and uptake of bill payment assistance. We find that protections reduce disconnections and the need for households to forgo expenses on essential needs. We further find that protections are most beneficial to people of color and households with young children. We conclude with a discussion of the policy implications for energy insecure populations.

Keywords: energy insecurity, utility disconnection moratoria, vulnerable populations

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Introduction

Most U.S. states and territories implemented public health mitigation policies, such as stay-at-home orders, in March 2020 to control the spread of COVID-19. These mandates severely limited domestic population movement[1] by closing businesses, schools, and other gathering places. The stay-at-home orders provided public health benefits, including reductions in COVID-19 infections and fatalities[2], but they also contributed to reduced economic activity, a spike in unemployment[3], increased financial worries[4], and adversely affected the ability of many households to pay their monthly bills[5].

In response to the economic disruption caused by stay-at-home orders and the possibility that millions of Americans would be unable to pay their energy bills, many U.S. states enacted temporary measures to prevent regulated electric utilities from disconnecting residential customers for nonpayment. Specifically, 34 states and the District of Columbia implemented moratoria to protect their residents from utility disconnections. These measures gradually expired throughout the latter months of 2020, even as the pandemic persisted. While these moratoria were temporary, most states have regular – often seasonal – limits on when, and under what circumstances, a regulated utility can shut off service to its customers. The degree and timing of these policies, however, vary, and there is little empirical analysis of whether these policies substantially reduce disconnections or provide households meaningful relief from energy-related material hardship, a phenomenon often referred to as energy insecurity.

One reason for the paucity of disconnection protection policies analysis is data limitations. Historically, few utilities have released disconnection information and, even when publicly available, the data are not granular enough to link them to household-level characteristics. Two recent analyses, however, have taken advantage of variation in COVID-era, emergency, state-level utility protections as well as disconnection data disclosed by utilities during the COVID-19 pandemic that make some progress on related questions. Jowers et al[6] explored housing precarity across the United States during the pandemic, analyzing eviction and utility disconnection moratoria and their impacts on COVID-19 infections and related deaths. The authors found that moratoria on utility disconnections reduced infections by 4.4% and mortality rates by 7.4%. In another study, Cicala[7] analyzed data reported by utilities in the state of Illinois to evaluate patterns of disconnections at the zip-code level, and found that residents in Black and Hispanic zip codes were four times more likely than white households to be disconnected.

In this analysis, we similarly evaluate the impact of the state-level COVID-specific disconnection protections on household well-being. We capture additional granularity by studying household-level data from a nationally-representative survey of low-income households, which, unlike past work, enables us to control for important household-level characteristics. Moreover, because this study is national in scale, we can leverage the heterogeneity in the scope and duration of the temporary pandemic moratoria orders, creating an opportunity to use spatial and temporal variation to estimate the policies' effects on various household-level indicators of energy insecurity.

We address two primary research questions. First, to what extent do utility disconnection protections result in fewer disconnections? Second, what are the socio-economic consequences of these protections and, specifically, do the protections curtail households' need to forgo other expenses or reduce their need to rely on financial assistance to pay their energy bills?

To study these questions, we merge monthly state-level utility disconnection protections with original survey data designed and collected by the authors. The survey is a nationally representative sample of households with incomes at or below 200 percent of the federal poverty line (FPL). We collect data from the same respondents at four points in time between April/May of 2020 and May of 2021, approximately the first year of the pandemic. The survey measures household-level composition and monthly indicators of whether a respondent reported being able to pay their energy bills and if their utility disconnected them from their electricity service for nonpayment. Due to the timeline of the study, we have the unique opportunity to consider the impact of both the state-level, emergency disconnection moratoria as well as regular, seasonal protections. Through a series of regressions, we estimate the effect of these policies on low-income households. Results from our empirical analysis suggest that, on average, when protections were in place, households were less likely to be disconnected from their electricity service and forgo basic food and healthcare expenses to pay an energy bill. We also find some suggestive evidence that disconnection protections reduced a respondent's reliance on social networks and government agencies for assistance to pay an energy bill.

This paper makes several important contributions. First, our findings provide the first estimates of the effects of disconnection protection policies on household-level socio-economic outcomes. Second, these findings complement recent work[8,9,10] that reveals disparities in residential energy insecurity by demonstrating that disconnection policies specifically benefit socially vulnerable populations. Finally, our analysis offers insights for policymakers on how disconnection protections can serve as a policy instrument to address material hardship among low-income households both during crisis situations, such as the COVID-19 pandemic, as well as under more typical circumstances.

Disconnection Protection Policies

To address concerns about energy insecurity at the beginning of the pandemic, many states implemented emergency shutoff moratoria that prohibited regulated utilities from disconnecting customers from their energy services. Such implementation took different forms, in which some state governors declared emergency orders that suspended shutoffs while other states' public utility commissions issued orders for utilities to discontinue disconnections. Under these protections, ostensibly, residents receiving service from a regulated utility could not be disconnected by their utility provider for nonpayment.

Additionally, there was heterogeneity in both the start and end dates of the moratoria. Some states (e.g., Colorado) only implemented protections in the early months of the pandemic, while other states extended protections into 2021 (e.g., California). Moreover, utilities subject to disconnection limitations also varied across states, since only those utilities regulated by state public utility commissions (PUC) were required to abide by the emergency orders. For example, in the state of Arkansas, both investor-owned utilities (IOUs) and cooperatives are regulated by the state commission, whereas, in the state of Maryland all three utility types—IOUs, cooperatives, and municipal utilities—fall under state regulation. Thus, if residents living in Arkansas get their energy service via a municipal utility, they were not protected through the state disconnection protection order. In addition to mandatory moratoria, five states implemented voluntary moratoria in which regulated utilities agreed but were not legally prohibited from shutting off customers in cases of nonpayment.

Figure 1 shows a map of the emergency utility disconnection orders implemented through January 2021, including whether a state had a mandatory utility disconnection order, voluntary agreement, or no protection in place. Thirty-four states had a mandatory protection in place in at least one month. The map reveals protections were more likely to be voluntary or nonexistent in the Southern and Plain states. Additionally, protections with the longest duration were generally enacted in the Northeast, upper Midwest, and West Coast.

