THE UNIVERSITY OF CHICAGO
THE LAW SCHOOL
Abrams Environmental
Law Clinic

July 26, 2024

Via E-Filing

Ms. Lisa Felice
Executive Secretary
Michigan Public Service Commission
7109 West Saginaw Highway
Lansing, MI 48917

RE: MPSC Case No. U-21534

Dear Ms. Felice:

Please find enclosed the Accompanying Exhibits DAO-125 to DAO-136 (Part 4 of 5) for the Direct Testimony of Justin Schott on Behalf of Soulardarity and We Want Green, Too, along with proof of service for electronic filing in the above-referenced matter. Please do not hesitate to contact me with any questions or comments.

Sincerely,

Mark N. Templeton, *pro hac vice*
6020 S. University Avenue
Chicago, IL 60637
Phone: (773) 702-9611
Email: templeton@uchicago.edu

xc: Parties to Case No. U-21534

HOUSEHOLD ENERGY INSECURITY SURVEY

Winter 2021-2022

ENERGY JUSTICE LAB
INDIANA UNIVERSITY

Household Energy Insecurity Survey

Authors

Sanya Carley
David Konisky
Trevor Memmott

About the survey

The Household Energy Insecurity Survey measures the prevalence of energy insecurity among a nationally-representative sample of low-income households (households with incomes at or below 200% of the Federal Poverty Line) in the United States. The survey was administered to a sample of 1,000 respondents, and includes questions about household energy insecurity, household composition and dwelling characteristics, and strategies American families use to manage their energy consumption and cope with energy-related materials hardships.

This survey was administered online in January 2022 and pertains to conditions experienced between November 2021 and January 2022, a three-month winter time space. The survey was administered on behalf of the Indiana University research team by YouGov, a private polling and market research firm. The survey has a margin of error of 3 percentage points.

For more information, please contact the Principal Investigators for this study: Sanya Carley (scarley@indiana.edu) or David Konisky (dkonisky@indiana.edu).

Citation for this report: Sanya Carley, David Konisky, and Trevor Memmott, “Household Energy Insecurity Survey, Winter 2021-2022, Indiana University, Bloomington.”

About the Energy Justice Lab

The Energy Justice Lab at Indiana University is a research group conducting studies about the equity and justice dimensions of the clean energy transition. Through research, the lab offers insights on what energy justice means as it relates to the energy transition and what individuals and communities on the frontlines are facing, what vulnerability means in the energy justice context, what types of policies and programs are in place to address these issues, and how well government is doing to protect vulnerable communities. Professors Sanya Carley and David Konisky serve as Co-Directors of the Energy Justice Lab.

Energy insecurity in the United States

Energy insecurity, or the inability to meet one's energy needs, is a widespread and growing problem among low-income households in the United States. When households are unable to pay their energy bills or are disconnected from their utility service, they may struggle to keep their home at a comfortable temperature and often must engage in strategies that can be detrimental to their physical, mental, and financial well-being.

Recognizing that energy insecurity continues to impact and endanger vulnerable populations across the United States, the Household Energy Insecurity Survey regularly measured the prevalence and patterns of energy insecurity among a nationally-representative sample of low-income households. This Winter 2021-2022 survey covers the winter months of November and December 2021, and January 2022, which included periods of severe cold and storms, as well as extremely high prices for natural gas.

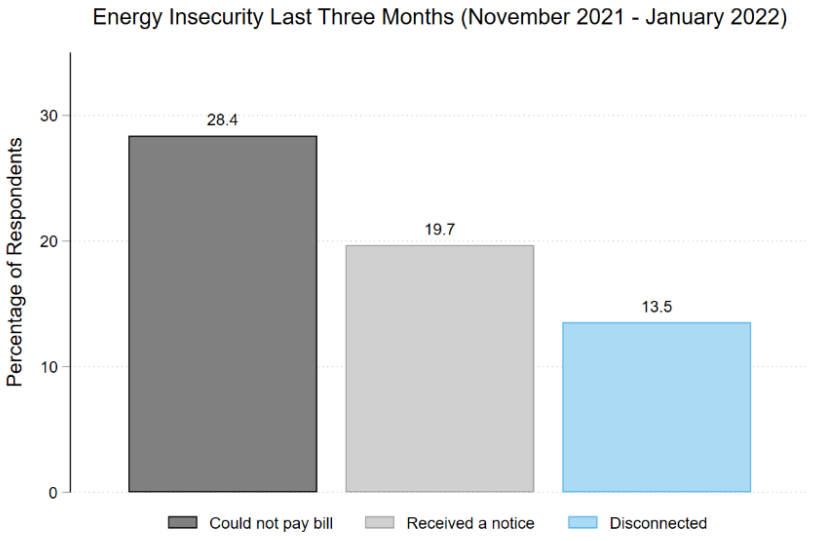
Key findings

- Household energy insecurity is prevalent among low-income households in the United States.
- Black and Hispanic households experience higher levels of energy insecurity.
- Energy insecurity is widespread among households with vulnerable populations, especially families with children.
- Households often forgo other basic household needs to pay their energy bills.
- To cope with the expense of energy, households often adjust the temperature in their homes to uncomfortable levels and accumulate utility debt.

ENERGY JUSTICE LAB
INDIANA UNIVERSITY

Household energy insecurity is prevalent among low-income households in the United States.

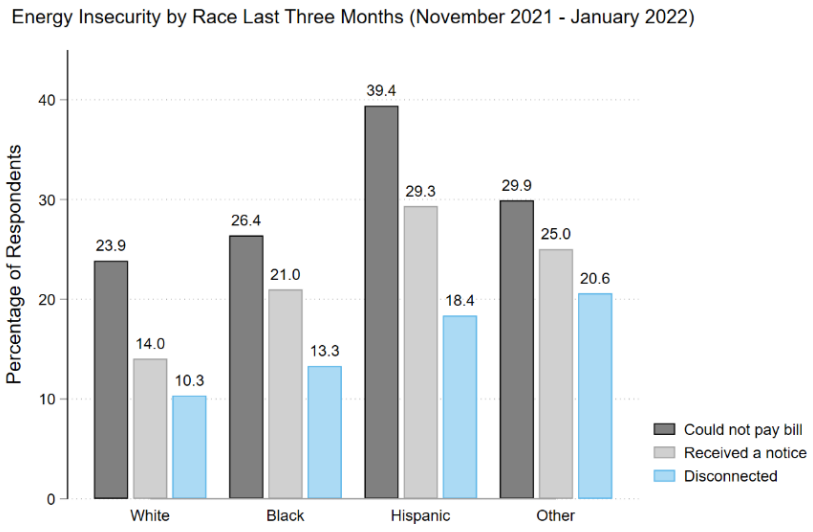
The survey asked respondents whether they were able to pay their energy bill, whether they received a notice of disconnection, and whether their energy services were disconnected by a utility provider over the course of the last three months (November 2021 through January 2022).



More than 28% of respondents reported being unable to pay their energy bill, nearly 20% received a disconnection notice, and 13.5% had their energy service (e.g., electricity, natural gas) disconnected by their utility provider.

Black and Hispanic households experience higher levels of energy insecurity

From November 2021 through January 2022, almost 40% of Hispanic respondents and more than 26% of Black respondents were not able to pay an energy bill. Hispanic households were about 50% more likely than white households to report being unable to pay an energy bill during this period.

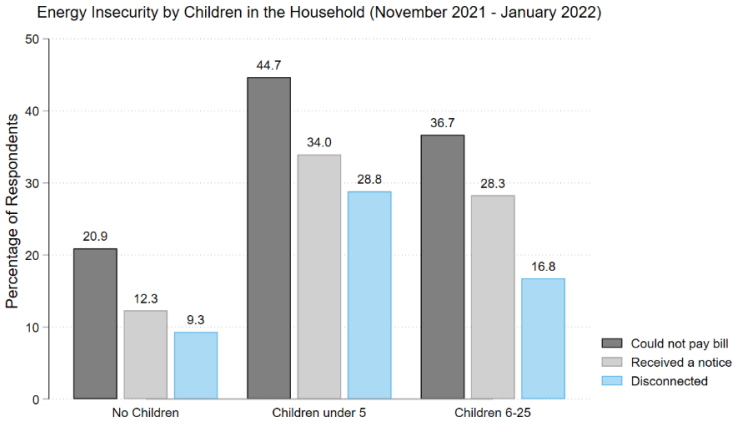


In addition, 29% of Hispanic respondents and 21% of Black respondents received a disconnection notice, and more than 18% of Hispanic respondents and 13% of Black respondents had their energy service disconnected by their utility provider. Compared to white respondents, Hispanic and Black respondents were 80% and 30%, respectively, more likely to have their service disconnected by their utility provider.

ENERGY JUSTICE LAB
INDIANA UNIVERSITY

Energy insecurity is widespread among households with vulnerable populations, especially families with children

From November 2021 through January 2022, nearly 45% of households with children younger than 5 years old in the household could not pay an energy bill, 34% received a disconnection notice, and 29% were disconnected from their utility service.



For those with children in the household between the ages of 6 and 17 years old, nearly 37% could not pay their bill, 26% received a notice, and 17% were shut off by their utility.

Other vulnerable households also experienced high rates of energy insecurity; 31% of households with a disability could not pay a bill and 12% had their service disconnected by their utility provider. For households with a member over the age of 65, 27% could not pay their bill and 13% were disconnected.

Households often forgo other basic household needs to pay their energy bills.

More than 21% of respondents reported that, between November 2021 and January 2022, they had to forgo basic household expenses like food or medical care to afford their energy bill “on multiple occasions” (15%) or “all the time” (6%).

About 37% of respondents indicated that they had to either give up energy needs to afford other expenses or had to give up other expenses in order to afford their household energy bill. Approximately 33% of respondents reported that they reduced their energy consumption “Most of the time” (19%) or “Always” (14%) in order to save money on their energy bill.

To cope with the expense of energy, households often adjust the temperature in their homes to uncomfortable levels and accumulate utility debt.

From November 2021 through January 2022, 14% of respondents reported that they never had a comfortable temperature in their home and 30% reported only having a comfortable temperature in their home some of the time.

Around 38% of respondents reported having some level of utility debt, and the average level of debt was $129.

ARTICLES
https://doi.org/10.1038/s41560-020-00763-9

nature energy

Sociodemographic disparities in energy insecurity among low-income households before and during the COVID-19 pandemic

Trevor Memmott, Sanya Carley ✉, Michelle Graff and David M. Konisky

Energy insecurity is a growing public health threat among low-income populations in the United States. Prior research has shown that energy insecurity is associated with adverse health effects and can lead people to engage in risky coping strategies. Here we evaluate rates of energy insecurity, which factors contribute to it, and how the early months of the COVID-19 pandemic exacerbated the problem. We show that energy insecurity is highly prevalent among households at or below 200% of the federal poverty line. We further show that Black and Hispanic households are more likely to experience energy insecurity and face utility disconnection, as are households with young children, individuals that require electronic medical devices and those in dwellings with inefficient or poor conditions. These conditions exist under normal circumstances, and the COVID-19 pandemic seems to have exacerbated the overall incidence of energy insecurity.

Energy insecurity—conceptualized as the inability of a household to meet its basic energy needs[1,2]—is a pervasive problem in the United States and elsewhere[3]. Scholars use terms such as energy poverty, fuel poverty and energy vulnerability to capture similar conditions[4–8] that involve both affordability and access to reliable energy sources. Although electricity is necessary for essential services (for example, heating, cooling, cooking, lighting and medical devices), policymakers have failed to recognize the scope and scale of the energy insecurity problem[9]. In response to energy insecurity, vulnerable households are more likely to engage in risky behaviours to meet their energy needs[10], which include using high-interest payday loans[11], a reliance on dangerous heating sources, such as space heaters or ovens[12], or forgoing other basic needs, such as food and medical care[13]. Individuals in energy-insecure households are more likely to remain in poverty for longer periods of time[14] and are more likely to suffer adverse mental and physical health consequences[15–18], which include an increased incidences of death[19]; these impacts are especially prevalent for children[20,21] and the elderly[22,23].

The economic disruption thus far caused by the COVID-19 pandemic has increased pre-existing inequalities, which include those associated with energy insecurity. Black and Hispanic communities have been impacted by disproportionate rates of coronavirus-related infections, hospitalizations and mortality[24,25]; and Black and Hispanic populations, young workers, mothers of school-aged children, and low-educated individuals have experienced large employment shocks[26–29]. This study expands this work by examining which American families experience energy insecurity during a public health crisis. In so doing, we also contribute to a growing literature on energy justice, material hardship and vulnerable populations[1,30,31].

The extant literature on energy insecurity has found that Blacks, Hispanics, those without a college degree and households with young children are all more likely to be energy insecure[2,31,32]. These studies provide a strong foundation that scholars and practitioners currently rely on to understand the problem of domestic energy insecurity. Current knowledge of the scope and scale of energy insecurity, however, primarily comes from the analysis of two limited data sources: the Residential Energy Consumption Survey (RECS)[33] and the American Community Survey (ACS). The RECS contains few energy insecurity questions, is administered only every four years, does not provide state-level geographical identifiers, and examines the public at large rather than the most vulnerable populations; and, although the ACS contains items on energy expenditures, it does not capture affordability[34]. Analyses using these datasets have made important contributions to our understanding of energy insecurity, but neither the ACS nor the RECS enable a comprehensive empirical analysis of US energy insecurity.

To address these shortcomings, we administered a nationally representative survey of 2,381 adults with household incomes at or below 200% of the Federal Poverty Level (FPL) in April and May 2020. The survey captures multiple measures of energy insecurity, collects demographic, health and housing conditions information, and enables the evaluation of energy insecurity over the course of a year, which allows us to compare the prevalence and correlates of energy insecurity during both 'normal' circumstances and in the early months of the COVID-19 pandemic[35,36].

To summarize our findings, energy insecurity is highly prevalent among low-income American households, especially among households that identify as Black and Hispanic. We found that those who require use of an electronic medical device and live in poor or less-efficient housing conditions experience higher rates of energy insecurity. The COVID-19 pandemic has thus far deepened the prevalence of energy insecurity among low-income households, as some speculated may occur[37], with some indication of growing disparities.

Describing energy insecure households

We evaluate energy insecurity across three measures, which represent a range in severity: inability to pay an energy bill, receipt of a utility disconnection notice and disconnection from energy service. All measures rely on respondent recall about conditions over the past year (from roughly April/May 2019 to April/May 2020) and over the past month (April/May 2020), respectively. Although we cannot rule out recall bias, we believe it is likely that most

Paul H. O'Neill School of Public and Environmental Affairs, Indiana University, Bloomington, IN, USA. ✉e-mail: scarley@indiana.edu

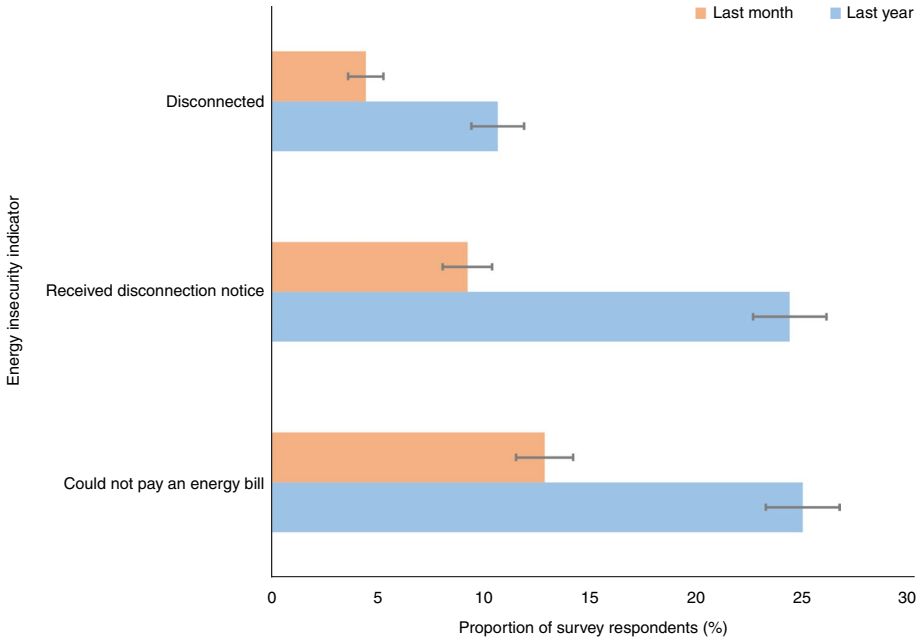


Fig. 1 | Proportion of survey respondents facing energy insecurity. Respondents who reported an inability to pay their energy bill, received a disconnection notice or were disconnected in the past year (blue) and in the past month (orange). The grey bars represent 95% CIs ($n = 2,381$).

respondents accurately remember events such as being unable to pay a bill, learning that they will soon be disconnected unless urgent action is taken, or being disconnected from the grid and losing access to electricity.

The survey results (Fig. 1) reveal that 25% (the 95% confidence interval (CI) is 23.0–27.0%) of low-income households could not afford to pay an energy bill in the past year and nearly 13% (95% CI 10.9–14.9%) could not afford their bill in the past month. In the past year, just over 25% (95% CI 23.6–27.6%) of respondents received a notice from their utility provider that their power may be disconnected due to lack of payment, and over 10% (95% CI 8.6–12.6%) had their service disconnected. In the past month, during the onset of the economic dislocation from the COVID-19 pandemic, 9% (95% CI 7.2–11.2%) of respondents had received a notice and 4% (95% CI 2.4-6.4%) were disconnected.

To further characterize the general prevalence of energy insecurity among low-income US households, as well as its incidence since the onset of the COVID-19 pandemic, we combined the survey data with estimates from the 2018 ACS for those who live at or below 200% of the FPL to approximate the number of US households and individuals that are energy insecure. Specifically, we extrapolated from the survey data to the US population by multiplying the proportion of survey respondents that reported some level of energy insecurity by the number of US households (individuals) that the ACS estimates to be at or below 200% of the FPL. As shown in Table 1, we estimate that, in the past year, approximately 4.7 (24.3) million households (individuals) could not pay an energy bill, and just over 50%—2.4 (12.5) million households (individuals)—indicated that at least one of the bills they could not pay was in the past month. Although we estimate that 4.8 (24.9) million households (individuals) received a disconnection notice and approximately 41% of these households were disconnected in the past year, the proportion of households that were disconnected from the grid after they received a notice rose to about 48% during the COVID-19 pandemic.

To put these estimates into context, we compared them with the RECS survey, which provides a nationally representative snapshot of all domestic housing units in the United States. According to the most recent RECS, 17 million households received a disconnection notice in 2015, and 3 million households had their electricity disconnected. We can approximate from our 2020 survey that roughly 30% of all US households who received disconnection notices had incomes at or below 200% of the FPL, and nearly two-thirds of those that were disconnected came from households at or below 200% of the FPL. Although these approximations should be interpreted cautiously given differences in survey methodology and timing, we can infer that low-income households are being disconnected at much

Table 1 | Estimates of US households experiencing energy insecurity

	Could not pay an energy bill	Received notice	Disconnected
Number of households × 10^6 (estimate range)			
Past year (April/May 2019 to April/May 2020)	4.7 (4.4–5.2)	4.8 (4.5–5.3)	2.0 (1.6–2.4)
Past month (April/May 2020)	2.4 (2.1–2.8)	1.7 (1.4–2.1)	0.8 (0.5–1.2)
Number of individuals × 10^6 (estimate range)			
Past year (April/May 2019 to April/May 2020)	24.3 (22.4–26.3)	24.9 (23.0–26.9)	10.3 (8.4–12.3)
Past month (April/May 2020)	12.5 (10.6–14.5)	8.9 (7.0–10.9)	4.3 (2.3–6.2)

The approximate number of households—defined by the ACS as family members who reside together—and individuals who suffer from energy insecurity in the United States based on the 2018 ACS estimates[54] of households that live at or below 200% of the FPL and the proportion of respondents that reported they could not pay an energy bill, received a disconnection notice or were disconnected from energy service. The range represents the 95% CIs for the estimates.

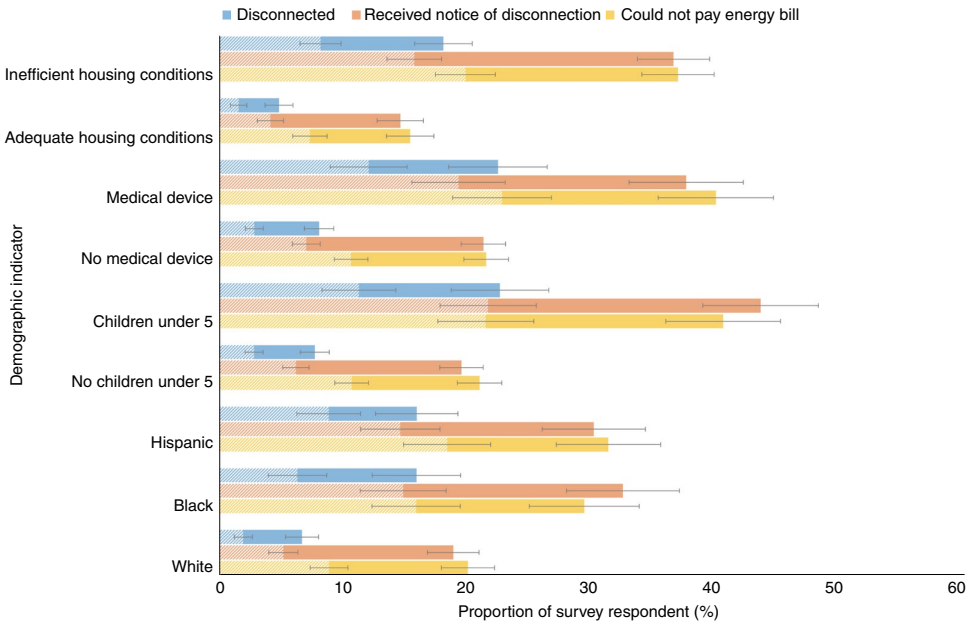


Fig. 2 | Energy insecurity by demographic characteristics. The proportion of households that could not afford an energy bill (yellow), received a disconnection notice (orange), or were disconnected from the grid (blue) in the past year (full bars) compared with those in the past month alone (dashed components), according to key indicators. Grey bars represent the 95% CIs ($n = 2,381$).

higher rates after receipt of a notice from their utility than average- to high-income households.

To further understand energy insecure households, we disaggregated the indicators of energy insecurity by race, number of dependents, health and housing conditions. These findings are illustrated in Fig. 2, in which each full bar represents the proportion of survey respondents who reported being energy insecure in the past year. We find that Black households, Hispanic households, households with young children, those with a member that relies on an electronic medical device and those who reside in poor housing conditions (for example, mould, holes in the wall and/or floor, plumbing problems, broken heating and air conditioning, exposed electrical sockets, non-working stove and/or refrigerator, or poor insulation) all reported higher incidences of energy insecurity. These characteristics are positively associated with all three energy insecurity measures, which demonstrates that these disparities are prevalent during typical circumstances (that is, the year prior to the onset of the COVID-19 pandemic, which was characterized by a normal-to-strong US domestic economy[38]).

Figure 2 further suggests that many of these disparities have grown since the beginning of the COVID-19 pandemic. Although the survey data do not enable us to make precise year-on-year comparisons, there was a higher prevalence of energy insecurity across many of these sociodemographic and household attributes during the early period of the COVID-19 pandemic (dashed bars in Fig. 2). For example, 20% of White households and 30% of Black households could not pay an energy bill in the past year, which accounts for 12 full months; whereas 9% of White households and 16% of Black households indicated that they had trouble paying their energy bill in just the past month alone, a month that is not typically a weather aberration, nor was it extreme in 2020. Additionally, Hispanic respondents were 2.4 times more likely than White respondents to be disconnected from the grid in the past 12 months, but 4.7 times more likely to be disconnected during the early period of the COVID-19 pandemic. Similar patterns emerged across the other indicators displayed in Fig. 2, which provides some evidence of an increase in disparities in energy insecurity during the beginning of the public health and economic crisis that results from the COVID-19 pandemic.

Sociodemographic predictors of energy insecurity

To better identify the determinants of household energy insecurity, we estimated a series of logistic regression models. This analysis evaluated the correlates of energy insecurity over the past year and in the past month to compare patterns of household energy insecurity during typical circumstances and the potential unique hardships that these households experienced since the onset of the pandemic. For brevity, we present the results of our models in Fig. 3 for the demographic, health and housing characteristics that are consistently statistically associated with at least two of our indicators of energy insecurity. For clarity, we discuss our findings in terms of odds ratios. Full model regression results are also presented in Supplementary Table 1. In the models, we also include measures for households with a disabled member, other race categories (which include Asian, Native American and mixed households), whether the household is situated in an urban or rural zip code, whether the household received government assistance and the respondent's age, gender, employment status and level of educational attainment (see Supplementary Table 2 for a full list of variables).

As illustrated in Fig. 3, Black respondents were more likely than White respondents to be energy insecure across all three energy insecurity measures in the past year, with Hispanic households more likely to receive a notice of disconnection or be disconnected from the electric grid. More specifically, compared with White households, Black and Hispanic households experienced more severe forms of energy insecurity at higher rates. Black households experienced 1.9 times greater odds of receiving a disconnection notice and 2.2 times greater odds of having their utility service disconnected than the White household respondents. Hispanic households faced disconnection at 1.9 times greater odds than White household respondents.

Moreover, the COVID-19 pandemic appears to have increased racial disparities. The regression analysis suggests that Black

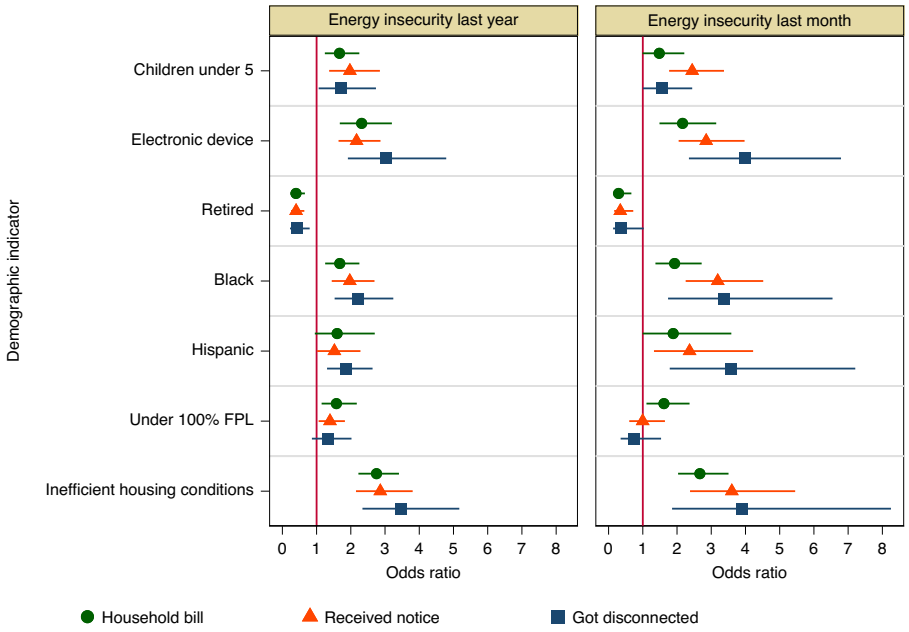


Fig. 3 | Sociodemographic correlates of energy insecurity. Values are odds ratios with 95% CIs, estimated from logistic regression models ($n = 2,359$). The models also include variables for household member with a disability, unemployed, other race or ethnicity, gender, age, education, dwelling type (mobile home, apartment or attached home), percentage of urban area within the zip code and receipt of government assistance. The full model estimates are provided in Supplementary Table 1.

respondents were more likely to face all three forms of insecurity and Hispanic respondents were more likely to receive a notice or be disconnected in the time since the pandemic began compared to over the course of the previous year. Blacks (Hispanics) were at 3.4 (3.6) greater odds of being disconnected from their utility service during the pandemic than White respondents. These temporal differences in prevalence across racial groups suggest that energy insecurity intensified during the early months of the pandemic, although we cannot infer this definitively from the statistical analysis because the CIs for the coefficients across the models overlap.

Similarly, respondents who live in households in which at least one person requires the use of a home electronic medical device were more likely to be unable to pay their bills, to receive a notice and to be disconnected, both over the course of the prior year and during the early period of the COVID-19 pandemic. During the early months of the pandemic, for example, electronic device users faced 4.0 times greater odds of having their utility service disconnected compared with those who did not require the use of a medical device, which suggests that this vulnerable population is at high risk of losing power and facing tangible health risks. In addition, households with children under the age of five, those who live in poor or inefficient dwelling conditions, and those that have received government assistance in the past month also faced a higher risk of experiencing energy insecurity. We found that retired individuals, on average, were less energy insecure.

Lastly, respondents that had a household income under 100% of the FPL were more likely to be unable to pay their energy bill in both the past year and the past month as well as more likely to receive a disconnection notice in the past year, as compared with those whose household incomes were between 150 and 200% of the FPL. The lack of a statistical association between income levels and disconnection from the electric grid is a noteworthy null finding. It suggests that economic characteristics are not the sole predictors of the most severe measure of energy insecurity and that race, health and housing conditions remain positive correlates of energy insecurity across all three measures, even when income is accounted for.

The impact of COVID-19 on energy insecurity

To this point, the analysis has provided suggestive evidence about the relationship between the early period of the COVID-19 pandemic and energy insecurity by comparing the prevalence and determinants of energy insecurity at different points in time. To further examine this relationship, we analysed the responses to several COVID-19-related survey items: whether they had received a COVID-19 stimulus payment (part of the Coronavirus Aid, Relief and Economic Security Act), whether their employment status had changed due to the pandemic and whether someone in their household had symptoms of or a positive test for COVID-19. Lastly, we included a factor score (see Supplementary Table 3) to measure 'COVID-19 hardship' or the material hardship (for example, financial, food and medical insecurity) a respondent experienced in the immediate aftermath of the pandemic.

A larger proportion of households that were adversely affected by the public health crisis also experienced all three levels of energy insecurity in the past month (Fig. 4). Additionally, those that received a stimulus cheque were less likely to face issues as the pandemic began to unfold.

Next, we re-estimated the logistic regression model for the energy insecurity measures reported during the early COVID-19 period and included these variables as regressors. The full set of results (Supplementary Table 4) reveals that, in general, the same set of covariates that were correlated with energy insecurity in the past year remained statistically associated with energy insecurity in the past month, even when we controlled for the potential confounding effects of COVID-19.

Conditions associated with COVID-19 are positively associated with energy insecurity (Fig. 5). Material hardship and unemployment and/or lost hours due to the pandemic are statistically associated

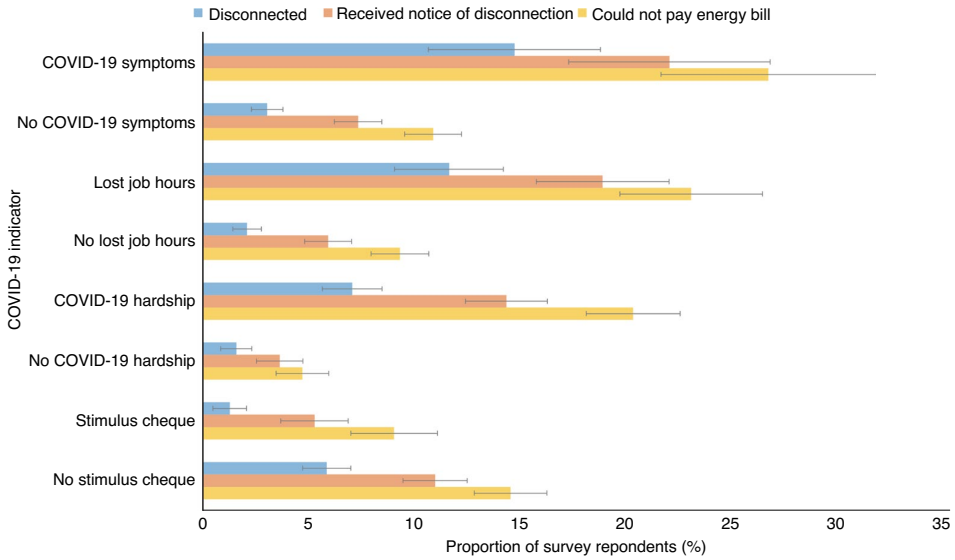


Fig. 4 | COVID-19-related conditions and energy insecurity. The proportion of households that could not afford an energy bill (yellow), received a disconnection notice (orange), or were disconnected from the grid (blue) in the past month by various COVID-19-related measures. Grey bars represent 95% CIs ($n = 2,381$).

with all three forms of energy insecurity. Those that reported having a household member with symptoms or a COVID-19 diagnosis had greater odds of reporting an inability to pay one's energy bill, whereas those who received a stimulus cheque had greater odds of avoiding utility disconnection. The results regarding the COVID-19 stimulus assistance may also capture unobserved characteristics about those that received this cash assistance (that is, stable residence and bank accounts). It is important to note that only about one-third of respondents reported that they had received a stimulus cheque.

Addressing energy insecurity is imperative

This study provides estimates of the prevalence of energy insecurity among low-income households in the United States, which reveal that approximately 4.8 million households were unable to pay at least one energy bill during the past year and a similar number received a notice from their utility that they faced the threat of disconnection from energy service. Of those that received a notice, more than two in five families had their energy shut off. These numbers equate to tens of millions of Americans.

We also found notable disparities across all three indicators of energy insecurity, which include race, families with young children, households with an individual who relies on an electronic medical device, and people who live in residences in poor condition. The latter results are consistent with previous works that identify housing conditions and inefficient housing stock as a leading contributor to energy insecurity in the United States[18,34,39–41]. It is important to emphasize, moreover, that these inequalities exist, especially between Black and Hispanic households and White households, even when income is accounted. Given that people who experience these circumstances also tend to suffer from other types of material hardship, such as food insecurity[13,20] and limited access to affordable health care[18], these disparities in energy insecurity probably amplify the challenges that these vulnerable populations face.

Further, our analysis indicates that energy insecurity has intensified because of the COVID-19 pandemic. Both the economic dislocation and, to some extent, the virus itself are associated with difficulty in meeting household energy needs during the early period of the pandemic. Moreover, our results provide strong suggestive evidence that the sociodemographic disparities that existed prepandemic—that is, during 'normal' circumstances—widened during the early months of the crisis. This finding is consistent with past research that showed that economic downturns tend to exacerbate material hardship among already vulnerable populations[42,43].

During the early months of the pandemic, US federal, state and local governments put a range of emergency measures in place to help households cope with material hardship (for example, eviction and utility shutoff moratoriums, expanded unemployment insurance, discounted housing payments and direct cash assistance). In the case of the electricity service specifically, many states adopted temporary shutoff protections to supplement the patchwork of existing state-level policies that limit the circumstances in which utilities can disconnect customers[44]. As these temporary measures elapse, one might anticipate further incidence and severity of energy insecurity. In the short term, additional financial assistance programmes, extensions of state-level protections and the establishment of a national moratorium on electricity disconnections would mitigate household energy insecurity through the duration of the pandemic. In the long term, potential government interventions might include investments in energy efficiency programmes to help households afford energy.