<Insert Figure 1>

In addition to the COVID-19 emergency disconnection orders, over 40 states have statutory-based utility disconnection protections that aim to limit shutoffs during specific times of the year and/or for vulnerable populations. There are three general categories of state-level protections: 1) seasonal protections (i.e., states prohibit regulated utilities from disconnecting electric service to residents in certain months of the year); 2) temperature protections (i.e., states prohibit regulated utilities from disconnecting electric service to residents if the temperature is above or below a certain threshold); and 3) population-based protections (i.e., states prohibit regulated utilities from disconnecting electric service to specific members of the population, including but not limited to senior citizens and those with specific medical conditions)[11]. As of 2021, 29 states implemented some form of seasonal protections and 23 have temperature-based protections, some of which overlap[12].

Often, these policies do not fully prohibit disconnections. Rather, they require customers to demonstrate eligibility for an exemption[12]. For example, four states have no disconnection protections unless a household member has a physician or public health official certify, through documentation, that they would be adversely affected by a shutoff. And, again, it is important to emphasize that protections only apply to utilities under state jurisdiction. In all but one state, Nebraska, investor-owned utilities fall under state regulation, whereas only 11 states regulate municipal providers, and 16 states regulate cooperatives. Finally, 46 states and the District of Columbia allow customers to set up a payment plan as an alternative to disconnection[12], though these plans neither include long-term debt relief on the interest accrued for not paying in full nor are they adjusted based on the resident's income or ability to pay[13].

In the present analysis, we consider the individual and aggregate effects of the COVID-specific mandatory and voluntary moratoria on several outcome measures. Our study additionally couples the temporary moratoria with the pre-existing seasonal protections. Specifically, we include seasonal policies – defined at the monthly level – if the law protects all regulated customers, regardless of the amount they owe on their utility bills, if they are facing financial hardship, or are a qualified low-income customer. During our study period, eleven states had a seasonal protection in place in at least one month, though seven of these states had a disconnection moratorium that extended through the entirety of their seasonal protection period— Arkansas, Massachusetts, New York, Pennsylvania, Washington, Wisconsin, and Wyoming. We are not able to incorporate all seasonal disconnection protections. We exclude those that rely on household characteristics or payment requirements, and we do not include daily temperature-based protections because of the monthly structure of our survey data. Thus, over the duration of the study period, an individual may have been protected by a temporary emergency order or through a seasonal disconnection protection, which will likely bias our estimates in a conservative direction. Figure 2 displays the timing of the emergency protections as well as the regular seasonal protections during our study's time period, for each state and Washington, D.C. (May 2020 to May 2021).

<Insert Figure 2>

Empirical Expectations

We exploit variation in COVID-19 pandemic disconnection policies as well as state-level seasonal protections to quantify the effect of utility shutoff protections. We expect these state-level utility protections to have three potential implications. First, we expect shutoff moratoria to significantly reduce disconnections. In addition, we expect that populations who tend to suffer from higher rates of energy insecurity will have benefitted the most from these protections and thus experience the largest decreases in their probability of having their service disconnected by their utility.

Second, disconnection moratoria should allow households to shift their spending from their energy bill to other essential goods, like food and medicine. Past research shows that low-income households are more sensitive to disruptive economic events[14] and those facing utility insecurity are more likely to engage in bill juggling—including strategic non- or partial- payment of other bills—to keep their electric service from being disconnected[15]. Because disconnection moratoria explicitly remove the risk that a household loses electricity service, low-income households could potentially redirect their spending to other household necessities[16]. This is especially salient for individuals and families who lost income or employment because of the economic fallout of the COVID-19 pandemic.

Third, we expect people covered by disconnection protections to have reduced their reliance on financial assistance to help pay off their energy bills. Under "normal" circumstances, energy insecure households often receive financial help from friends, family members, churches, or local nonprofits to avoid disconnections[17]. Additionally, households sometimes seek assistance from more formal entities, including local government assistance programs, but these programs vary in their generosity, eligibility requirements, and availability[18]. However, those with limited social networks are less likely to receive assistance during times of need[19];

therefore, without an immediate threat of disconnection, we hypothesize that households are less likely to reach out to informal social networks or apply to more formal government programs to pay their energy bills.

To summarize, we expect that the disconnection protection policies implemented in many states reduced the prevalence of disconnections among households that are served by a regulated utility, when compared to similar households in states without such protections. Moreover, we posit that these households are less likely to have forgone other important household necessities or to have solicited financial assistance to pay an energy bill.

Results and Discussion

Results

To test our empirical expectations, we estimate a series of two-way fixed effects regression models, which are described in further detail in the *Methods* section. Table 1 presents the results with our first dependent variable: whether a household was disconnected from its utility service in any given month. For each dependent variable, we measure the impact of utility protection as the temporary, mandatory COVID-19 moratoria first, then add the voluntary protections second, followed by the seasonal protections last.

The model estimates show that respondents covered by disconnection protections were less likely to report being disconnected from their service, with minor variation in the effect sizes across the three models. To estimate the magnitude of the effects, we additionally estimate average marginal effects (AME) for several of our models. The results shown in Table 1 suggest that being protected by a mandatory moratorium reduced the likelihood of a household having their energy shutoff, controlling for other factors. The coefficient of 2.7 ($p = 0.000$) implies that respondents who were not covered by a disconnection moratorium were disconnected at a rate of about 2.8% while those who were covered got disconnected at a rate of around 0.01%. For context, extrapolating from 2020 estimates of households at or below 200% of the FPL[20], this suggests that approximately 69,144 low-income households (179,744 individuals) avoided disconnections during the first year of the pandemic.

The results in Table 1 additionally reveal that race and other vulnerable household characteristics are correlated with higher rates of disconnections. Specifically, we find that Black households, Hispanic households, households with children under 5 years old, larger households, and those that are served by cooperative (relative to municipal) utilities were all more likely to be disconnected from their electricity service. We do not find that households with an unemployed respondent were more likely to be disconnected, which might reflect that many laid-off individuals received enhanced unemployment benefits during the pandemic, enabling them to avoid some expected material hardship[21].