There remains much to learn about the prevalence and determinants of energy insecurity. The findings in this study about race and ethnicity require further inquiry. Past work emphasizes that Blacks and Hispanics disproportionately experience energy insecurity[45]; the analysis presented here indicates that this association holds, even after controlling for income and housing conditions. That is, there is something left unexplained about the energy experiences of Black and Hispanic households that needs to be identified to fully understand the prevalence of energy insecurity in these groups.

Among other unanswered questions are what strategies people employ to cope with energy insecurity. There are at least two important dimensions to examine. The first dimension relates to the financial strategies that people adopt to balance their energy needs with material hardship. Sociological research on material hardship, for example, found that households engage in credit balancing and strategic non-payment to manage their overall expenses[46]. This type

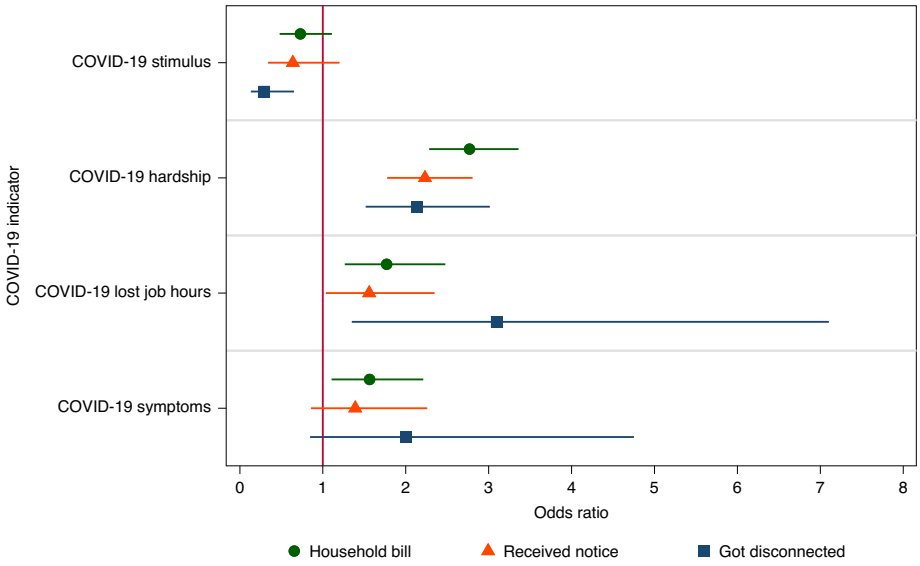


Fig. 5 | COVID-19-related correlates of energy insecurity. Odds ratios with 95% CIs, estimated from logistic regression models ($n = 2,287$). Models also include variables for households with children under 5, household member with a disability, unemployed, household member using an electronic device, retired, Black, Hispanic, other race or ethnicity, gender, age, income, education, dwelling type (mobile home, apartment, attached home), housing conditions, percent zip code urban and receipt of government assistance. Full model estimates are provided in Supplementary Table 4. Robustness checks using ordinary least squares estimation and other variations defined in the Methods section are presented in Supplementary Tables 5–12.

of behaviour may result in households accruing long-term debts, which may turn a short-term problem into a longer-term one. Households may also seek out relief or financial assistance from both formal (for example, utilities and government programmes such as the Low Income Home Energy Assistance Program or the Weatherization Assistance Program) and informal sources (for example, family and friends, faith-based organizations and other non-profit organizations).

Beyond the financial aspects, scholars should also continue to examine the behavioural response of individuals to energy insecurity[1], by which we mean how people cope with less electricity consumption, either because of concerns about affordability or due to the loss of service as a result of non-payment. For example, little is known, at least from large, quantitative studies, about how people stay cool during the summer months or warm during the winter months if they cannot afford to turn on their air conditioning or heat. Research on behaviours during times of crisis suggests that individuals may do more risky things[9,10], which in this context could lead to severe adverse effects to health and well-being.

Methods

Survey design and implementation. The survey was fielded in an online format through a contract with YouGov, a private polling and market research firm. YouGov generates representative samples using a matched sample methodology. YouGov develops a target population from general population studies, from which it draws a random set of respondents to create a target sample. Using a matching algorithm, the firm selects potential respondents from its US panel of approximately two million opt-in participants that match the target sample[47], working with partner organizations to enhance its sample when necessary. YouGov's survey approach has been validated extensively[47–49].

For this survey, YouGov interviewed a total of 2,914 respondents who were matched down to the final dataset of 2,381 participants, using a sampling frame on gender, age, race and education constructed by stratified sampling from the 2017 ACS one-year sample of individuals whose income is at or below 200% of the FPL. The matched cases were weighted to the sampling frame using propensity scores, and then the matched cases and the frame were combined and a logistic regression was estimated for inclusion in the frame. The propensity score function included age, gender, race and/or ethnicity, education and geographical region. The propensity scores were grouped into deciles of the estimated propensity score in the frame and poststratified according to these deciles. The weights were then poststratified on a four-way stratification of gender, age (four categories), race (four categories) and education (four categories) to produce the final weight, which was used in all the reported results and analyses. The survey has a margin of error of 2%.

Our research design focused on low-income households because energy insecurity tends to be more heavily concentrated among households in this economic category[50]. We selected an income threshold of at or below 200% of the FPL for several reasons: (1) scholars[51] and practitioners[52] have previously relied on 200% of the FPL as an indicator of low-income households in the United States; (2) federal energy assistance programmes set their income limits at 150% of the FPL, so surveying households at or below 200% of the FPL allows us to collect a sample of households that are within and above income eligibility thresholds, and (3) we were more likely to achieve a nationally representative sample of US households by sampling households at or below 200% of the FPL, rather than 100% of the FPL.

The survey was administered between 30 April and 25 May 2020, and took respondents, on average, ten minutes to complete. We asked survey respondents to answer a series of questions about their housing conditions, health status and energy insecurity over the past year, as well as over the past month (a period that we define in this study as during April or May 2020). We also asked a series of questions specifically about how respondents' circumstances had changed since the onset of the COVID-19 pandemic, which we defined as beginning in the second week of March 2020, which roughly coincides with the timing of when state governments began to enact stay-at-home orders and social distancing measures.

Statistical analysis. To measure the determinants of energy insecurity, we employed a series of logistic regressions. The binary dependent variables measure whether (1) a respondent's household could not pay their energy bill, (2) their household received a disconnection notice and (3) their household electricity was disconnected. The survey asked respondents about these outcomes for different time frames, which enabled us to compare energy insecurity over the course of the past year with that in the past month (during the economic crisis brought about by the pandemic). To control for potential omitted variable biases due to unobserved interstate (across state) variation, we included a series of state dummy variables, which allowed us to exploit within-state variation. We further clustered standard errors at the state level to account for within-cluster correlations. We also conducted the year, month and COVID-19 specific analyses using linear regression analysis (Supplementary Tables 5 and 6). As for the logistic regressions, we included state dummy variables and clustered our standard errors at the state level. We found consistent outcomes across both the logistic and linear empirical specification for all three of our models.

Lastly, we conducted a final set of robustness checks that employed both the logistic and linear regression empirical specifications. To test whether our

COVID-19 measures were accounting for unmeasured variation, we narrowed the sample to those who experienced energy insecurity in the past year but not in the past month. This allowed us to check whether the material hardship, economic and health factors that relate to the pandemic remain statistically linked to energy insecurity. If the factors remained correlated, it suggests that the COVID-19 measures were merely accounting for some omitted variable and were not specific contributors to energy insecurity in the past month, or as the public health crisis began to unfold. Both the logistic (Supplementary Table 7) and linear (Supplementary Table 8) models largely revealed a loss of significance across the COVID-19 measures, which indicates that the pandemic and the economic disruption it caused is, in fact, responsible for deepening energy insecurity in the past month across our survey population. We also tested a set of regressions with an additional control variable for respondents' self-reported average monthly energy bill expenditure. Although household energy expenditures is a positive and significant predictor of our measures of energy insecurity in both time periods, we did not include this as a variable in our main models because 110 survey respondents did not report this value. Therefore, the missing observations would reduce our sample size by roughly 5 percent. Importantly, when controlling for energy expenditures, our results remain relatively consistent for both the logistic (Supplementary Tables 9 and 10) and linear (Supplementary Tables 11 and 12) models.

Ethics. This research involved human subjects. It was approved by the Indiana University Office of Research Compliance, under protocol number 2004296209. In accordance with this protocol, informed consent was provided by all the study participants.

Reporting Summary. Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability

Data and associated materials used in this study are available in the Harvard Dataverse repository[53], which includes the original survey data and codebook, the STATA data-processing do-file and the STATA data analysis do-file. Replication sources can be found at https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/OMJWNB.

Received: 27 August 2020; Accepted: 8 December 2020;
Published online: 18 January 2021

References

1. Hernández, D. Understanding 'energy insecurity' and why it matters to health. *Soc. Sci. Med.* **167**, 1–10 (2016).
2. Hernández, D., Aratani, Y. & Jiang, Y. (2014). *Energy Insecurity among Families with Children* (National Center for Children in Poverty, 2014).
3. *Residential Energy Consumption Survey 2015)* (US Energy Information Administration, 2015).
4. Thomson, H., Bouzarovski, S. & Snell, C. Rethinking the measurement of energy poverty in Europe: a critical analysis of indicators and data. *Indoor Built Environ.* **26**, 879–901 (2017).
5. Thomson, H. & Snell, C. Quantifying the prevalence of fuel poverty across the European Union. *Energy Policy* **52**, 563–572 (2013).
6. Bouzarovski, S. & Petrova, S. A global perspective on domestic energy deprivation: overcoming the energy poverty–fuel poverty binary. *Energy Res. Soc. Sci.* **10**, 31–40 (2015).
7. Bouzarovski, S. Energy poverty in the European Union: landscapes of vulnerability. *Wiley Interdiscip. Rev. Energy Environ.* **3**, 276–289 (2014).
8. Ürge-Vorsatz, D. & Herrero, S. T. Building synergies between climate change mitigation and energy poverty alleviation. *Energy Policy* **49**, 83–90 (2012).
9. Bednar, D. J. & Reames, T. G. Recognition of and response to energy poverty in the United States. *Nat. Energy* **5**, 432–439 (2020).
10. Meder, B., Le Lec, F. & Osman, M. Decision making in uncertain times: what can cognitive and decision sciences say about or learn from economic crises? *Trends Cogn. Sci.* **17**, 257–260 (2013).
11. Levy, R. & Sledge, J. *A Complex Portrait: An Examination of Small-Dollar Credit Consumers* (Center for Financial Services Innovation, 2012).
12. Campbell, R. B. *Home Fires Involving Heating Equipment* (National Fire Protection Association, 2016).
13. Bhattacharya, J., DeLeire, T., Haider, S. & Currie, J. Heat or eat? Cold-weather shocks and nutrition in poor American families. *Am. J. Public Health* **93**, 1149–1154 (2003).
14. Bohr, J. & McCreery, A. C. Do energy burdens contribute to economic poverty in the United States? A panel analysis. *Soc. Forces* **99**, 155–177 (2020).
15. Liddell, C. & Morris, C. Fuel poverty and human health: a review of recent evidence. *Energy Policy* **38**, 2987–2997 (2010).
16. Mendell, M. J., Mirer, A. G., Cheung, K., Tong, M. & Douwes, J. Respiratory and allergic health effects of dampness, mold, and dampness-related agents: a review of the epidemiologic evidence. *Environ. Health Perspect.* **119**, 748–756 (2011).
17. Shenassa, E. D., Daskalakis, C., Liebhaber, A., Braubach, M. & Brown, M. Dampness and mold in the home and depression: an examination of mold-related illness and perceived control of one's home as possible depression pathways. *Am. J. Public Health* **97**, 1893–1899 (2007).
18. Hernández, D. & Siegel, E. Energy insecurity and its ill health effects: a community perspective on the energy–health nexus in New York City. *Energy Res. Soc. Sci.* **47**, 78–83 (2019).
19. Berko, J., Ingram, D. D., Saha, S. & Parker, J. D. *Deaths Attributed to Heat, Cold, and Other Weather Events in the United States, 2006–2010* Report 76 (National Center for Health Statistics, Centers for Disease Control and Prevention, US Department of Health and Human Services, 2014).
20. Cook, J. T. et al. A brief indicator of household energy security: associations with food security, child health, and child development in US infants and toddlers. *Pediatrics* **122**, e867–e875 (2008).
21. Frank, D. A. et al. Heat or eat: the Low Income Home Energy Assistance Program and nutritional and health risks among children less than 3 years of age. *Pediatrics* **118**, e1293–e1302 (2006).
22. Nord, M. & Kantor, L. S. Seasonal variation in food insecurity is associated with heating and cooling costs among low-income elderly Americans. *J. Nutr.* **136**, 2939–2944 (2006).
23. Snyder, L. P. & Baker, C. A. Affordable home energy and health: making the connections. *AARP Public Policy Inst.* **1**, 5–36 (2010).
24. Garg, S. et al. Hospitalization rates and characteristics of patients hospitalized with laboratory-confirmed coronavirus disease 2019—COVID-NET, 14 States, March 1–30, 2020. *Morbid. Mortal Wkly Rep.* **69**, 458–464 (2020).
25. Thebault, R., Ba Tran, A., Williams, V. The coronavirus is infecting and killing black Americans at an alarmingly high rate. *Washington Post* (7 April 2020).
26. Oppel Jr, R., Gebeloff, R. Lai, K., Wright, W., Smith, M. (2020). The Fullest Look Yet at the Racial inequity of Coronavirus. *New York Times* (5 July 2020)
27. Collins, C., Landivar, L. C., Ruppanner, L. & Scarborough, W. J. (2020). COVID-19 and the Gender Gap in Work Hours. *Gend. Work Organ.* https://doi.org/10.1111/gwao.12506 (2020).
28. Fairlie, R. W., Couch, K. & Xu, H. *The Impacts of COVID-19 on Minority Unemployment: First Evidence from April 2020 CPS Microdata* IZA DP no. 13264 (IZA Institute of Labor Economics, 2020).
29. Montenovo, L. et al. *Determinants of Disparities in COVID-19 Job Losses* Working Paper 27132 (National Bureau of Economic Research, 2020).
30. Carley, S. & Konisky, D. M. The justice and equity implications of the clean energy transition. *Nat. Energy* **5**, 569–577 (2020).
31. Jenkins, K. E., Stephens, J. C., Reames, T. G. & Hernández, D. Towards impactful energy justice research: transforming the power of academic engagement. *Energy Res. Soc. Sci.* **67**, 101510 (2020).
32. Hernández, D., Jiang, Y., Carrión, D., Phillips, D. & Aratani, Y. Housing hardship and energy insecurity among native-born and immigrant low-income families with children in the United States. *J. Child. Poverty* **22**, 77–92 (2016).
33. Mohr, T. M. Fuel poverty in the US: evidence using the 2009 residential energy consumption survey. *Energy Econ.* **74**, 360–369 (2018).
34. Reames, T. G. Targeting energy justice: exploring spatial, racial/ethnic and socioeconomic disparities in urban residential heating energy efficiency. *Energy Policy* **97**, 549–558 (2016).
35. Lyubich, E. *The Race Gap in Residential Energy Expenditures* Energy Institute WP 306 (Energy Institute at Haas, 2020).
36. Jessel, S., Sawyer, S. & Hernández, D. Energy, poverty, and health in climate change: a comprehensive review of an emerging literature. *Front. Public Health* **7**, 357 (2019).
37. Graff, M. & Carley, S. COVID-19 assistance needs to target energy insecurity. *Nat. Energy* **5**, 352–354 (2020).
38. *Gross Domestic Product, Fourth Quarter and Year 2019 (Advance Estimate)* (Bureau of Economic Analysis, 2020).
39. Min, J., Hausfather, Z. & Lin, Q. F. A high-resolution statistical model of residential energy end use characteristics for the United States. *J. Ind. Ecol.* **14**, 791–807 (2010).
40. Dubois, U. From targeting to implementation: the role of identification of fuel poor households. *Energy Policy* **49**, 107–115 (2012).
41. Santamouris, M. et al. On the relation between the energy and social characteristics of the residential sector. *Energy Build.* **39**, 893–905 (2007).
42. Pilkauskas, N. V., Currie, J. M. & Garfinkel, I. The great recession, public transfers, and material hardship. *Soc. Serv. Rev.* **86**, 401–427 (2012).
43. Huang, J., Birkenmaier, J. & Kim, Y. Job loss and unmet health care needs in the economic recession: different associations by family income. *Am. J. Public Health* **104**, e178–e183 (2014).
44. Flaherty, M., Carley, S. & Konisky, D. M. Electric utility disconnection policy and vulnerable populations. *Electr. J.* **33**, 106859 (2020).
45. Lewis, J., Hernández, D. & Geronimus, A. Energy efficiency as energy justice: addressing racial inequities through investments in people and places. *Energ. Effic.* **13**, 419–423 (2020).

46. Seefeldt, K. S. Constant consumption smoothing, limited investments, and few repayments: the role of debt in the financial lives of economically vulnerable families. *Soc. Serv. Rev.* **89**, 263–300 (2015).
47. Vavreck, L. & Rivers, D. The 2006 cooperative congressional election study. *J. Elect. Public Opin. Parties* **18**, 355–366 (2008).
48. Ansolabehere, S. & Rivers, D. Cooperative survey research. *Annu. Rev. Political Sci.* **16**, 307–329 (2013).
49. Ansolabehere, S. & Schaffner, B. F. Does survey mode still matter? Findings from a 2010 multi-mode comparison. *Political Anal.* **22**, 285–303 (2014).
50. Ross, L., Drehobl, A. & Stickles, B. *The High Cost of Energy in Rural America: Household Energy Burdens and Opportunities for Energy Efficiency* (American Council for an Energy Efficient Economy, 2018).
51. She, P. & Livermore, G. A. Material hardship, poverty, and disability among working-age adults. *Soc. Sci. Q.* **88**, 970–989 (2007).
52. Karpman, M., Gonzalez, D., Zuckerman, S. & Adams, G. *What Explains the Widespread Material Hardship among Low-Income Families with Children?* (Urban Institute, 2018).
53. Memmott, T., Konisky, D., Carley, S. & Graff, M. *Replication Data for: Sociodemographic Disparities in Energy Insecurity among Low-Income Households Before and During the COVID-19 Pandemic* (Harvard Dataverse, 2020); https://doi.org/10.7910/DVN/OMJWNB
54. *Distribution of Total Population by Federal Poverty Level* (Kaiser Family Foundation, 2018).

Acknowledgements

We thank D. Hernández for sharing her survey instrument on energy insecurity, which informed our own survey design. This research was supported through funding provided by the National Science Foundation, the Alfred P. Sloan Foundation, the Environmental Resilience Institute, funded by Indiana University's Prepared for Environmental Change Grand Challenge initiative, and the Indiana University's Office of the Vice President of Research.

Author contributions

All the authors contributed to the conceptualization, research design, analysis and writing of this article.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary information is available for this paper at https://doi.org/10.1038/s41560-020-00763-9.

Correspondence and requests for materials should be addressed to S.C.

Peer review information *Nature Energy* thanks Stefan Bouzarovski, Lee White and the other, anonymous, reviewer(s) for their contribution to the peer review of this work.

Reprints and permissions information is available at www.nature.com/reprints.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

nature research

Corresponding author(s): Sanya Carley

Last updated by author(s): Nov 23, 2020

Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Research policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed	
☐	☒	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒	The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☐	☒	A description of all covariates tested
☐	☒	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒	A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒	For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☒	☐	Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	All data collection is open source and can be found at: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/OMJWNB
Data analysis	All data analysis is open source and can be found at: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/OMJWNB

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

Data and associated materials used in this study are available in the Harvard Dataverse repository, including the original survey data and codebook, the STATA data processing do-file, and the STATA data analysis do-file. Replication sources can be found at: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/OMJWNB

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☒ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	A quantitative cross-sectional study of energy insecurity before and during the COVID-19 pandemic
Research sample	A nationally representative sample of 2,381 respondents at or below 200% of the Federal Poverty Line.
Sampling strategy	The survey was fielded through YouGov, which generates representative samples using a matched sample methodology. YouGov develops a target population from general population studies, from which it draws a random set of respondents to create a target sample.
Data collection	The survey was fielded in an online format through a contract with YouGov.
Timing	The survey was administered between April 30 and May 25, 2020.
Data exclusions	No data were excluded.
Non-participation	No participants dropped out/declined participation.
Randomization	N/A

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☐	☐ Antibodies
☐	☐ Eukaryotic cell lines
☐	☐ Palaeontology and archaeology
☐	☐ Animals and other organisms
☐	☐ Human research participants
☐	☐ Clinical data
☐	☐ Dual use research of concern

Methods

n/a	Involved in the study
☐	☐ ChIP-seq
☐	☐ Flow cytometry
☐	☐ MRI-based neuroimaging

Antibodies

Antibodies used	*Describe all antibodies used in the study; as applicable, provide supplier name, catalog number, clone name, and lot number.*
Validation	*Describe the validation of each primary antibody for the species and application, noting any validation statements on the manufacturer's website, relevant citations, antibody profiles in online databases, or data provided in the manuscript.*

Eukaryotic cell lines

Policy information about cell lines

Cell line source(s)	*State the source of each cell line used.*
Authentication	*Describe the authentication procedures for each cell line used OR declare that none of the cell lines used were authenticated.*
Mycoplasma contamination	*Confirm that all cell lines tested negative for mycoplasma contamination OR describe the results of the testing for mycoplasma contamination OR declare that the cell lines were not tested for mycoplasma contamination.*

Commonly misidentified lines
(See ICLAC register)

Name any commonly misidentified cell lines used in the study and provide a rationale for their use.

Palaeontology and Archaeology

Specimen provenance

Provide provenance information for specimens and describe permits that were obtained for the work (including the name of the issuing authority, the date of issue, and any identifying information).

Specimen deposition

Indicate where the specimens have been deposited to permit free access by other researchers.

Dating methods

If new dates are provided, describe how they were obtained (e.g. collection, storage, sample pretreatment and measurement), where they were obtained (i.e. lab name), the calibration program and the protocol for quality assurance OR state that no new dates are provided.

☐ Tick this box to confirm that the raw and calibrated dates are available in the paper or in Supplementary Information.

Ethics oversight

Identify the organization(s) that approved or provided guidance on the study protocol, OR state that no ethical approval or guidance was required and explain why not.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Animals and other organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research

Laboratory animals

For laboratory animals, report species, strain, sex and age OR state that the study did not involve laboratory animals.

Wild animals

Provide details on animals observed in or captured in the field; report species, sex and age where possible. Describe how animals were caught and transported and what happened to captive animals after the study (if killed, explain why and describe method; if released, say where and when) OR state that the study did not involve wild animals.

Field-collected samples

For laboratory work with field-collected samples, describe all relevant parameters such as housing, maintenance, temperature, photoperiod and end-of-experiment protocol OR state that the study did not involve samples collected from the field.

Ethics oversight

Identify the organization(s) that approved or provided guidance on the study protocol, OR state that no ethical approval or guidance was required and explain why not.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Human research participants

Policy information about studies involving human research participants

Population characteristics

Describe the covariate-relevant population characteristics of the human research participants (e.g. age, gender, genotypic information, past and current diagnosis and treatment categories). If you filled out the behavioural & social sciences study design questions and have nothing to add here, write "See above."

Recruitment

Describe how participants were recruited. Outline any potential self-selection bias or other biases that may be present and how these are likely to impact results.

Ethics oversight

Identify the organization(s) that approved the study protocol.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Clinical data

Policy information about clinical studies

All manuscripts should comply with the ICMJE guidelines for publication of clinical research and a completed CONSORT checklist must be included with all submissions.

Clinical trial registration

Provide the trial registration number from ClinicalTrials.gov or an equivalent agency.

Study protocol

Note where the full trial protocol can be accessed OR if not available, explain why.

Data collection

Describe the settings and locales of data collection, noting the time periods of recruitment and data collection.

Outcomes

Describe how you pre-defined primary and secondary outcome measures and how you assessed these measures.

Dual use research of concern

Policy information about dual use research of concern

Hazards

Could the accidental, deliberate or reckless misuse of agents or technologies generated in the work, or the application of information presented in the manuscript, pose a threat to:

No	Yes	
☐	☐	Public health
☐	☐	National security
☐	☐	Crops and/or livestock
☐	☐	Ecosystems
☐	☐	Any other significant area

Experiments of concern

Does the work involve any of these experiments of concern:

No	Yes	
☐	☐	Demonstrate how to render a vaccine ineffective
☐	☐	Confer resistance to therapeutically useful antibiotics or antiviral agents
☐	☐	Enhance the virulence of a pathogen or render a nonpathogen virulent
☐	☐	Increase transmissibility of a pathogen
☐	☐	Alter the host range of a pathogen
☐	☐	Enable evasion of diagnostic/detection modalities
☐	☐	Enable the weaponization of a biological agent or toxin
☐	☐	Any other potentially harmful combination of experiments and agents

ChIP-seq

Data deposition

☐ Confirm that both raw and final processed data have been deposited in a public database such as GEO.

☐ Confirm that you have deposited or provided access to graph files (e.g. BED files) for the called peaks.

Data access links *May remain private before publication.*	*For "Initial submission" or "Revised version" documents, provide reviewer access links. For your "Final submission" document, provide a link to the deposited data.*
Files in database submission	*Provide a list of all files available in the database submission.*
Genome browser session (e.g. UCSC)	*Provide a link to an anonymized genome browser session for "Initial submission" and "Revised version" documents only, to enable peer review. Write "no longer applicable" for "Final submission" documents.*

Methodology

Replicates	*Describe the experimental replicates, specifying number, type and replicate agreement.*
Sequencing depth	*Describe the sequencing depth for each experiment, providing the total number of reads, uniquely mapped reads, length of reads and whether they were paired- or single-end.*
Antibodies	*Describe the antibodies used for the ChIP-seq experiments; as applicable, provide supplier name, catalog number, clone name, and lot number.*
Peak calling parameters	*Specify the command line program and parameters used for read mapping and peak calling, including the ChIP, control and index files used.*
Data quality	*Describe the methods used to ensure data quality in full detail, including how many peaks are at FDR 5% and above 5-fold enrichment.*
Software	*Describe the software used to collect and analyze the ChIP-seq data. For custom code that has been deposited into a community repository, provide accession details.*

Flow Cytometry

Plots

Confirm that:

☐ The axis labels state the marker and fluorochrome used (e.g. CD4-FITC).

☐ The axis scales are clearly visible. Include numbers along axes only for bottom left plot of group (a 'group' is an analysis of identical markers).

☐ All plots are contour plots with outliers or pseudocolor plots.

☐ A numerical value for number of cells or percentage (with statistics) is provided.

Methodology

Sample preparation	*Describe the sample preparation, detailing the biological source of the cells and any tissue processing steps used.*
Instrument	*Identify the instrument used for data collection, specifying make and model number.*
Software	*Describe the software used to collect and analyze the flow cytometry data. For custom code that has been deposited into a community repository, provide accession details.*
Cell population abundance	*Describe the abundance of the relevant cell populations within post-sort fractions, providing details on the purity of the samples and how it was determined.*
Gating strategy	*Describe the gating strategy used for all relevant experiments, specifying the preliminary FSC/SSC gates of the starting cell population, indicating where boundaries between "positive" and "negative" staining cell populations are defined.*

☐ Tick this box to confirm that a figure exemplifying the gating strategy is provided in the Supplementary Information.

Magnetic resonance imaging

Experimental design

Design type	*Indicate task or resting state; event-related or block design.*
Design specifications	*Specify the number of blocks, trials or experimental units per session and/or subject, and specify the length of each trial or block (if trials are blocked) and interval between trials.*
Behavioral performance measures	*State number and/or type of variables recorded (e.g. correct button press, response time) and what statistics were used to establish that the subjects were performing the task as expected (e.g. mean, range, and/or standard deviation across subjects).*

Acquisition

Imaging type(s)	*Specify: functional, structural, diffusion, perfusion.*
Field strength	*Specify in Tesla*
Sequence & imaging parameters	*Specify the pulse sequence type (gradient echo, spin echo, etc.), imaging type (EPI, spiral, etc.), field of view, matrix size, slice thickness, orientation and TE/TR/flip angle.*
Area of acquisition	*State whether a whole brain scan was used OR define the area of acquisition, describing how the region was determined.*

Diffusion MRI ☐ Used ☐ Not used

Preprocessing

Preprocessing software	*Provide detail on software version and revision number and on specific parameters (model/functions, brain extraction, segmentation, smoothing kernel size, etc.).*
Normalization	*If data were normalized/standardized, describe the approach(es): specify linear or non-linear and define image types used for transformation OR indicate that data were not normalized and explain rationale for lack of normalization.*
Normalization template	*Describe the template used for normalization/transformation, specifying subject space or group standardized space (e.g. original Talairach, MNI305, ICBM152) OR indicate that the data were not normalized.*
Noise and artifact removal	*Describe your procedure(s) for artifact and structured noise removal, specifying motion parameters, tissue signals and physiological signals (heart rate, respiration).*

Volume censoring — *Define your software and/or method and criteria for volume censoring, and state the extent of such censoring.*

Statistical modeling & inference

Model type and settings — *Specify type (mass univariate, multivariate, RSA, predictive, etc.) and describe essential details of the model at the first and second levels (e.g. fixed, random or mixed effects; drift or auto-correlation).*

Effect(s) tested — *Define precise effect in terms of the task or stimulus conditions instead of psychological concepts and indicate whether ANOVA or factorial designs were used.*

Specify type of analysis: ☐ Whole brain ☐ ROI-based ☐ Both

Statistic type for inference (See Eklund et al. 2016) — *Specify voxel-wise or cluster-wise and report all relevant parameters for cluster-wise methods.*

Correction — *Describe the type of correction and how it is obtained for multiple comparisons (e.g. FWE, FDR, permutation or Monte Carlo).*

Models & analysis

n/a	Involved in the study
☐	☐ Functional and/or effective connectivity
☐	☐ Graph analysis
☐	☐ Multivariate modeling or predictive analysis

Functional and/or effective connectivity — *Report the measures of dependence used and the model details (e.g. Pearson correlation, partial correlation, mutual information).*

Graph analysis — *Report the dependent variable and connectivity measure, specifying weighted graph or binarized graph, subject- or group-level, and the global and/or node summaries used (e.g. clustering coefficient, efficiency, etc.).*

Multivariate modeling and predictive analysis — *Specify independent variables, features extraction and dimension reduction, model, training and evaluation metrics.*

Community Organizing and Family Issues (COFI)
and Legal Action Chicago
Ex. 1.0 (CORR)

State of Illinois

Illinois Commerce Commission

The Peoples Gas Light and Coke Company	)	
Proposed general increase in rates and Revisions to service classifications, riders and terms and conditions of service	)	
and	)	Docket Nos. 23-0068 / 23-0069 (cons.)
North Shore Gas Company	)	
Proposed general increase in rates and Revisions to service classifications, riders and terms and conditions of service	)	

Direct Testimony of

Roger D. Colton

On Behalf Of

Community Organizing and Family Issues (COFI)

and

Legal Action Chicago

(Corrected)

Community Organizing and Family Issues (COFI)
and Legal Action Chicago
Ex. 1.0 (CORR)

May 9, 2023

Community Organizing and Family Issues (COFI)
and Legal Action Chicago
Ex. 1.0 (CORR)

Table of Contents

Q. PLEASE STATE YOUR NAME AND ADDRESS.

A. My name is Roger Colton. My address is 34 Warwick Road, Belmont, MA 02478.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT POSITION?

A. I am the owner of the firm Fisher Sheehan & Colton, Public Finance and General Economics of Belmont, Massachusetts. In that capacity, I provide technical assistance to a variety of federal and state agencies, consumer organizations and public utilities on rate and customer service issues involving water/sewer, natural gas and electric utilities.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS PROCEEDING?

A. I am testifying on behalf of Community Organizing and Family Issues (COFI) and Legal Action Chicago, both of Chicago, Illinois. COFI's mission is to build the power and voice of parents, primarily mothers and grandmothers from Black and Brown communities, to shape the public decisions that affect their lives and the lives of their families. COFI envisions a world with racial, economic, and educational justice where all children and families have an equal opportunity to succeed in life. In addition to its Chicago-based office, COFI also has offices in Aurora, Elgin and East St. Louis.

Legal Action Chicago is a not-for-profit legal agency that focuses not on individual disputes, but on policies and systems that harm groups of people or even entire communities, with a priority on addressing racial equity. Working with and for people living in poverty, and in collaboration with community leaders, Legal Action Chicago advocates for broad positive changes through various approaches, which includes legislative initiatives, regulatory advocacy, and class action lawsuits.

Q. PLEASE DESCRIBE YOUR PROFESSIONAL BACKGROUND.

A. I work primarily on low-income utility issues. This involves regulatory work on rate and customer service issues, as well as research into low-income usage, payment patterns, and affordability programs. At present, I am working on various projects in the states of Connecticut, Maryland, Pennsylvania, Ohio, Michigan, Illinois, and Washington. My clients include state agencies (e.g., Pennsylvania Office of Consumer Advocate, Maryland Office of People's Counsel, Connecticut Office of Consumers Council), federal agencies (e.g., the U.S. Department of Health and Human Services), community-based organizations (e.g., National Housing Trust, Natural Resources Defense Council, Sierra Club), and private utilities (e.g., Toledo Water).

Not all of my work involves rate case testimony. For example, I recently completed, under contract to the City of Toledo, Ohio, a draft Water Affordability Plan for that city. In May of last year, I completed a detailed report examining the affordability of water service in Knoxville, Kentucky for a community-based organization, Knoxville Water and Energy for All (KWEA). In October of 2022, I completed an evaluation of the Electric Assistance Program (EAP) for the New Hampshire Public Utilities Commission.

In addition to state-specific and utility-specific work, I engage in national work throughout the United States. For example, in 2020, I represented a coalition of major national consumer organizations to comment on the Environmental Protection Agency's proposed framework by which to judge community financial capability. I also continue to be "Of Counsel" to the National Coalition for Legislation on Affordable Water

(NCLA-Water). A brief description of my professional background is provided in Appendix A.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND.

A. After receiving my undergraduate degree in 1975 (Iowa State University), I obtained further training in both law and economics. I received my law degree in 1981 from the University of Florida. I received my Master's Degree in Regulatory Economics from the MacGregor School at Antioch University in 1993.

Q. HAVE YOU EVER PUBLISHED ON PUBLIC UTILITY REGULATORY ISSUES?

A. Yes. I have published three books and more than 80 articles in scholarly and trade journals, primarily on low-income utility and housing issues. I have published three times that number of technical reports for various clients on energy, water, telecommunications and other associated low-income utility issues. My most recent publication (2018) was a chapter in a book published by the London-based Edward Elgar Publishing, which book was titled "Energy Justice: US and International Perspectives." My chapter, "The equities of efficiency: distributing energy usage reduction dollars," set forth a methodology grounded in law and economics by which to objectively measure whether utility investments in energy efficiency are being equitably distributed.

Q. HAVE YOU EVER TESTIFIED BEFORE THIS OR OTHER UTILITY COMMISSIONS?

A. Yes. I have testified before the Illinois Commerce Commission ("ICC" or "Commission") on several occasions over the past 35 years on issues affecting universal service and customer service for electric, natural gas, and water providers. Most recently, I testified on behalf the Office of the Attorney General in the 2018 uncollectible reconciliation proceedings involving Commonwealth Edison (Docket No. 18-1456), Ameren Energy (Docket No. 18-1486), Nicor Gas (Docket No. 18-1437), and Peoples Gas/North Shore Gas (Docket Ns. 18-1464 / 18-1465). I also previously worked as an attorney for the Illinois Governor's Office of Consumer Services (GOCS).