<Insert Table 1>

In Table 2, we display the results of our estimation of the effect of disconnection protections on the likelihood that a household forgoes other basic household expenses (Models 1-3) and receives financial assistance to pay an energy bill (Models 4-6). These results indicate that disconnection protections decreased the probability that a household reported having to forgo other basic expenses, which suggests that when people are less concerned about being disconnected, they can allocate their resources toward other household necessities such as medical care and food. AME estimates suggest that being protected by a mandatory moratorium reduced the likelihood of a household forgoing basic household expenses, controlling for other factors. The 2.5 (p=0.000) coefficient implies that respondents not covered by a moratorium reported forgoing expenses at a rate of approximately 10.6% while respondents who were covered reported a rate of approximately 8.1%. With respect to receiving financial assistance to help pay an energy bill, the coefficients in Models 4 through 6 are negative but none reach a standard level of statistical significance. These estimates suggest that there may be an effect consistent with our expectations, but it is not definitive.

<Insert Table 2>

Regarding the estimates for control variables, we find that Black households, households that are under 100 percent FPL, and those that have children under 5 years old were more likely to seek financial assistance to pay their energy bills; whereas those that were served by an investor-owned utility (IOU) were less likely to seek financial assistance. We additionally find that larger households, Hispanic households, those who experienced unemployment during the first year of the pandemic, those with incomes that are at or below 100 percent FPL, and households with children under 5 were all more likely to have to forgo expenses even when disconnection protections were in place. Surprisingly, we find that receipt of government assistance is positively associated with forgoing expenses, which may reflect the correlation between a low-income family needing to simultaneously participate in government assistance and forgo expenses, rather than suggesting that receipt of assistance necessitates that a family forgo expenses.

Contrary to our expectations, we find that adding voluntary and seasonal protections had little impact on the estimated coefficients of disconnection protections across all models. Therefore, the results may suggest that mandatory moratoria were the most binding of the three types of the policies during this time.

Discussion

This study finds that the utility disconnection moratoria that states implemented during the COVID-19 pandemic had a substantial impact on disconnections. People in states without such protections, or who were not covered by their state moratorium in a given month, faced a greater likelihood of being disconnected than those who were covered by a moratorium. Based on our models, mandatory moratoria decreased the likelihood of a respondent being disconnected from an estimated rate of 2.8% to 0.01%. Additionally, it is likely that some utility companies were more forgiving to customers in arrears during the pandemic, irrespective of an implemented moratorium, meaning our estimates are likely conservative. Our primary model suggests, however, that even when controlling for key economic indicators, vulnerable households – specifically Black households, Hispanic households, and households with children under 5 years old – were more likely to have their electricity disconnected by their utility for nonpayment. These results suggest that utility protections help, but disparities in rates of disconnections for vulnerable families continue to persist.

We also find that utility disconnection moratoria decreased the likelihood that a household had to forgo basic household expenses, such as food or medical care, to pay an energy bill and avoid the threat of utility disconnection. Evidence shows that when attempting to avoid utility disconnection, households often engage in a set of economically harmful coping strategies, such as accruing credit card debt or strategically skipping bill payments.[22] In this context, our findings suggests that disconnection moratoria have an economic impact beyond utility service shutoffs by allowing families to avoid tradeoffs between keeping the power on and carrying debt, having enough to eat, or seeking medical assistance.

The results presented here have several implications for policymakers. First, disconnection moratoria are effective in reducing incidence of utility disconnections and other energy-related material hardship. Protections are particularly helpful for vulnerable populations, yet more and better-targeted government and utility assistance might be required to overcome the current racial disparities that have been documented by previous energy insecure literature. This finding is especially important as rates of energy insecurity are likely to rise in the future as climate change increases average temperatures and extreme weather events[23].

Second, we find that the effects of moratoria on energy insecurity are largely driven by mandatory protections, as opposed to voluntary or seasonal protections. This finding provides important insight for lawmakers and regulators who wish to reduce energy insecurity because it suggests voluntary and seasonal protections are not preventing disconnections, nor do they appear to significantly reduce the likelihood that a household will forgo other expenses. Unlike mandatory disconnection protections, voluntary policies yield the decision about household disconnection to the utilities, who are primarily concerned with recovering their costs. In addition, ongoing seasonal protections are complicated and often do not offer full protection to vulnerable populations. Further, it is likely that effect sizes were at least partially driven by the fact that these mandatory moratoria were not burdensome to customers – e.g., they did not require documentation or require a household to show that its family's economic circumstances had deteriorated – which is not true of many of the seasonal protections[11]. Past research has shown that detailed eligibility requirements reduce program take-up[24].

Another critical point to consider is that millions of Americans are served by unregulated utility providers. Therefore, especially in times of crisis, policymakers should consider expanding disconnection protections to all customers, including municipal and cooperative utility customers. However, when designing and implementing disconnection moratoria, policymakers must consider that utilities will need to recoup arrears, meaning the companies may pass costs on to other customers through higher electricity rates.

Finally, our findings show that our current stable of welfare programs, including standard programs, like Medicaid, as well as energy specific programs, like LIHEAP, do not statistically reduce one's likelihood of being disconnected or a household's need to forgo medical and food expenditures. This finding stresses the importance of funding and expanding energy assistance programs that are accessible and available to low-income populations to avoid the most deleterious impacts of energy insecurity. Additional support for these programs may also help relieve some households in the U.S. of the chronic cycle of energy insecurity. Further, while utility disconnections both prevented utility shutoffs and the likelihood that a household had to forgo expenses, state moratoria were not paired with utility debt relief – with the exception of the California Arrearage Payment Program (CAPP) which provided over $1.5 billion in relief for delinquent customers.[25] A 2020 report from National Energy Assistance Directors Association (NEADA) estimated that customer utility debt increased from $12 billion pre-pandemic to $32 billion at the end of 2020.[26] Thus, disconnection moratoria may provide substantial benefits in the short term but, if not combined with debt relief, do little to prevent energy insecurity in the long term.

Our analysis provides important new information on the impact of state-level disconnection protections on the energy security and financial stability of low-income populations. These results have important implications for both advocates and government officials. Our study shows the importance of designing utility disconnection policies to protect the most vulnerable populations and reduce energy insecurity, especially during periods of economic crisis.