Overall, I have testified before state utility regulatory commissions on more than 320 occasions regarding utility issues affecting low-income customers and customer service. I have testified in regulatory proceedings in 43 states and various Canadian provinces on a wide range of utility issues. A list of the jurisdictions in which I have testified as an expert witness is listed in Appendix A.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my Direct Testimony is to examine and respond to the Company's proposed low-income discount rate and rate design in this proceeding. In my testimony, I examine:

- the affordability of the natural gas rates of Peoples Gas Light and Coke Company and North Shore Gas Company for each company's low-income customers;
- the relationship between low-income bill affordability and a range of traditional utility regulatory policies, including using utility rates to provide price signals; using utility rates to encourage the efficient use of energy; and promoting efficient and effective collections practices;

- a set of reasonable modifications to PGL/NSG's proposed low-income discounts that will better promote affordability and, by extension, will better achieve the identified traditional utility regulatory objectives; and

- the Companies' current and proposed residential customer charges, and propose modifications that better align with affordability principles.

Q. PLEASE SUMMARIZE THE RECOMMENDATIONS YOU MAKE THROUGHOUT YOUR TESTIMONY.

A. Based on the data and analysis I present throughout my testimony, I recommend as follows:

1) The PGL and NSG low-income discounts should be comprised of five tiers rather than two tiers. The tiers should be: (1) Below 50% of FPL; (2) 50% to 100% of FPL; (3) 100% to 150% of FPL; (4) 150% to 200% of FPL; and a fifth tier not covered by the Companies' current proposal, (5) 200% to 300% of FPL.
2) The tiered discounts provided through PGL/NSG discounts should be based on the total bill.
3) The tiered discounts provided through PGL should be as follows: (1) Tier 1: 83%; (2) Tier 2: 68%; (3) Tier 3: 45%; (4) Tier 4: 20%; and (5) Tier 5: 5%. The Tiered discounts provided through NSG should be as follows: (1) Tier 1: 79%; (2) Tier 2: 60%; (3) Tier 3: 36%; (4) Tier 4: 12%; and (5) Tier 5: 5%.
4) For those customers at or below 200% of FPL, tiered discounts provided through PGL/NSG should be applied to customers who are income-*eligible* for LIHEAP, rather than limited to customers who are current *participants* in a LIHEAP program.

5) The Companies' proposed increases to the customer charge portion of the bill take a higher proportion of household resources out of monthly incomes, and make it more difficult for low-income customers to control their exposure to unaffordable bills through the implementation of energy efficiency measures. In addition, the actions that low-income customers are forced to take as efforts to control their bills (e.g., keeping their homes too hot or too cold, shutting off their home but for a limited space) have less of an impact on reducing their bills to more affordable levels the higher the fixed customer charge. In any rate order approved in this proceeding, the Commission should not increase the customer charge and, in fact, should reduce the percentage of revenues collected through the customer charge over the levels the Companies now collect.

This is a summary of my recommendations. Each recommendation is presented in more detail in the body of my testimony.

Part 1. The Affordability of PGL/NSG Natural Gas Service.

Q. PLEASE EXPLAIN THE PURPOSE OF THIS SECTION OF YOUR TESTIMONY.

A. In this section of my testimony, I assess the ongoing affordability of natural gas service provided by Peoples Gas Light and Coke Company (hereafter "PGL" or "Peoples") and North Shore Gas Company (hereafter "NSG" or "North Shore").

Q. HAVE YOU HAD OCCASION TO REVIEW THE HISTORY OF PGL'S AND NSG'S RESIDENTIAL BILLS?

A. Yes. I have reviewed average PGL and NSG residential bills as reported in the Commission's annual "Comparison of Gas Sales Statistics." I have set forth in the Chart below the data reported by the Commission for each year from 2013 through 2021 (the last year for which the Commission has published data). As can be seen, there was a short-term spike in PGL bills in 2014 (to $1,478). Even setting aside that short-term spike, PGL bills have consistently been higher than average natural gas bills for the State as a whole. In 2021, PGL bills were nearly 20% higher than the statewide average. From 2013 through 2019, PGL's residential bills were consistently between 30% and 45% higher than the statewide average.

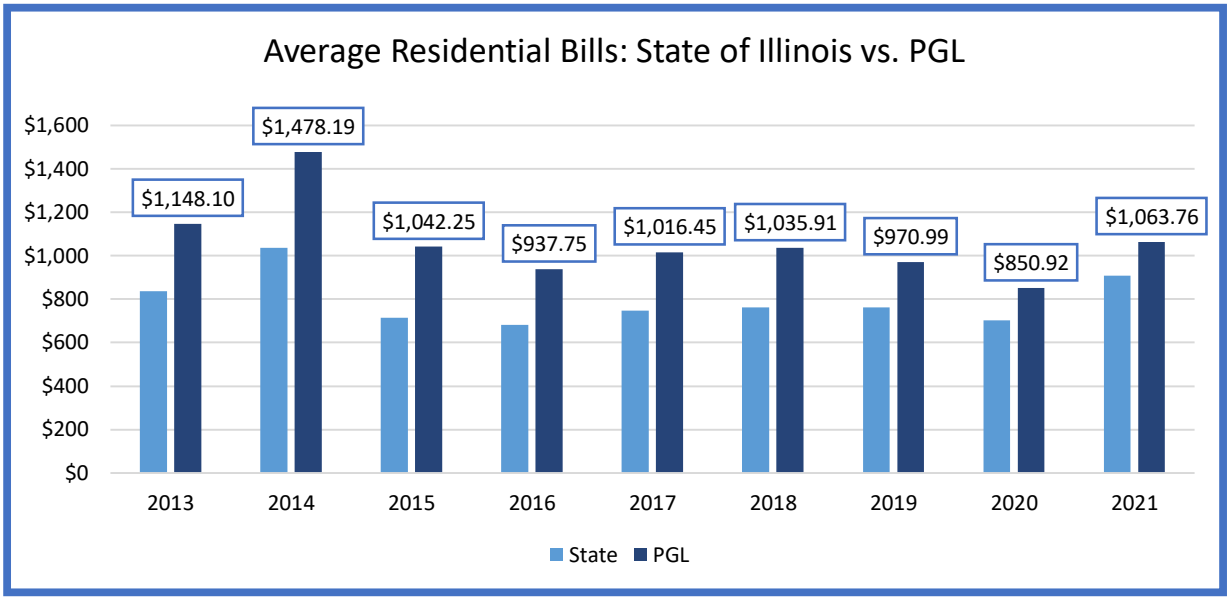
I compare these trends in bills to low-income status in the PGL and NSG service territories. More specifically, I examine the First Quintile (Q1) of Income for the zip codes comprising each utility's service territory.[1] I matched each company's zip codes with average Q1 incomes[2] by zip code reported by the Census Bureau for 2021.[3] I

[1] The zip codes for the PGL and NSG service territories are those reported in each utility's filing of Disconnections and Credit and Collection Report filed monthly with the Commission.

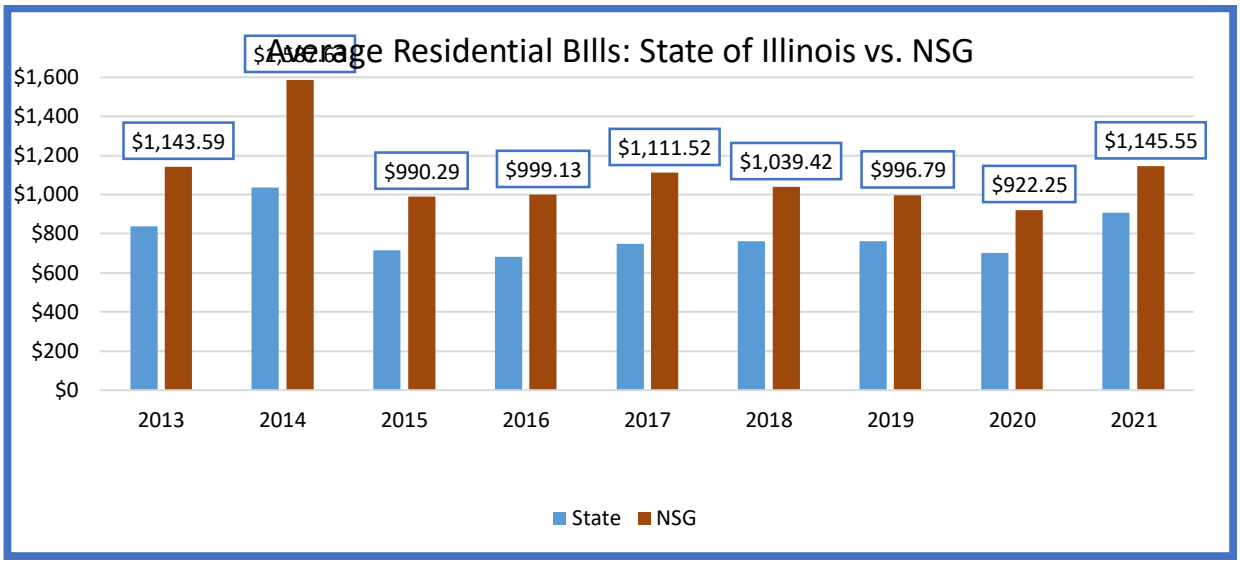
[2] American Community Survey, 5-year data, 2021, Table B19081.

[3] The Census data I use is for Zip Code Tabulation Areas (ZCTAs). ZCTAs are nearly, but not quite, identical to Zip Codes. ZCTAs are used by the U.S. Census Bureau, while Zip Codes are creatures of the U.S. Postal Service. According to the U.S. Census Bureau: "ZIP Code Tabulation Areas (ZCTAs) are generalized areal representations of United States Postal Service (USPS) ZIP Code service areas. The USPS ZIP Codes identify the individual post office or metropolitan area delivery station associated with mailing addresses. USPS ZIP Codes are not areal features but a collection of mail delivery routes. The term ZCTA was created to differentiate between this entity and true USPS ZIP Codes." For a generalized discussion of the differences between Zip Codes and ZCTA, *See* U.S. Census Bureau, *ZIP Code Tabulation Areas*, https://www.census.gov/programs-surveys/geography/guidance/geo-areas/zctas.html (last accessed May 9, 2023).

examine the zip code with the lowest Q1 income amongst PGL's and NSG's zip codes and tracked that Q1 income for the time period 2013 through 2021.



A similar trend can be seen in NSG rates. Since 2013, NSG residential bills have been higher than statewide average bills in every single year. NSG bill been at least 25% higher than statewide average residential bills in the period 2013 through 2021. From 2014 through 2017, NSG residential bills were roughly 50% higher than the statewide average residential bills. From 2018 through 2021, NSG residential bills were between 25% and 35% higher than the statewide average.

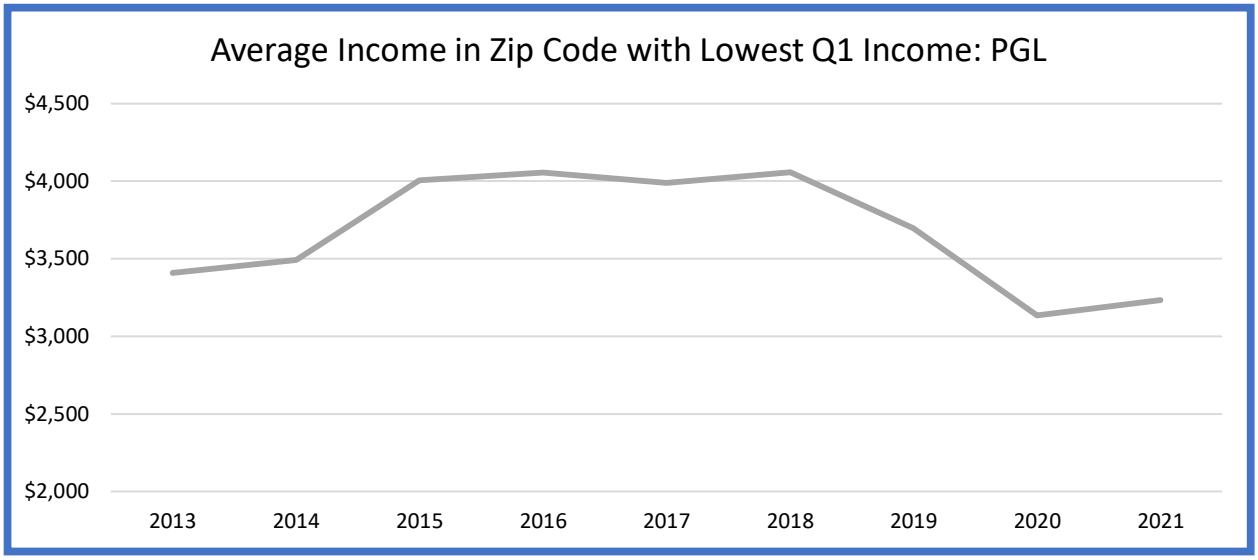


Q. HAVE YOU HAD AN OPPORTUNITY TO COMPARE THESE NATURAL GAS BILLS TO THE INCOMES OF LOWER-INCOME HOUSEHOLDS?

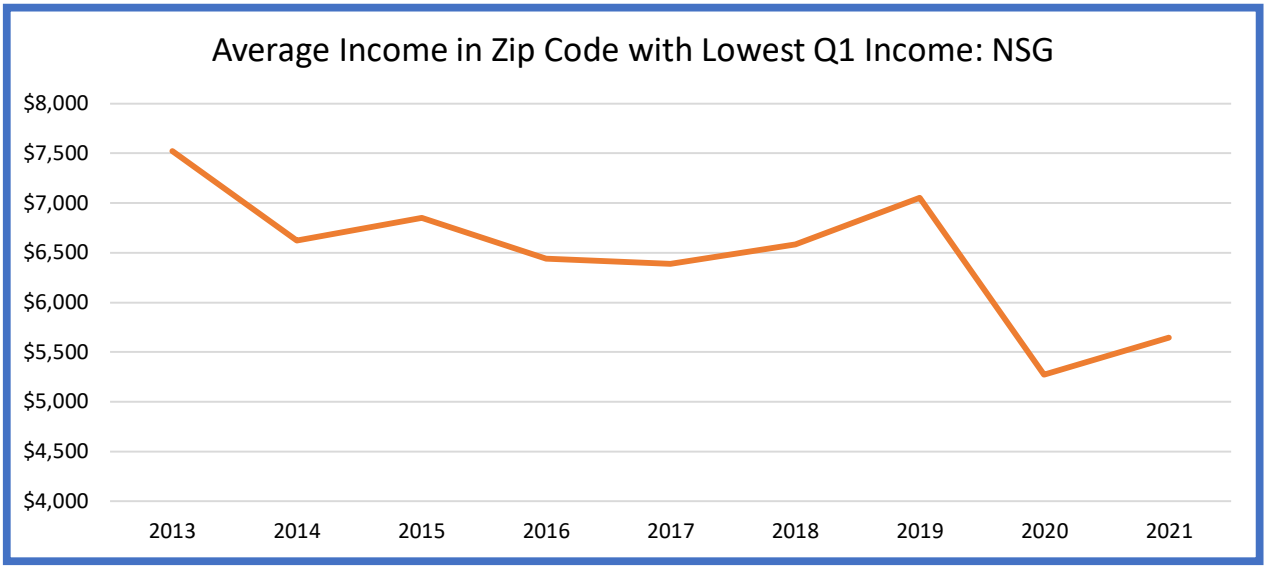
A. Yes. In the Chart below, I track the average income in the zip code with the lowest First Quintile (Q1) income[4] in the PGL service territory.[5] Two observations are evident from this data. First, the average Q1 income is lower in 2021 than it was in 2016 through 2018, even without accounting for inflation. Thus, while PGL bills were 13% higher in 2021 than they were in 2016, Q1 incomes were lower. While PGL bills increased by 25% from 2020 to 2021, Q1 incomes in the group of households with the lowest incomes served by PGW increased by only 3%.

[4] The Census Bureau rank orders households by income, from the lowest income to the highest income in each geographic area for which it publishes data. It then divides that rank ordering into five equal parts, each part of which is called a "quintile." The one-fifth of households with the lowest income is known as the First Quintile (Q1) (sometimes referred to as the Bottom Quintile), while the one-fifth of households with the highest income is known as the Fifth Quintile (sometimes referred to as the Top Quintile).

[5] U.S. Census Bureau, American Community Survey, Table B19081, 2013–2021.



The lowest incomes in the NSG service territory show an even more dramatic difference. The Chart below shows the equivalent data I discuss above, except with respect to the NSG service territory. As can be seen, in the zip code with the lowest Q1 income in the NSG service territory, the average income has seen a sharp decline since 2013. Even with the slight uptick in Q1 income in 2021 as compared to 2020, the average Q1 income in 2021 was 25% lower than it was in 2013. The average 2021 Q1 income ranged from 12% to 15% lower than the average Q1 income had been in the period 2016 through 2018.



As with PGL, there is a mismatch between the movement in NSG bills and the movement in NSG low incomes. For example, at the same time the Q1 incomes had declined by 20% (2019 through 2021), NSG bills had increased by 20% (from $997 in 2019 to $1,146 in 2021). Over the same period NSG bills had increased by 20% (2015 to 2021), NSG Q1 incomes had declined by 18%.

Finally, it is worth noting that across both PGL's and NSG's service territory, the real-world purchasing power of customers' incomes—including Q1 customers—has shrunk due to the effects of inflation. These customers' average incomes have dropped in raw dollars, while at the same time, the cost of necessary goods and services has continued to rise, particularly over the past two years.[6]

[6] U.S. Dep't of Labor, Bureau of Labor Statistics, CPI Inflation Calculator, https://www.bls.gov/data/inflation_calculator.htm (last accessed May 9, 2023); U.S. Dep't of Labor, Bureau of Labor Statistics, CPI for All Urban Consumers (CPI-U), https://data.bls.gov/timeseries/CUUR0000SA0L1E?output_view=pct_12mths (last accessed May 9, 2023).