Experimental procedures

Lead contact

Further information and requests for resources and reagents should be directed to Trevor Memmott: tmemmott@iu.edu

Materials availability

The materials used or analyzed during the current study will be made available in a public repository at the time of publication

Data and code availability

The data that support the findings of this study will be made available in a public repository at the time of publication.

Data

The data we analyze in this paper come from an original, four-wave, panel survey of low-income households that we designed to examine energy insecurity during the pandemic. During each wave, we asked respondents a range of questions about their household composition, economic circumstances, and energy (in)security. We also asked respondents to identify their utility provider to match utility data to state disconnection moratoria. Among those respondents for whom we did not have self-reported utility data, we assign their utility type using several approaches. First, using geospatial files in QGIS, we assign a respondent a utility type if the household's zip code is fully contained within the service territory of single IOU, municipal utility, or cooperative utility. In cases where multiple utilities operate in a zip code, we assign a utility type if more than half of the utilities in a single zip code are a single type (i.e., three utilities service a single zip code, and if two of three utilities in zip code are IOUs, we assign it as an IOU). We drop the remaining 352 observations – approximately 1.5 percent of the sample – for which we do not have utility data.

YouGov, a private polling and data analytics firm, administered the survey online. To create a nationally-representative sample from its standing panel, YouGov employs a two-stage process wherein the firm generates a target sample by drawing a random sample from a target population that is derived from the general population (for this case, using data from the 2017 American Community Survey). The firm then uses a matching algorithm to select potential respondents from its panel of approximately two million U.S. participants to generate a representative sample[27]. Scholars have validated extensively the underlying methodology that YouGov uses[27,28,29,30].

Because energy insecurity is more prevalent among low-income families[31], we designed the survey to focus on households with incomes at or below 200 percent of the FPL. Not only has past research used 200 percent of the FPL as an indicator of low-income U.S. households[32], but this income threshold is particularly relevant for the present study because federal energy bill assistance programs, such as the Low Income Home Energy Assistance Program (LIHEAP), often set eligibility at 150 percent of the FPL, enabling us to consider households both above and below the threshold.

Table 3 summarizes the timing and sample size for each of the four waves of the panel survey. The first wave of the survey (n=2,831 respondents) was between April 30 and May 25, 2020 and incorporates a second identical survey that we fielded simultaneously to Indiana residents, wherein we include those Indiana participants who also participated in the subsequent waves of the survey and weighted these responses to be nationally representative; the second wave of the survey between August 4 and August 20, 2020 (n=2,247 respondents); the third wave of the survey between January 15 and January 22, 2021 (n=1,670 respondents); and the fourth wave of the survey between May 24 and June 5, 2021 (n=1,378 respondents). The reduction in sample size over the course of the survey was anticipated. We set approximate thresholds for our sample size to maintain a sufficiently large and nationally representative sample in each wave of the survey, and closed the survey after these thresholds were met to minimize the time duration of data collection. YouGov generates post-stratified weights using propensity scores based on gender, race and ethnicity, age, geographic region, and education levels; we employ these weights in our analysis. We used an unbalanced panel in our analysis to preserve the original sample population and avoid potential issues that can arise due to survey attrition[33]. We also provide an alternative estimation using a balanced panel of respondents. Results are consistent with the unbalanced panel and can be found in Table S5 in the Supplemental Information Section.

Table 3: Dates that each survey wave was administered, along with survey sample size and the number of months covered by each wave

	Wave 1	**Wave 2**	**Wave 3**	**Wave 4**
Survey Administration Date	4/30/2020 – 5/25/2020	8/4/2020 – 8/20/2020	1/15/2021 – 1/22/2021	5/24/2021 – 6/5/2021
Sample Size	2,831	2,247	1,670	1,378
Months Covered	April/May 2020	June-August 2020	September 2020-January 2021	February-May 2021

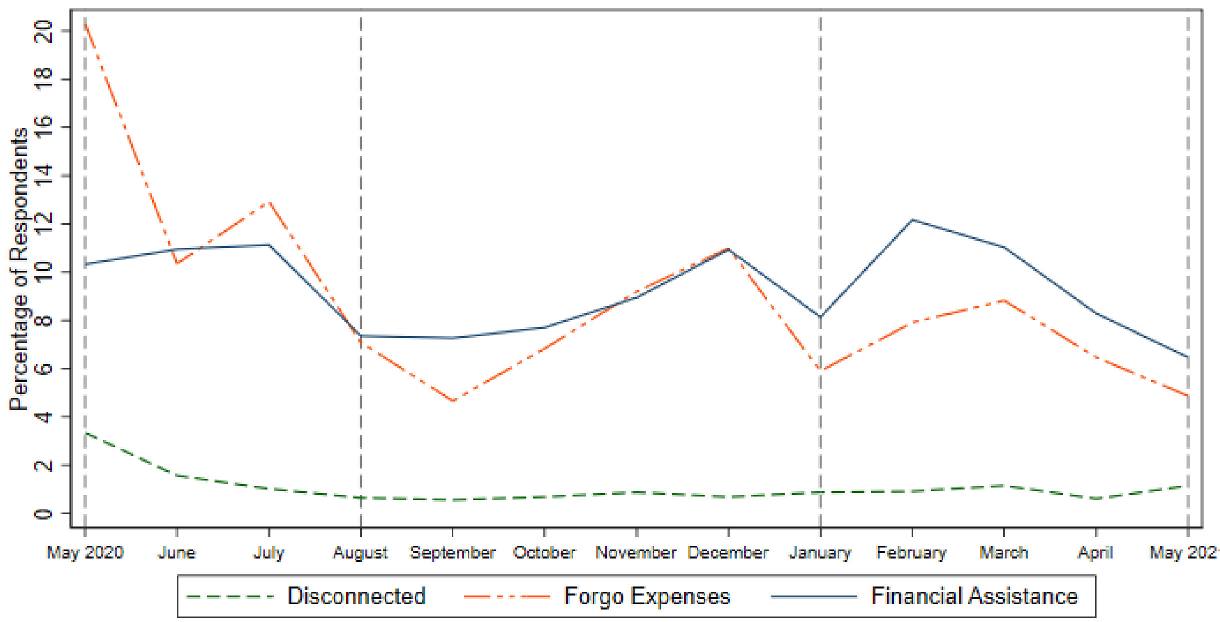
In each of the four survey waves, we asked respondents to reflect on the previous months and report in which months they experienced certain events, such as utility disconnection, making trade-offs across food and medical care versus paying energy bills, and uptake of financial assistance. While such recall questions may be prone to error, we believe that respondents are likely to remember the general timing of these conditions and circumstances. To address potential recall bias, we also provide an alternative estimation which aggregates our data to the level of a survey wave and regress our outcome variables on the number of days that a respondent was protected during that wave. These models, which are consistent with our primary model specifications, are further described in our Supplemental Information section.