Q. HAVE YOU EXAMINED PGL AND NSG BILL BURDENS?

A. Yes. I have examined both PGL and NSG bill burdens from two different perspectives: (1) existing rates; and (2) proposed rates. Using data provided by PGL and NSG,[7] I have examined bills as a percentage of income (i.e., "bill burdens") both at existing and at proposed rates.[8] Throughout my testimony, my reference to bill burdens or natural gas burdens references this total bill burden, unless I expressly note to the contrary. I then calculate average natural gas burdens for each zip code served by the two utilities at differing ranges of the Federal Poverty Level (given average household size in each zip code). Using data from PGL's Schedule A-3 filed in this proceeding, I calculated the average annual revenue for PGL heating customers.

PGL Annual Avg Revenue[9] (Schedule A-3, Line 3)	Current Rates	Proposed Rates
Residential Heating[10]	$1,136	$1,472

[7] (Part 1), 285 Filing (Schedules), Schedule A-3, filed pursuant to 83 Ill. Admin. Code, §285.1015.

[8] "Bill burdens" represent a simple ratio. I place the average annual bill in the numerator and the annual household income in the denominator. The resulting ratio is the "bill burden." For example, if a household has an annual bill of $1,200 and an annual income of $8,000, that household's "bill burden" is 15% ($1,200 / $8,000 = 0.15).

[9] Base rate revenues reported by the Company exclude revenue from Riders 1, and excludes ratemaking adjustments for Rider UEA, UEA-GC, ICTA, VITA and VBA. Schedule A-3.

[10] PGL reports that it has 655,786 heating customers and 92,604 non-heating customers. Accordingly, the focus in my discussion will be on natural gas heating customers.

I then use the revenues reported in NSG's Schedule A-3 filed in this proceeding to determine average annual residential heating revenues.[11]

NSG Annual Avg Revenue[12] (Schedule A-3, Line 3)	Current Rates	Proposed Rates
Residential Heating[13]	$1,261	$1,345

For purposes here, I define "affordability" to be a total home energy burden of 6%. That 6% burden has been the standard most frequently relied upon by policymakers with respect to affordable home energy.[14] The 6% burden has been frequently adopted,[15]

[11] NSG reports that it served 135,666 heating customers and 1,485 non-heating customers. Accordingly, the focus in my discussion will be on natural gas heating customers.

[12] Base rate revenues reported by the Company exclude revenue from Riders 1, and excludes ratemaking adjustments for Rider UEA, UEA-GC, ICTA, VITA and VBA. Schedule A-3.

[13] PGL reports that it has 655,786 heating customers and 92,604 non-heating customers. Accordingly, the focus in my discussion will be on natural gas heating customers.

[14] Throughout my testimony, unless I explicitly note to the contrary, the terms "home energy burdens" and "energy bill burdens" are intended to be used interchangeably.

[15] 6% is based on the recognition that total shelter costs are generally deemed to be unaffordable to the extent that they exceed 30% of income. Moreover, utility costs tend to equal 20% of total shelter costs. A multiplication of those two data points (20% times 30%) yields the 6% figure.

including in the states of Washington,[16] New Hampshire,[17] New York,[18] New Jersey,[19] and Illinois.[20] In addition, the Pennsylvania PUC has capped home energy burdens for households with annual income at or below 50% of Poverty Level at 6% of income.[21] Most recently, the Connecticut Public Utilities Regulatory Authority (PURA) held that a 6% burden for total home energy costs was the appropriate definition of affordability.[22]

Having defined an affordable ***total*** home energy burden as being equal to 6%, that burden needs to be allocated between natural gas bills and electric bills. Non-governmental organizations have also widely adopted this affordability measure.[23] I then

[16] WASH ADMIN. CODE § 194-40-030 (2021) ("'Energy assistance need' means the amount of assistance necessary to achieve an energy burden equal to six percent for utility customers").

[17] New Hampshire Pub. Utils. Comm'n, Dkt. No. DE 06-079, Order No. 24,664, 3–4 (Sept. 1, 2006). ("[T]he current [Electric Assistance Program] was designed with the goal of making electricity affordable at 4 % of gross household income for non-electric heat customers (and at 6% of income for households with electric heat).").

[18] New York Pub. Serv. Comm'n, Case 14-M-0565, *Order Adopting Low Income Program Modifications and Directing Utility Filings*, 7–48 (effective May 20, 2016) (favoring a 6% energy burden level because it appears to be a widely accepted limit for utility payments, including in New Jersey and Ohio; and also reflected by EIA data).

[19] New Jersey Dep't of Community. Affairs, *Universal Service Fund (USF)*, https://www.state.nj.us/dca/divisions/dhcr/faq/usf.html#q1 (last visited Mar. 24, 2023). (requiring USF customers who use natural gas for heating and electricity to pay 2% for their natural gas service and 2% for their electricity service. If, however, the customer uses electricity for heating, the entire 4% is devoted to the electricity service. The discount provided to customers is based on the difference between their annual utility bill (after LIHEAP is applied) and the required percentage of household income.).

[20] 305 ILCS 20/18(c)(2) (2022) (Illinois administers a percentage of income plan (PIP) that charges customers a maximum of 6% of their income for gas and electric service.).

[21] Pennsylvania Pub. Util. Comm'n, Docket M-2019-3012599, Final Policy Statement and Order, 29–31 (Sept. 19, 2019).

[22] Connecticut Pub. Util. Reg. Auth., Dkt. No. 17-12-03RE11, Decision, 2 (Oct. 19, 2022).

[23] *See e.g.*, Am. Council for an Energy-Efficient Economy, Understanding Energy Affordability, available at https://aceee.org/sites/default/files/energy-affordability.pdf (last accessed May 9, 2023); Sierra Club, Calculate Your Energy Burden, available at https://www.sierraclub.org/energy-burden-calculator (last accessed May 9, 2023).

allocate the 6% burden as 3% for electricity and 3% for natural gas, consistent with Illinois policy as expressed in the Energy Assistance Act.[24] (The Companies appear to support this allocation as well. (*See* NSG Response to JM 3.01 ("The goal [of the low-income rate proposal as the Companies structured it] was to get as many LIHEAP and PIPP customers to a point where they were paying approximately 3% of their income towards their natural gas bill.")).

Whatever specific home energy burden is ultimately used to define "affordability," however, the affordability of PGL/NSG bills should be structured to adopt the principle that it is most appropriate to measure bill affordability by reference to bills as an affordable percentage of income. The adoption of a percentage-based benchmark by various states and other actors in the utilities space, discussed above, supports this perspective. Furthermore, using a percentage of household income analysis is consistent with the approach to assessing the cost burden of other housing-relating expenses, including water/sewer, mortgages and rent. Finally, it is consistent with common sense: a good or service is not "affordable" merely because it costs five, ten, or twenty dollars; it is only "affordable" relative to a person's actual ability to purchase it within their household budget.

The results of my analysis are presented from two perspectives. First, I examine the "depth" of unaffordability. In examining the depth of Poverty, the question presented is "how unaffordable are PGL/NSG bills." Second, I examine the "breadth" of

[24] 305 ILCS 20/18(c)(2) (2022) ("If the [PIPP program] participant takes both gas and electric service, 50% of the credit shall be allocated to the entity that provides the participant's primary energy suppl for heating.")

unaffordability. In examining the breadth of unaffordability, I examine the question "how prevalent are unaffordable PGL/NSG bills."

Q. WHAT DO YOU FIND REGARDING THE DEPTH OF PGL/NSG UNAFFORDABILITY?

A. Table 1 presents a summary of the depth of PGL/NSG unaffordability. For both utilities, customers with income at or below 50% of Poverty have bill burdens more than four times higher than the affordable level (of 3%). Not surprisingly, as incomes increase, the depth of unaffordability declines. By the time incomes reach between 100% and 150% of Poverty, the bill burden is only 1.5 times higher than that which is affordable. By the time incomes reach between 150% and 200% of Poverty, both NSG and PGL bill burdens reach 3.1% (both remaining higher than the affordable level).

Table 1. Average PGL/NSG Bill Burdens at Selected Poverty Ranges (Existing Rates)

PGL Bill Burdens			
0 – 50% FPL	50 – 100% FPL	100 – 150% FPL	150 – 200% FPL
13.4%	7.2%	4.3%	3.1%
NSG Bill Burdens			
0 – 50% FPL	50 – 100% FPL	100 – 150% FPL	150 – 200% FPL
13.6%	7.3%	4.4%	3.1%

Both utilities, however, propose substantial rate hikes in this proceeding. The Table below shows the extent to which the affordability of natural gas burdens in each service territory will decline even further given those rate increases. PGL bill burdens climb even higher than NSG burdens do— nearly six times higher than that which is

deemed to be affordable at incomes less than 50% of Poverty. Bills for both PGL and NSG remain substantially in excess of an affordable burden for both natural gas utilities.

Table 2. Average PGL/NSG Bill Burdens at Selected Poverty Ranges (Proposed Rates)

PGL Bill Burdens			
0 – 50% FPL	50 – 100% FPL	100 – 150% FPL	150 – 200% FPL
17.4%	9.3%	5.6%	4.0%
NSG Bill Burdens			
0 – 50% FPL	50 – 100% FPL	100 – 150% FPL	150 – 200% FPL
14.5%	7.8%	4.7%	3.3%

Q. WHAT DO YOU FIND REGARDING THE BREADTH OF PGL/NSG UNAFFORDABILITY?

A. The Tables above show only the ***depth*** of unaffordability in the PGL/NSG service territories. The ***breadth*** of unaffordability is shown in Table 3 (PGL) and Table 4 (NSG) below. My focus in these Tables is on burdens at the proposed rates of the two respective utilities. The Tables show the unreasonable burdens that would be imposed on the low-income customers in the PGL and NSG service territories at the rates proposed in this proceeding.

Of the 56 zip codes studied in the PGL service territory, average PGL burdens fell between 13% and 23% of income for households with income less than 50% of Poverty at proposed rates. In the vast majority of zip codes, average PGL bill burdens fell between 15% and 20% of income (41 of 56 zip codes). No PGL zip code had a burden exceeding 23% at proposed rates, and no zip code had a burden of less than 13 at proposed rates.

As would be expected, as incomes increase, the PGL/NSG burdens decline. Even with the decline, PGL/NSG burdens never reach an affordable level. At incomes between 50% and 100% of Poverty, average NSG burdens are between 7% and 12% of income. At incomes between 100% and 150% of Poverty, natural gas burdens are between 4% and 5% of income in 55 of PGL's 56 zip codes.

Table 3. PGL Natural Gas Bill Burdens at Proposed Rates and Selected Ranges of Federal Poverty Level (FPL)

<50% FPL		*50 – 100% FPL*		*100 – 150% FPL*		*150 – 200% FPL*	
Burden	*No. Zip Codes*	*Burden*	*No. Zip Codes*	*Burden*	*No. Zip Codes*	*Burden*	*No. Zip Codes*
<13%	*0*	*<7%*	*0*	*<4%*	*0*	*<3%*	*0*
13-14%	*2*	*7-8%*	*6*	*4-5%*	*14*	*3-4%*	*32*
14-15%	*4*	*8-9%*	*21*	*5-6%*	*27*	*4-5%*	*23*
15-16%	*13*	*9-10%*	*14*	*6-7%*	*14*	*5-6%*	*1*
16-17%	*9*	*10-11%*	*8*	*7-8%*	*1*	*>6%*	*0*
17-18%	*6*	*11-12%*	*7*	*>8%*	*0*		
18-19%	*8*	*>12%*	*0*				
19-20%	*5*						
20-21%	*5*						
21-22%	*3*						
22-23%	*1*						
>23%	*0*						

The range of unaffordable burdens is narrower for NSG, a not surprising result given its smaller service territory and customer base. For customers with income less than 50% of FPL, no zip code had an average NSG burden in excess of 17%, but no zip code had an average burden of less than 12% of income. By the time incomes had increased to between 150% and 200% of income, 27 of the 28 zip codes studied had average burdens

of between 3% and 4% of income. The intermediate ranges of FPL had burdens falling between those two ends of the continuum of burdens for low-income customers, with maximum burdens for customers at 50% to 100% of Poverty not exceeding 9% of income, and maximum burdens for customers at 100% to 150% of Poverty not exceeding 6% of income.

Table 4. NSG Natural Gas Bill Burdens at Proposed Rates and Selected Ranges of Federal Poverty Level (FPL)

<50% FPL		*50 – 100% FPL*		*100 – 150% FPL*		*150 – 200% FPL*	
Burden	*No. Zip Codes*	*Burden*	*No. Zip Codes*	*Burden*	*No. Zip Codes*	*Burden*	*No. Zip Codes*
<12%	*0*	*<6%*	*0*	*<4%*	*0*	*<2%*	*0*
12-13%	*1*	*6-7%*	*1*	*4-5%*	*26*	*2-3%*	*1*
13-14%	*4*	*7-8%*	*20*	*5-6%*	*2*	*3-4%*	*27*
14-15%	*16*	*8-9%*	*7*	*>6%*	*0*	*>4%*	*0*
15-16%	*6*	*>9%*	*0*				
16-17%	*1*						
>17	*0*						

Even the burdens at the higher income ranges give rise for concern. Given that these burdens are calculated using the mid-point of the FPL tier, and at average bills, the burdens for these FPL tiers could easily exceed the percentage of income deemed to be affordable.

Q. ARE THERE SUBSTANTIAL NUMBERS OF CUSTOMERS AFFECTED BY THESE HIGH ELECTRIC BURDENS IN THE SELECTED POVERTY RANGES YOU EXAMINED IN THE PGL AND NSG ELECTRIC SERVICE TERRITORIES?

A. Yes. I estimate that there are 282,634 customers with income at or below 200% of the Federal Poverty Level in the PGL service territory and 29,544 in the NSG service territory. I estimate this number by multiplying the Census Bureau's percentage of population at the selected Poverty ranges[25] in each zip code times the total number of customers in each zip code as reported by the two utilities. Of the PGL customers with income at or below 200% of FPL, I estimate that 23.0% have income less than 50% of FPL, 25.8%% have income between 50% and 100% of FPL, 26.2% have income between 100% and 150% of FPL, and 25.1% have income between 150% and 200% of Poverty. I estimate a smaller proportion of NSG customers falling in the lowest range of FPL, with an estimated 18.3% having income below 50% of Poverty; 19.3% having income between 50% and 100% of Poverty; 32.4% having income between 100% and 150% of Poverty; and 30.1% having income between 150% and 200% of Poverty.

[25] U.S. Census Bureau, American Community Survey, 5-year data, Table C17002.

Rahul Agrawal Bejarano

(734) 679 8503 | 3725 Macomb St NW, APT 509, Washington, DC, 20016 | rahulab@umich.edu

EDUCATION

University of Michigan, School of Environment and Sustainability — Graduated May '22
- Master of Science – concentration in Sustainable Systems, GPA: 4.00

University of Michigan, College of Engineering – BSE - Cum Laude — Graduated May '20
- Major: Computer Science, Minor: International Engineering

RESEARCH EXPERIENCE

Lead Data Scientist – Energy Equity Project, University of Michigan — Ann Arbor, MI, May '21 - Present
- Developing and adjusting a set of indices and metrics to evaluate energy equity in the US, based on stakeholder feedback (100+ responses)
- Surveying practitioners, regulators, community members, utilities, and philanthropists (100 + representatives), to assess their priorities and challenges evaluating energy equity
- Creating a series of vector based maps to highlight energy equity across the US at a state, county and census tract level

Seafood and Food Security Data Scientist, American University — Washington D.C, May '22- Present
- Developing the ARTIS seafood supply chain database, mapping global seafood trade from production through trade to consumption.
- Designed and maintained ARTIS API for distribution of ARTIS data
- Developed an R pipeline to automatically generate country, species and product reports

Researcher – Seafood Globalization Lab, American University — Washington D.C, May '20 – May '22
- Leading a research project investigating the relationships between global seafood trade with the US and news coverage, using US Trade Census data and the GDELT news repository
- Developed a web application that searches newspaper articles worldwide and summarizes results with interactive data visualizations
- Created a database of US seafood imports, highlighting transport, species, product, and country to estimate their transportation GHG emissions

Research Assistant – SEAS, University of Michigan — Ann Arbor, MI, August '21 - Present
- Developing an R Shiny web application, using GIS maps, that allows users to simulate the impacts of urban development and greening projects around the Great Lakes Region

Researcher – School of Information, University of Michigan — Ann Arbor, MI, May '19 – Nov '20
- Evaluated a coding curriculum (based in web scraping) for non-CS majors using Eccles expectancy value theory, and steps to completion
- Created a script that scraped 20 million+ Github repositories to retrieve current ways/examples of industry experts using web scraping
- Developed scripts to visualize and analyze the impact of gender, SES, and prior experience in participant survey data
- Analyzed and coded interview transcripts to discover trends that refer to identity as a barrier to future class involvement

OTHER EXPERIENCE

Midwest Big Data Hub — Ann Arbor, MI, May '21 – Present

Data Science and Software Engineering Consultant
- Managing current fellows' projects and advising in the Curricular Innovation Program, specifically on how to create effective environment data tools that communicate a clear data narrative
- Composed a tutorial series on web development, using R Shiny, targeted towards researchers with very little to no coding experience, with the goal of having them develop a complete web application within 2 hours

Curricular Innovation Program Fellow — Feb '21 – May '21
- Developed an accessible data analytics platform for undergraduates (100+, at 2 universities) to test their own hypotheses using Serengeti Snapshot data from Zooniverse

	Software Developer – Harvard University, School of Public Health • Developing an automated workflow that cleans and transfers public health data to usable CSV/spreadsheet format to analyze food security	Ann Arbor, MI July '21 – Sept '21
	Software Development Intern – Kraken Foods • Created an automated email delivery service, that analyzed stake-holder priorities and delivered relevant personalized feedback • Coordinated operational projects, such as sourcing vendors and distributors and coordinating early involvement with potential partners	Ann Arbor, MI April '17 – Jan '18
LEADERSHIP EXPERIENCE	**MPowered Entrepreneurship** *Chief Operating Officer* • Developed partnerships with local startups and businesses bringing unique guest speakers and workshops to the organization • Led weekly professional development & planning meetings (80+ people). *Project Director: Startup High School* • Led outreach efforts, coordinating with local schools and businesses for a HS student startup competition • Recruited, interviewed and led a team of four (from 40 applicants)	Ann Arbor, MI Mar '18 – May '19 Mar '17 – Mar '18
SKILLS	**Programming and Software** • C/C++, Python, R, R Shiny, ReactJS, JavaScript, SQL, HTML, CSS **Foreign Languages** • Spanish – Bilingual Proficiency (Speaking, Reading, Writing)	
PUBLICATIONS	• Van Berkel, Estabrook, Fox, **Agrawal Bejarano,** Maillard, Gill, Goto, Lemos "PPGISr: An R Package for Public Participatory GIS." *SoftwareX*, vol. 22, May 2023, p. 101389, https://doi.org/10.1016/j.softx.2023.101389. • Willis, Klemens, **Agrawal Bejarano**, Hebert, Russell, Snapshot Serengeti Online: a fully online, open-source inquiry lab on tropical ecology, ATBC Abstract 2021 • Easton R. White, Halley E., Froehlich, Jessica A. Gephart, Richard S. Cottrell, Trevor A. Branch, **Rahul Agrawal Bejarano**, Julia K. Baum, Early effects of COVID-19 on US fisheries and seafood consumption. Fish Fish. 2021; 22: 232– 239. https://doi-org.proxy.lib.umich.edu/10.1111/faf.12525 • Kathryn Cunningham, Barbara J. Ericson, **Rahul Agrawal Bejarano**, and Mark Guzdial. 2021. Avoiding the Turing Tarpit: Learning Conversational Programming by Starting from Code's Purpose. Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems. Association for Computing Machinery, New York, NY, USA, Article 61, 1–15. DOI:https://doi-org.proxy.lib.umich.edu/10.1145/3411764.3445571 • Cunningham, K., **Bejarano, R. A**., Guzdial, M., & Ericson, B. (2020). "I'm Not a Computer": How Identity Informs Value and Expectancy During a Programming Activity. In Gresalfi, M. and Horn, I. S. (Eds.), The Interdisciplinarity of the Learning Sciences, 14th International Conference of the Learning Sciences (ICLS) 2020, Volume 2 (pp. 705-708). Nashville, Tennessee: International Society of the Learning Sciences.	

United States Census Bureau

QuickFacts
Michigan

QuickFacts provides statistics for all states and counties. Also for cities and towns with a ***population of 5,000 or more***.

All Topics	Michigan
Population Estimates, July 1, 2022, (V2022)	**10,033,281**
PEOPLE	
Population	
Population estimates, July 1, 2023, (V2023)	10,037,261
Population Estimates, July 1, 2022, (V2022)	**10,033,281**
Population estimates base, April 1, 2020, (V2023)	10,077,674
Population estimates base, April 1, 2020, (V2022)	10,077,674
Population, percent change - April 1, 2020 (estimates base) to July 1, 2023, (V2023)	-0.4%
Population, percent change - April 1, 2020 (estimates base) to July 1, 2022, (V2022)	-0.4%
Population, Census, April 1, 2020	10,077,331
Population, Census, April 1, 2010	9,883,640
Age and Sex	
Persons under 5 years, percent	5.3%
Persons under 18 years, percent	21.0%
Persons 65 years and over, percent	18.7%
Female persons, percent	50.3%
Race and Hispanic Origin	
White alone, percent	78.8%
Black or African American alone, percent (a)	14.1%
American Indian and Alaska Native alone, percent (a)	0.7%
Asian alone, percent (a)	3.5%
Native Hawaiian and Other Pacific Islander alone, percent (a)	Z
Two or More Races, percent	2.8%
Hispanic or Latino, percent (b)	5.7%
White alone, not Hispanic or Latino, percent	74.0%
Population Characteristics	
Veterans, 2018-2022	498,788
Foreign born persons, percent, 2018-2022	6.9%
Housing	
Housing units, July 1, 2022, (V2022)	4,611,660
Owner-occupied housing unit rate, 2018-2022	72.5%
Median value of owner-occupied housing units, 2018-2022	$201,100
Median selected monthly owner costs -with a mortgage, 2018-2022	$1,472
Median selected monthly owner costs -without a mortgage, 2018-2022	$565
Median gross rent, 2018-2022	$1,037
Building permits, 2022	21,983[1]
Families & Living Arrangements	
Households, 2018-2022	4,009,253
Persons per household, 2018-2022	2.45
Living in same house 1 year ago, percent of persons age 1 year+, 2018-2022	87.8%
Language other than English spoken at home, percent of persons age 5 years+, 2018-2022	9.9%
Computer and Internet Use	
Households with a computer, percent, 2018-2022	93.4%
Households with a broadband Internet subscription, percent, 2018-2022	87.8%
Education	
High school graduate or higher, percent of persons age 25 years+, 2018-2022	91.8%
Bachelor's degree or higher, percent of persons age 25 years+, 2018-2022	31.1%
Health	
With a disability, under age 65 years, percent, 2018-2022	10.1%
Persons without health insurance, under age 65 years, percent	5.5%

Economy	
In civilian labor force, total, percent of population age 16 years+, 2018-2022	61.4%
In civilian labor force, female, percent of population age 16 years+, 2018-2022	57.1%
Total accommodation and food services sales, 2017 ($1,000) (c)	23,056,352
Total health care and social assistance receipts/revenue, 2017 ($1,000) (c)	74,194,505
Total transportation and warehousing receipts/revenue, 2017 ($1,000) (c)	25,019,797
Total retail sales, 2017 ($1,000) (c)	143,437,054
Total retail sales per capita, 2017 (c)	$14,377
Transportation	
Mean travel time to work (minutes), workers age 16 years+, 2018-2022	24.5
Income & Poverty	
Median household income (in 2022 dollars), 2018-2022	$68,505
Per capita income in past 12 months (in 2022 dollars), 2018-2022	$37,929
Persons in poverty, percent	⚠ 13.4%

BUSINESSES

Businesses	
Total employer establishments, 2021	224,676
Total employment, 2021	3,768,321
Total annual payroll, 2021 ($1,000)	216,772,518
Total employment, percent change, 2020-2021	-5.8%
Total nonemployer establishments, 2021	774,125
All employer firms, Reference year 2017	165,460
Men-owned employer firms, Reference year 2017	106,137
Women-owned employer firms, Reference year 2017	29,706
Minority-owned employer firms, Reference year 2017	13,091
Nonminority-owned employer firms, Reference year 2017	141,153
Veteran-owned employer firms, Reference year 2017	8,714
Nonveteran-owned employer firms, Reference year 2017	142,782

GEOGRAPHY

Geography	
Population per square mile, 2020	178.0
Population per square mile, 2010	174.8
Land area in square miles, 2020	56,608.22
Land area in square miles, 2010	56,538.90
FIPS Code	26

About datasets used in this table

Value Notes

1. Includes data not distributed by county.

⚠ Methodology differences may exist between data sources, and so estimates from different sources are not comparable.

Some estimates presented here come from sample data, and thus have sampling errors that may render some apparent differences between geographies statistically indistinguishable. Click the Quick Info icon to the left of each row in TABLE vie learn about sampling error.

The vintage year (e.g., V2023) refers to the final year of the series (2020 thru 2023). Different vintage years of estimates are not comparable.

Users should exercise caution when comparing 2018-2022 ACS 5-year estimates to other ACS estimates. For more information, please visit the 2022 5-year ACS Comparison Guidance page.

Fact Notes

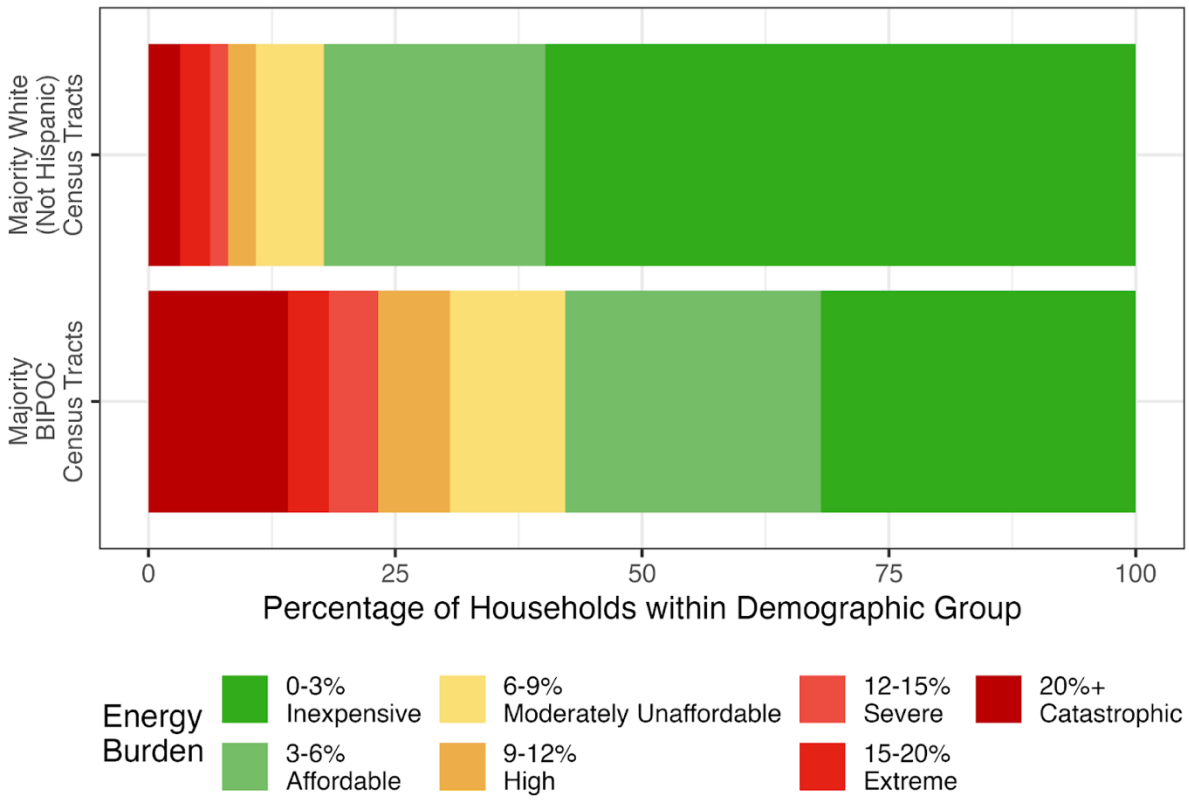
(a) Includes persons reporting only one race
(c) Economic Census - Puerto Rico data are not comparable to U.S. Economic Census data
(b) Hispanics may be of any race, so also are included in applicable race categories

Value Flags

- Either no or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest or upper interval of an open ended distrit
F Fewer than 25 firms
D Suppressed to avoid disclosure of confidential information
N Data for this geographic area cannot be displayed because the number of sample cases is too small.
FN Footnote on this item in place of data
X Not applicable
S Suppressed; does not meet publication standards
NA Not available
Z Value greater than zero but less than half unit of measure shown

QuickFacts data are derived from: Population Estimates, American Community Survey, Census of Population and Housing, Current Population Survey, Small Area Health Insurance Estimates, Small Area Income and Poverty Estimates, State and C Housing Unit Estimates, County Business Patterns, Nonemployer Statistics, Economic Census, Survey of Business Owners, Building Permits.

JS Workpaper 3 – Energy burden disparities by race and income.



Majority White census tracts have 18% of households with an unaffordable. Majority BIPOC census tracts have 42% of households with an unaffordable energy burden. Proportionally there are 2.4 times as many households in majority BIPOC census tracts with an unaffordable energy burden as households in majority white households. This divide is further exacerbated when taking Severe to Catastrophic energy burdens (12%+). Majority BIPOC census tracts proportionately have 2.9 times more households with a Severe to Catastrophic energy burden, 23%, compared to majority white census tracts, 8%.

	Energy Burden Classification	Energy Burden Range	Number of Households	Energy Burden	Percent of Households
Majority BIPOC Census Tracts	Inexpensive	0-3%	135,439	2.2	31.9
	Affordable	3-6%	109,879	5.0	25.9
	Moderately Unaffordable	6-9%	49,602	7.8	11.7
	High	9-12%	30,773	11.2	7.2
	Severe	12-15%	21,364	13.9	5.0
	Extreme	15-20%	17,417	17.7	4.1
	Catastrophic	20%+	60,071	31.5	14.1

Majority White (Not Hispanic) Census Tracts	Inexpensive	0-3%	1,209,708	1.9	59.8
	Affordable	3-6%	453,146	4.5	22.4
	Moderately Unaffordable	6-9%	139,337	7.8	6.9
	High	9-12%	56,900	10.9	2.8
	Severe	12-15%	37,081	14.1	1.8
	Extreme	15-20%	60,836	17.9	3.0
	Catastrophic	20%+	65,189	26.6	3.2

Sources:

o Energy Burden Data
(Raw data for MI energy burdens and number of BIPOC households collected from DOE LEAD: https://www.energy.gov/scep/slsc/lead-tool)

o MI census tracts
(US Census Bureau https://www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2010&layergroup=Census+Tracts)

o DTE service territory
(DTE service territory GIS layer collected from https://atlas.eia.gov/datasets/f4cd55044b924fed9bc8b64022966097/explore?filters=eyJOQU1FIjpbIkRURSBFTEVDVFJJQyBDT01QQU5ZIl19&location=42.911225%2C-81.880048%2C6.78)

o FLO JS Workpaper 2k (code file that get list of census tracts within DTE Service territory)

o FLO JS Workpaper 2j (final GIS layer with MI census tracts within DTE service territory)

o Doe_lead_profiles_fpl.Rmd (code that creates figure 4)

JS Workpaper 4 - High Energy Burden Low-Income Tracts vs. % Black

DATA SOURCE: Climate and Economic Justice Screening Tool (CEJST) - Council on Environmental Quality (CEQ). Downloaded April 1, 2024.
https://screeningtool.geoplatform.gov/en/downloads#4.27/34.38/-99.17