Outcome Variables

We employ three main outcome variables in the analysis. To address the first research question, we measure whether a survey respondent reported that their household was disconnected from its utility service in any month from May 2020 through May 2021. We use two other survey items to address the second research question of whether the presence of disconnection protections allowed residents to shift resources to other household needs and to reduce their reliance on financial assistance. The first variable captures whether respondents reported forgoing basic expenses, like food and medical care, to pay their energy bills in each month, and the second measures whether the respondent reported receiving financial assistance to pay their energy bill (e.g., from a government agency, their energy provider, a friend or family member, a faith-based organization, a nonprofit, a payday lender, or a loan from a banking institution) in each month. Survey questions are included in Table S11.

During our study period, about 1.7 percent of respondents reported that they had their electricity service disconnected by their utility, approximately 10 percent had to forgo basic household expenses to pay an energy bill, and about 10 percent received financial assistance to pay an energy bill. For all three outcome variables, rates were higher among respondents who were not protected by a disconnection moratorium. Figure 3 graphs the outcome variables over the study period and shows that all three measures were at their highest in the first month of the pandemic (e.g., when lock-down orders were first put into place), and then fluctuated thereafter with some evidence of seasonal effects.

Figure 3: Distribution of survey respondents' being disconnected (green, dashed), having to forgo basic household expenses (red, alternating solid and dash), and receiving energy assistance from informal social networks (blue, solid), monthly from May 2020-May 2021.



Notes: The vertical lines represent the final month of each survey period (May 2020, August 2020, January 2021, and May 2021).

Primary Independent Variable

The treatment variable measures whether a respondent was covered under a state disconnection protection in each month. We employ three iterations of treatment. The first measures whether a respondent was covered by a COVID-related temporary mandatory disconnection moratorium, which we expect will drive much of the variation in the effect of protections, as mandatory protections are designed to prohibit any disconnections among protected populations. The second measures whether a respondent was covered by a COVID-related temporary voluntary or mandatory disconnection moratorium. We expect that adding voluntary protections, wherein utility companies agree not to shutoff respondents, will account for additional variation in our outcome variables. Finally, our third measure includes whether a respondent was covered by a COVID-related temporary mandatory or voluntary protection or a regular seasonal protection. We think that including seasonal protections alongside the temporary COVID-related protections best captures the full effect of disconnection protections during the study period.

To measure protection, we code a respondent as a “1” if their state had a disconnection protection in place and their utility service fell under state regulation and a “0” if the respondent was not covered in that month. A state is coded as covered if a protection was in place for 15 or more days. We use 15 as a cut-off because it represents respondents being protected against utility disconnection for at least half the days in a month. In our sample, which ranges from May 2020 through May 2021, about 56% of respondents were protected under a moratorium in at least one month using this definition.

The nature of our survey data does not enable us to formally check for parallel trends before the imposition of policies, but we can evaluate whether household characteristics differ among those in our survey population who were and were not covered by a COVID-19 temporary, mandatory, or voluntary disconnection moratorium in each month. Because there is within-state variation in protection based on type of utility, we are not concerned with state-level dispersion of policies. Instead, we consider household-level characteristics in our analyses to ensure that the households covered and not covered by moratoria are comparable. Table 4 compares the means of respondents based on key underlying characteristics—race, employment status, education, whether a household’s income was at or below 100% of the FPL, whether the household had children under 5 in the household, and household size—for those who were and were not covered by a moratorium in May of 2020. We also provide a balancing table of all observations in each month from May 2020 through May 2021 in Table S6 in the Supplemental Information section. We do not find substantial difference in means, except in the case of utility provider type. This is a function of state regulatory policies, wherein IOUs are far more likely to fall under state regulation, and cooperative and municipal utilities are less so. Importantly, the results of Table 4 show a similar, or relatively balanced, distribution in sociodemographic characteristics that have previously been associated with energy insecurity – race, income, and having young children in the household – between the two groups of households. Thus, we would not expect differential rates of utility disconnection or energy-related financial hardship among those who were covered by a disconnection moratorium and those who were not based on pre-coverage household characteristics.

Table 4: Distribution of pre-treatment control variables among respondents who were covered or not covered under state disconnection protection in May 2020

	Not Covered			**Covered**			
	Count	Mean	Std. Dev.	Count	Mean	Std. Dev.	Diff. in Means
Black	958	0.17	0.38	1047	0.17	0.38	0.00
Hispanic	958	0.15	0.36	1047	0.13	0.34	0.04
Unemployed	958	0.20	0.40	1047	0.20	0.40	0.00
Education	958	2.81	1.24	1047	2.88	1.32	0.07
Under_100%_FPL	958	0.36	0.48	1047	0.37	0.48	0.01
Household member under 5	958	0.17	0.37	1047	0.15	0.36	0.02
Household size	958	2.86	1.70	1047	2.73	1.83	0.16
Own home	958	1.66	0.60	1047	1.62	0.60	0.04
Household member over 65	958	0.35	0.48	1047	0.43	0.50	0.08
Cooperative	958	0.26	0.44	1047	0.08	0.27	0.18
Muni	958	0.32	0.47	1047	0.07	0.27	0.25
IOU	958	0.42	0.49	1047	0.86	0.37	0.44

Control variables

In addition to our main regressors, we control for several household characteristics that may otherwise confound the relationship between disconnection protection policies and the energy insecurity outcomes. Specifically, we use three variables to control for whether a respondent received government assistance in the previous month, all of which we think would make a household less likely to experience energy insecurity. The first variable measures whether a respondent noted having received funding from one of the two major federal energy assistance programs (i.e., the Weatherization Assistance Program (WAP) or LIHEAP); and the second variable indicates whether a respondent reported having received another form of government assistance (specifically, assistance from the Supplemental Nutrition Assistance Program (SNAP), Temporary Assistance for Needy Families (TANF), Supplementary Security Income (SSI) or Social Security Disability Income (SSDI), Medicaid or Medicare, Veterans Benefit, or unemployment insurance). We also include several variables measuring sociodemographic characteristics that past scholarship has indicated are associated with energy insecurity: the respondent's race[34], employment status[9], educational obtainment[35], income[36], household size (i.e., how many members are in the household)[18], and whether the household has children under the age of 5 years old[37]. Finally, we control for the utility type from which the respondent receives service. We present all variable definitions in Table 5.

Table 5: Descriptive statistics and variable definitions for all the variables used in the regression models, using survey weights

Variable	Description	Observations	Min	Max	Mean	Std Dev
Disconnected	A binary variable set to 1 if the respondent was disconnected in the previous month	21,837	0	1	0.02	0.13
Forgo expenses	A binary variable to set to 1 if the respondent indicated that they had to forgo a basic household expenses to pay for an energy bill in the previous month	21,837	0	1	0.10	0.30
Financial Assistance	A binary variable set to if the respondent indicated that they received assistance paying their energy bill from a government agency, energy provider, a friend or family member, a faith-based organization, a nonprofit, a payday lender, or a loan from a banking institution	21,837	0	1	0.10	0.30
Mandatory	A binary variable set to 1 if the respondent was covered by a mandatory disconnection moratorium for at least 15 days in a given month	21,837	0	1	0.39	0.49
Mandatory + Voluntary		21,837	0	1	0.41	0.49

Mandatory + Seasonal + Voluntary	A binary variable set to 1 if the respondent was covered by a mandatory or voluntary disconnection moratorium for at least 15 days in a given month	21,837	0	1	0.42	0.50
	A binary variable set to 1 if the respondent was covered by a mandatory, voluntary, or seasonal disconnection moratorium for at least 15 days in a given month					
WAP/LIHEAP (lagged one month)	A binary variable indicating whether a respondent received WAP or LIHEAP in the previous month	21,824	0	1	0.05	0.21
Other Government Assistance (lagged one month)	A binary variable indicating whether a respondent received SNAP, TANF, SSI, SSDI, Medicaid or Medicare, Veterans Benefits, or unemployment insurance in the previous month	21,824	0	1	0.37	0.48
Black	A binary variable set to 1 if the respondent indicated that they identify as Black	21,837	0	1	0.17	0.38
Hispanic	A binary variable set to 1 if the respondent indicated that they identify as Hispanic	21,837	0	1	0.20	0.40
Unemployed	A binary variable set to 1 if the respondent indicated that they were unemployed in the given month	21,837	0	1	0.17	0.37
Education	The level of education a respondent has obtained, ranging from no high school through a post graduate education	21,837	1	6	2.70	1.35
Under 100% FPL	A binary variable set to 1 if a respondent is under 100% of the Federal Poverty Line.	21,837	0	1	0.40	0.49
Household size	The number of individuals residing in an individual's household, ranging from 1 through 20	21,837	1	20	2.76	1.78
Children under 5	A binary variable set to 1 if the household has at least 1 child under 5 living in the household	21,837	0	1	0.15	0.36
Own Home	A binary variable set to 1 if respondent owns their home	21,837	0	1	0.42	0.49
Household member over 65	A binary variable set to 1 if the household has at least 1 member over 65 living in the household	21,837	0	1	0.44	0.70
Cooperative	A binary variable set to 1 if the respondent gets their utility services provided by a Cooperative	21,837	0	1	0.15	0.36
IOU	A binary variable set to 1 if the respondent gets their utility services provided by an Investor-Owned Utility	21,837	0	1	0.66	0.47

Model

As noted, we estimate a series of two-way fixed effects regression models which exploit heterogeneity in protections across states and over time, and our main treatment variable is whether a respondent was covered by disconnection protection policies. Specifically, we estimate the following regression:

$$Y_{ist} = \alpha + \beta_1 Policy_{ist} + B_2 GA_{ist-1} + \beta_3 X'_{ist} + \gamma_s + \delta_t + \epsilon_{ist},$$

where Y_{ist} represents one of our three binary outcome variables for a respondent i in state *s* and in month *t*. $Policy$ is a binary variable indicating if a respondent was covered by a disconnection protection. As described in the *Data* section, we consider a respondent covered if a protection was in place for their utility for at least half a month (i.e., 15 days). GA represents whether a respondent received government assistance in the previous month, and X' is a vector of sociodemographic control variables. The model includes state and month fixed effects to control for unobserved variation across states (i.e., economic conditions) and over time (i.e., seasonal or temperature variation). In addition to the three primary models, we also assess the heterogeneity of our results along sociodemographic indicators, including households of color, households at or below 100% of the FPL, those who are unemployed, and households with children under the age of 5 years old. We use a linear probability model (LPM) to estimate the main models, but we also estimate logistic regression models as a robustness check. Results of both the LPM and logistic regression models, which can be found in table S7 in the Supplemental Information section, yield consistent results.

In the Supplemental Information section, we also report the results of several additional robustness checks to further test for parallel trends and to address potential concerns that states adopted moratoria in response to prior rates of energy insecurity, differential within month coverage of protection policies, and recall bias in our self-reported outcome data. Specifically, we test whether utilities in states that adopted a mandatory moratorium had differential rates of connection prior to the pandemic (Table S8), use a continuous daily measure of protection to account for partial-month protections (Table S9), and aggregate our disconnection and protection data to the wave-level to account for potential recall bias (Table S10). These robustness checks, all of which are further explained in the Supplemental Information section, are consistent with the primary models presented in the paper and suggest that the two-way fixed effects approach provides unbiased estimates of the effect of utility disconnection protections on utility disconnections and energy-related material hardship.

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Author Contributions

All authors contributed equally to this manuscript.

Declaration of interests

The authors declare no competing interests.

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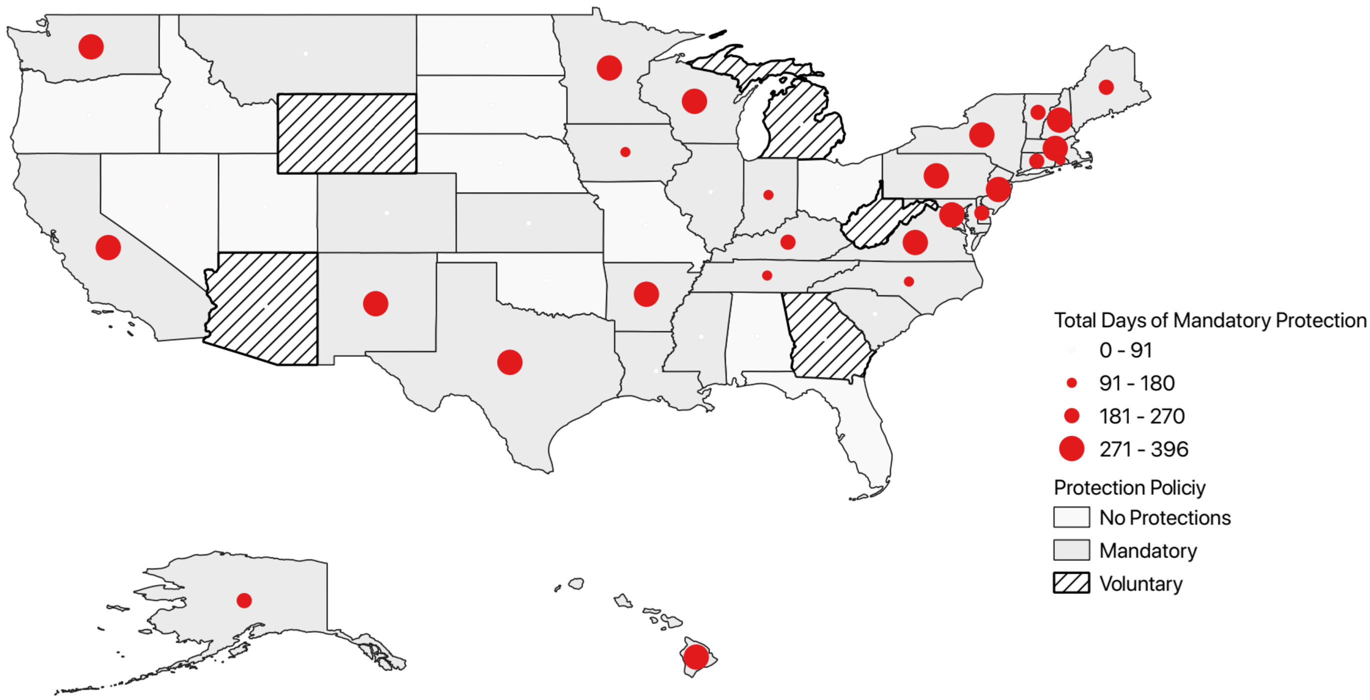
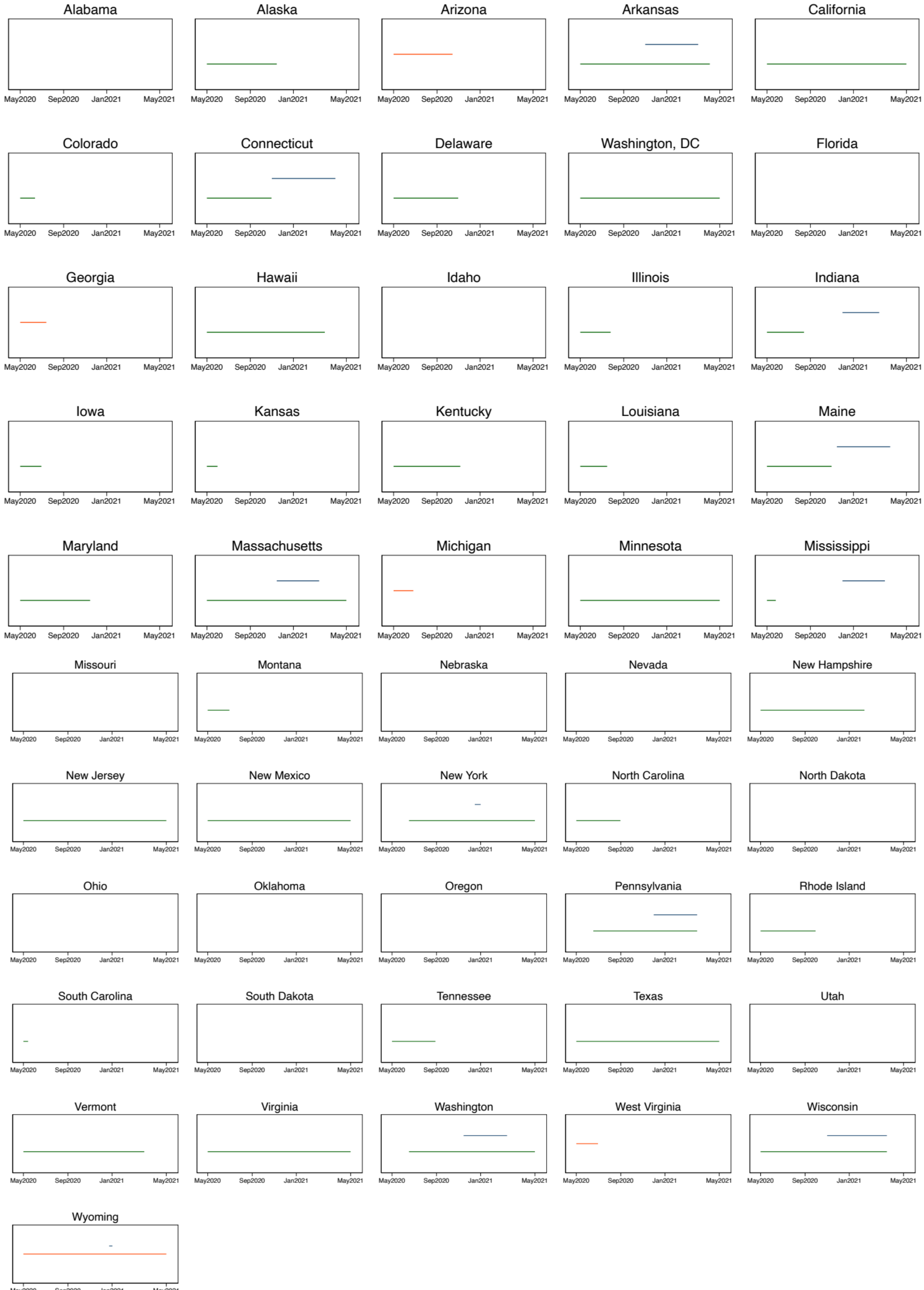
Figures and tables

Figure 1: Map of mandatory and voluntary disconnection moratoria from May 2020 through May 2021



Note: The map identifies which states enacted mandatory, voluntary, or had no emergency COVID-19 utility disconnection protections. The size of the red bubbles indicates the duration of these policies in days, with larger red bubbles representing more days of protection for residences.

Figure 2: Mandatory (green), voluntary (red), and standard seasonal (blue) disconnection protections from May 2020 through May 2021, by state.



Note: Rectangles are monthly timelines, from May 2020 to May 2021, representing the timing and duration of each state and Washington, D.C.'s mandatory, voluntary, and default seasonal protections. Respectively, green, red, and blue lines indicate mandatory, voluntary, and seasonal protection lengths. An empty rectangle indicates that the state did not have any protection – temporary or otherwise – enacted during the study period.

Table 1: Linear probability model predicting whether a respondent reported having their utility service disconnected.

	Model 1: Disconnected	Model 2: Disconnected	Model 3: Disconnected
Mandatory	-0.027***		
	(0.007)		
Mandatory + Voluntary		-0.025***	
		(0.006)	
Mandatory + Voluntary + Seasonal			-0.025***
			(0.006)
WAP/LIHEAP lag	0.002	0.002	0.002
	(0.006)	(0.006)	(0.006)
Other Government Assistance Lag	-0.002	-0.002	-0.002
	(0.003)	(0.003)	(0.003)
Black	0.010***	0.021***	0.021***
	(0.004)	(0.004)	(0.004)
Hispanic	0.012**	0.012**	0.012**
	(0.005)	(0.005)	(0.005)
Unemployed	0.003	0.003	0.003
	(0.004)	(0.004)	(0.004)
Education	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
Under 100% FPL	-0.001	-0.001	-0.001
	(0.003)	(0.003)	(0.003)
Children under 5	0.045***	0.045***	0.045***
	(0.008)	(0.008)	(0.008)
Household size	0.002*	0.002*	0.002*
	(0.001)	(0.001)	(0.001)
Own home	-0.003	-0.003	-0.003
	(0.002)	(0.002)	(0.002)
Household member over 65	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)
IOU	0.005	0.005	0.005
	(0.004)	(0.004)	(0.004)
Cooperative	0.024***	0.024***	0.024***
	(0.007)	(0.007)	(0.007)
State FE?	Yes	Yes	Yes
Month FE?	Yes	Yes	Yes
Observations	21,824	21,824	21,824

Cells contain OLS regression coefficients, with robust standard errors in parentheses. Levels of statistical significance: * $p < 0.1$, ** $p < 0.05$ *** $p < 0.01$

Table 2: Linear probability model predicting whether a respondent had to forgo a basic household expense, or received financial assistance to pay an energy bill in each month.

	Model 1: Forgo expenses	Model 2: Forgo expenses	Model 3: Forgo expenses	Model 4: Social assistance	Model 5: Social assistance	Model 6: Social assistance
Mandatory	-0.025***			-0.014		
	(0.010)			(0.010)		
Mandatory + Voluntary		-0.024**			-0.012	
		(0.009)			(0.006)	
Mandatory + Voluntary + Seasonal			-0.023**			-0.010
			(0.009)			(0.010)
WAP/LIHEAP lag	-0.009	-0.009	-0.009	0.011	0.011	0.011
	(0.012)	(0.012)	(0.012)	(0.014)	(0.014)	(0.014)
Other Government Assistance Lag	0.013**	0.014**	0.014**	-0.000	-0.000	-0.000
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Black	0.014*	0.014**	0.014**	0.022***	0.022***	0.022***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
Hispanic	0.031***	0.030***	0.030***	-0.015	-0.015	-0.015*
	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)	(0.009)
Unemployed	0.024***	0.024***	0.024***	0.011	0.011	0.011
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Education	0.001	0.001	0.001	0.004**	0.004**	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Under 100% FPL	0.039***	0.039***	0.039***	0.037***	0.037***	0.037***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Children under 5	0.035***	0.035***	0.035***	0.071***	0.071***	0.071***
	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)
Household size	0.015***	0.015***	0.015***	0.000	0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Own home	-0.003	-0.003	-0.003	0.013***	0.013***	0.013***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Household member over 65	-0.012***	-0.012***	-0.012***	0.005	0.005	0.005
	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)
IOU	-0.009	-0.009	-0.009	-0.014*	-0.014*	-0.015*
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Cooperative	0.007	0.007	0.007	0.002	0.002	0.002
	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)
State FE?	Yes	Yes	Yes	Yes	Yes	Yes
Month FE?	Yes	Yes	Yes	Yes	Yes	Yes
Observations	21,824	21,824	21,824	21,824	21,824	21,824

Cells contain OLS regression coefficients, with robust standard errors in parentheses. Levels of statistical significance: * $p < 0.1$, ** $p < 0.05$ *** $p < 0.01$

Appendix Table X

Variable	**Question Wording**
Disconnected	After receiving this notice, were you disconnected or did you lose service?
Forgo Expenses	In the last <x> months, has your household had to reduce or forgo expenses for basic household necessities, such as medicine or food, in order to pay an energy bill?
Social Assistance	In the last <x> month, have you received assistance in paying an energy bill from any of the following sources?