Location	Energy Burden (% income)	Avg. Annual Energy Cost ($)	Total Households	Household Income	Black/ African American (% pop.)	American Indian/ Native Alaskan (% pop.)	Asian (% pop.)	Native Hawaiian/ Other Pacific Islander (% pop.)	White Hispanic or Latino (% pop.)	White Non-Hispanic or Latino (% pop.)	Two or More Races (% pop.)	Other Races (% pop.)	Less Than High School (% pop.)	High School (% pop.)	Associates or Some College (% pop.)	Bachelors or Higher (% pop.)
Census Tract 5112, Wayne County, Michigan	49	$3,536	298	$7,221	93	0	0	0	0	6	0	0	6	29	55	9
Census Tract 5382, Wayne County, Michigan	45	$3,869	67	$8,589	94	0	0	0	0	6	0	0	0	10	18	72
Census Tract 5301, Wayne County, Michigan	42	$2,900	569	$6,931	99	0	0	0	0	0	1	0	36	21	40	3
Census Tract 5231, Wayne County, Michigan	39	$3,009	410	$7,651	18	0	0	0	24	33	10	16	46	22	26	6
Census Tract 5313, Wayne County, Michigan	39	$3,000	201	$7,622	94	0	0	0	0	2	4	0	26	24	45	5
Census Tract 1527, Oakland County, Michigan	38	$2,658	87	$7,036	3	0	0	0	1	95	0	0	0	1	10	89
Census Tract 9854, Wayne County, Michigan	36	$3,174	4	$8,764	0	0	0	0	0	100	0	0	0	53	47	0
Census Tract 5451, Wayne County, Michigan	35	$2,793	131	$7,996	97	1	0	0	0	1	1	0	17	53	26	5
Census Tract 5452, Wayne County, Michigan	35	$3,524	387	$10,192	100	0	0	0	0	0	0	0	25	26	43	6
Census Tract 5002, Wayne County, Michigan	32	$3,491	208	$10,818	99	0	0	0	0	1	0	0	2	22	67	9
Census Tract 5071, Wayne County, Michigan	32	$3,137	449	$9,934	96	0	0	0	0	1	3	0	13	50	23	14
Census Tract 5190, Wayne County, Michigan	31	$2,910	121	$9,438	90	0	0	0	0	9	0	0	15	55	26	5
Census Tract 5265, Wayne County, Michigan	30	$2,896	326	$9,738	81	0	0	0	10	1	0	9	44	22	26	8
Census Tract 5393, Wayne County, Michigan	30	$3,537	375	$11,758	100	0	0	0	0	0	0	0	6	12	49	33
Census Tract 5113, Wayne County, Michigan	29	$3,709	427	$12,639	39	0	9	0	0	48	3	1	25	30	33	13
Census Tract 5333, Wayne County, Michigan	29	$3,109	154	$10,810	91	0	1	0	0	5	3	0	17	46	24	12
Census Tract 5391, Wayne County, Michigan	29	$3,591	267	$12,206	98	1	0	0	0	0	0	0	31	29	34	7
Census Tract 5406, Wayne County, Michigan	29	$2,752	267	$9,399	78	0	0	0	0	7	2	13	9	36	40	15
Census Tract 5074, Wayne County, Michigan	28	$3,152	336	$11,401	97	1	0	0	0	1	0	1	16	38	40	6
Census Tract 5303, Wayne County, Michigan	28	$3,990	235	$14,065	97	0	0	0	0	1	2	0	8	53	35	4
Census Tract 5334, Wayne County, Michigan	28	$3,015	692	$10,959	100	0	0	0	0	0	0	0	11	41	42	6
Census Tract 5336, Wayne County, Michigan	28	$2,982	353	$10,784	97	0	0	0	0	2	1	0	32	39	25	4
Census Tract 5368, Wayne County, Michigan	28	$3,380	287	$11,925	97	1	0	0	0	1	1	0	11	52	31	6
Census Tract 5401, Wayne County, Michigan	28	$3,294	649	$11,915	94	0	0	0	0	6	0	0	26	37	32	5
Census Tract 5517, Wayne County, Michigan	28	$3,170	92	$11,272	0	0	3	0	0	96	1	0	4	16	33	47
Census Tract 2473.02, Macomb County, Michigan	27	$2,577	33	$9,608	0	0	0	0	0	99	1	0	0	13	80	7
Census Tract 1981, Oakland County, Michigan	27	$3,081	416	$11,537	2	0	40	0	0	55	0	3	61	14	14	11
Census Tract 5015, Wayne County, Michigan	27	$3,348	676	$12,340	95	0	0	0	0	4	0	1	17	40	33	11
Census Tract 5248, Wayne County, Michigan	27	$3,109	344	$11,336	65	0	0	0	12	8	5	10	21	32	40	6
Census Tract 5318, Wayne County, Michigan	27	$2,643	400	$9,685	98	0	0	0	0	2	1	0	29	30	37	4
Census Tract 5378, Wayne County, Michigan	27	$3,340	300	$12,256	98	0	0	0	0	1	0	1	25	39	34	2
Census Tract 5403, Wayne County, Michigan	27	$3,487	718	$12,820	95	0	0	0	0	2	0	3	16	33	42	9
Census Tract 5411, Wayne County, Michigan	27	$2,918	322	$10,757	85	0	2	0	0	5	4	3	32	27	38	3
Census Tract 5423, Wayne County, Michigan	27	$2,642	622	$9,788	98	0	0	0	0	2	0	0	14	28	50	8
Census Tract 5508, Wayne County, Michigan	27	$2,923	45	$10,680	3	0	2	0	0	94	1	0	2	13	34	50
Census Tract 5132, Wayne County, Michigan	26	$3,247	187	$12,489	89	0	1	0	0	10	1	0	35	30	26	8
Census Tract 5224, Wayne County, Michigan	26	$2,030	235	$7,679	93	0	0	0	1	3	2	0	7	47	35	12
Census Tract 5364, Wayne County, Michigan	26	$3,609	452	$13,695	100	0	0	0	0	0	0	0	11	51	31	8
Census Tract 5367, Wayne County, Michigan	26	$3,470	148	$13,256	99	0	1	0	0	0	0	0	16	39	44	2
Census Tract 5370, Wayne County, Michigan	26	$3,208	566	$12,555	99	0	0	0	0	1	0	0	15	33	46	5
Census Tract 5371, Wayne County, Michigan	26	$3,406	330	$12,912	98	0	0	0	0	1	1	0	20	35	38	6
Census Tract 5402, Wayne County, Michigan	26	$3,555	483	$13,803	99	0	0	0	0	0	0	0	29	37	31	3
Census Tract 5404, Wayne County, Michigan	26	$2,879	590	$11,197	99	0	0	0	0	1	0	0	19	36	42	3
Census Tract 5530, Wayne County, Michigan	26	$2,550	193	$9,845	93	0	0	0	0	7	0	0	31	29	34	7
Census Tract 1580, Oakland County, Michigan	25	$2,568	48	$10,074	3	0	1	0	0	96	1	0	0	3	7	91
Census Tract 5014, Wayne County, Michigan	25	$3,851	333	$15,198	94	0	0	0	0	6	0	0	23	29	39	8
Census Tract 5027, Wayne County, Michigan	25	$2,471	581	$9,762	98	0	0	0	0	2	0	0	32	37	29	2
Census Tract 5070, Wayne County, Michigan	25	$3,059	477	$12,204	97	0	0	0	0	1	1	0	18	43	31	8
Census Tract 5073, Wayne County, Michigan	25	$3,378	183	$13,619	98	0	0	0	0	1	1	0	8	27	53	12
Census Tract 5128, Wayne County, Michigan	25	$2,840	536	$11,570	95	0	0	0	0	2	0	2	26	50	17	6
Census Tract 5264, Wayne County, Michigan	25	$3,390	149	$13,650	10	1	0	0	49	6	9	25	59	28	13	0

Census Tract 5311, Wayne County, Michigan	25	$2,296	187	$9,041	89	0	0	0	1	9	1	0	15	45	37	3
Census Tract 5373, Wayne County, Michigan	25	$3,105	298	$12,272	99	0	0	0	0	0	0	0	19	40	41	0
Census Tract 5377, Wayne County, Michigan	25	$2,967	421	$11,758	99	0	0	0	0	0	0	0	28	40	29	3
Census Tract 5425, Wayne County, Michigan	25	$3,423	269	$13,781	98	0	0	0	0	1	1	0	9	29	50	12
Census Tract 5435, Wayne County, Michigan	25	$2,738	174	$10,922	88	1	0	0	0	7	4	0	23	38	32	7
Census Tract 5751, Wayne County, Michigan	25	$2,056	224	$8,184	0	0	0	0	3	95	1	0	19	25	37	18
Census Tract 5061, Wayne County, Michigan	24	$3,228	245	$13,508	90	1	1	0	0	7	0	0	17	39	39	4
Census Tract 5192, Wayne County, Michigan	24	$2,378	301	$9,972	79	0	13	0	0	8	0	0	23	27	26	23
Census Tract 5302, Wayne County, Michigan	24	$3,062	388	$12,818	91	0	1	0	0	7	1	0	12	37	37	15
Census Tract 5338, Wayne County, Michigan	24	$3,093	362	$12,755	89	0	0	0	3	5	2	1	28	28	41	3
Census Tract 5358, Wayne County, Michigan	24	$2,874	723	$12,224	86	0	0	0	0	4	0	9	24	47	28	1
Census Tract 5375, Wayne County, Michigan	24	$3,545	392	$14,761	96	0	0	0	0	3	0	0	26	29	35	10
Census Tract 5422, Wayne County, Michigan	24	$3,207	564	$13,387	99	0	0	0	0	0	1	0	16	42	35	7
Census Tract 5509, Wayne County, Michigan	24	$3,305	54	$13,721	2	0	6	0	0	90	1	0	3	17	29	51
Census Tract 2588, Macomb County, Michigan	23	$1,854	359	$8,073	69	0	0	0	1	29	1	0	8	19	43	30
Census Tract 1846, Oakland County, Michigan	23	$1,546	162	$6,642	3	0	1	0	0	95	1	0	10	8	19	64
Census Tract 5017, Wayne County, Michigan	23	$3,068	258	$13,557	74	1	0	0	0	25	1	0	21	43	31	4
Census Tract 5065, Wayne County, Michigan	23	$3,237	270	$13,952	96	0	0	0	0	4	0	0	18	42	35	5
Census Tract 5081, Wayne County, Michigan	23	$3,341	205	$14,833	78	0	0	0	9	7	6	0	29	39	22	10
Census Tract 5246, Wayne County, Michigan	23	$2,969	495	$12,861	16	0	0	0	18	26	12	28	33	55	11	2
Census Tract 5247, Wayne County, Michigan	23	$2,858	508	$12,386	80	0	0	0	8	1	1	9	22	50	23	4
Census Tract 5279, Wayne County, Michigan	23	$2,983	376	$13,167	73	0	0	0	8	5	11	3	21	18	49	12
Census Tract 5321, Wayne County, Michigan	23	$3,040	188	$13,022	84	0	0	0	0	14	0	1	21	24	37	17
Census Tract 5331, Wayne County, Michigan	23	$2,509	248	$10,922	97	0	0	0	0	2	1	0	20	27	47	5
Census Tract 5332, Wayne County, Michigan	23	$3,001	183	$13,250	86	0	0	0	0	10	5	0	3	44	37	17
Census Tract 5356, Wayne County, Michigan	23	$2,883	749	$12,612	95	0	0	0	0	4	1	0	10	29	55	6
Census Tract 5381, Wayne County, Michigan	23	$3,227	118	$14,236	88	0	0	0	0	11	0	0	17	14	25	44
Census Tract 5397, Wayne County, Michigan	23	$3,096	312	$13,217	100	0	0	0	0	0	0	0	38	31	23	7
Census Tract 5405, Wayne County, Michigan	23	$2,981	417	$13,176	99	0	0	0	0	1	0	0	5	43	44	8
Census Tract 5407, Wayne County, Michigan	23	$3,392	398	$14,538	89	0	0	0	1	4	2	4	36	23	39	3
Census Tract 5424, Wayne County, Michigan	23	$3,318	376	$14,551	98	0	0	0	0	2	0	0	8	27	55	10
Census Tract 5426, Wayne County, Michigan	23	$3,192	493	$13,730	100	0	0	0	0	0	0	0	4	49	43	5
Census Tract 5461, Wayne County, Michigan	23	$3,144	627	$13,734	89	0	0	0	1	6	5	0	34	25	33	8
Census Tract 5466, Wayne County, Michigan	23	$3,000	280	$12,876	94	0	0	0	0	3	4	0	25	31	41	3
Census Tract 1545, Oakland County, Michigan	22	$2,918	51	$13,210	1	0	2	0	0	96	0	0	11	8	14	67
Census Tract 1684, Oakland County, Michigan	22	$1,908	21	$8,784	18	0	2	0	0	77	2	1	2	16	34	48
Census Tract 1700, Oakland County, Michigan	22	$1,629	83	$7,318	1	0	0	0	1	97	1	0	4	10	25	61
Census Tract 5041, Wayne County, Michigan	22	$2,912	209	$13,049	100	0	0	0	0	0	0	0	26	48	19	7
Census Tract 5056, Wayne County, Michigan	22	$3,368	619	$15,100	98	0	0	0	0	1	1	1	19	34	40	8
Census Tract 5063, Wayne County, Michigan	22	$3,185	277	$14,276	96	0	0	0	0	2	1	1	17	43	33	7
Census Tract 5064, Wayne County, Michigan	22	$3,254	155	$14,621	72	0	0	0	1	21	5	0	48	30	15	7
Census Tract 5211, Wayne County, Michigan	22	$2,213	283	$9,921	30	0	0	0	17	25	2	26	30	21	42	6
Census Tract 5214, Wayne County, Michigan	22	$2,643	178	$11,931	64	0	1	0	0	23	0	12	17	53	19	11
Census Tract 5223, Wayne County, Michigan	22	$2,145	416	$9,627	90	0	0	0	0	3	8	0	19	49	28	4
Census Tract 5258, Wayne County, Michigan	22	$3,597	273	$16,525	14	0	0	0	11	19	20	37	58	27	14	1
Census Tract 5305, Wayne County, Michigan	22	$2,848	356	$12,760	95	0	0	0	0	3	2	0	26	22	31	20
Census Tract 5315.01, Wayne County, Michigan	22	$3,072	265	$13,834	67	1	0	0	0	3	29	0	5	46	49	0
Census Tract 5412, Wayne County, Michigan	22	$2,411	332	$11,073	93	0	0	0	1	6	0	0	43	25	23	9
Census Tract 5415, Wayne County, Michigan	22	$2,874	442	$13,317	98	0	0	0	0	1	1	0	10	32	49	9
Census Tract 5455, Wayne County, Michigan	22	$2,969	789	$13,590	85	0	0	0	0	9	3	3	25	32	37	7
Census Tract 5457, Wayne County, Michigan	22	$3,075	554	$14,067	61	0	0	0	5	31	2	1	23	41	25	11
Census Tract 5460, Wayne County, Michigan	22	$2,965	549	$13,419	84	0	0	0	0	5	6	4	13	30	56	2
Census Tract 5563, Wayne County, Michigan	22	$1,633	313	$7,399	3	0	2	0	0	95	0	0	7	46	20	27
Census Tract 5795.01, Wayne County, Michigan	22	$2,003	310	$9,037	25	0	0	3	5	52	6	9	22	31	46	1
Census Tract 5819, Wayne County, Michigan	22	$1,907	178	$8,569	0	1	1	0	1	96	1	0	3	45	49	4
Census Tract 5847, Wayne County, Michigan	22	$2,441	265	$10,985	1	0	0	0	0	98	0	0	30	35	33	1
Census Tract 1506, Oakland County, Michigan	21	$2,672	32	$12,894	1	0	2	0	0	97	0	0	1	1	10	88
Census Tract 1565, Oakland County, Michigan	21	$2,856	144	$13,769	3	0	1	0	0	96	0	0	3	3	11	83
Census Tract 1733, Oakland County, Michigan	21	$1,295	170	$6,066	10	0	0	0	0	88	1	0	1	9	11	78
Census Tract 1976, Oakland County, Michigan	21	$1,996	40	$9,341	2	0	3	0	1	93	1	0	4	56	10	29
Census Tract 5005, Wayne County, Michigan	21	$3,495	108	$16,431	95	0	0	0	0	5	0	0	10	24	62	3
Census Tract 5032, Wayne County, Michigan	21	$3,603	324	$17,180	95	0	0	0	0	5	0	0	11	45	44	1

Census Tract 5035, Wayne County, Michigan	21	$3,744	294	$17,620	100	0	0	0	0	0	0	0	11	39	48	2
Census Tract 5043, Wayne County, Michigan	21	$3,278	230	$15,987	96	0	0	0	0	4	0	0	33	36	25	6
Census Tract 5057, Wayne County, Michigan	21	$2,997	469	$14,386	98	0	1	0	0	1	0	0	33	30	33	5
Census Tract 5062, Wayne County, Michigan	21	$3,155	274	$15,070	97	0	0	0	0	2	1	0	9	65	20	6
Census Tract 5066, Wayne County, Michigan	21	$3,380	365	$16,197	94	0	5	0	0	1	0	0	13	31	37	19
Census Tract 5068, Wayne County, Michigan	21	$2,885	571	$14,055	98	0	0	0	0	1	1	0	8	47	36	9
Census Tract 5138, Wayne County, Michigan	21	$2,554	400	$12,028	96	0	0	0	0	2	2	0	27	33	32	8
Census Tract 5145, Wayne County, Michigan	21	$3,022	165	$14,634	100	0	0	0	0	0	0	0	13	27	59	1
Census Tract 5164, Wayne County, Michigan	21	$2,792	80	$13,572	79	2	0	0	0	13	6	0	13	48	26	13
Census Tract 5173, Wayne County, Michigan	21	$1,808	410	$8,772	87	0	1	0	0	10	1	0	29	24	29	18
Census Tract 5215, Wayne County, Michigan	21	$2,415	156	$11,626	86	0	0	0	0	12	0	1	24	41	15	19
Census Tract 5220, Wayne County, Michigan	21	$2,191	317	$10,677	96	0	0	0	0	3	0	1	23	18	56	3
Census Tract 5263, Wayne County, Michigan	21	$3,134	533	$14,955	10	0	0	0	43	14	3	31	68	16	13	3
Census Tract 5314, Wayne County, Michigan	21	$2,909	278	$13,789	97	0	0	0	0	3	0	0	30	35	27	8
Census Tract 5330, Wayne County, Michigan	21	$2,291	268	$10,720	86	0	5	0	0	8	0	1	26	26	31	18
Census Tract 5341, Wayne County, Michigan	21	$2,487	239	$11,744	97	0	0	0	0	2	1	0	22	29	45	4
Census Tract 5342, Wayne County, Michigan	21	$3,190	515	$15,520	96	0	0	0	0	3	1	0	20	29	45	5
Census Tract 5343, Wayne County, Michigan	21	$2,744	239	$12,994	92	0	4	0	3	0	0	1	15	47	36	2
Census Tract 5351, Wayne County, Michigan	21	$2,985	207	$14,008	100	0	0	0	0	0	0	0	40	16	42	1
Census Tract 5352, Wayne County, Michigan	21	$2,751	406	$13,104	97	0	0	0	0	2	1	0	27	29	36	7
Census Tract 5357, Wayne County, Michigan	21	$2,966	183	$14,081	85	0	0	0	0	3	12	0	34	26	36	4
Census Tract 5366, Wayne County, Michigan	21	$2,925	412	$14,128	99	0	0	0	0	0	0	0	22	47	22	9
Census Tract 5369, Wayne County, Michigan	21	$3,007	413	$14,283	97	0	0	0	0	0	3	0	16	37	38	8
Census Tract 5386, Wayne County, Michigan	21	$3,309	654	$15,424	98	0	0	0	0	2	0	0	6	36	40	18
Census Tract 5387, Wayne County, Michigan	21	$3,399	478	$15,960	96	0	0	0	0	1	0	3	14	32	40	14
Census Tract 5389, Wayne County, Michigan	21	$2,941	308	$13,772	97	0	2	0	0	1	0	0	18	39	27	16
Census Tract 5394, Wayne County, Michigan	21	$3,373	502	$16,418	99	0	0	0	0	0	0	0	2	23	66	9
Census Tract 5413, Wayne County, Michigan	21	$2,852	363	$13,553	78	0	0	0	1	20	0	1	12	32	44	12
Census Tract 5421, Wayne County, Michigan	21	$3,131	536	$15,048	99	0	0	0	0	0	0	0	23	37	35	5
Census Tract 5432, Wayne County, Michigan	21	$3,069	279	$14,656	97	0	0	0	0	0	1	1	34	28	27	11
Census Tract 5456, Wayne County, Michigan	21	$3,109	645	$14,734	13	0	0	0	5	75	0	7	31	23	28	18
Census Tract 5458, Wayne County, Michigan	21	$3,197	740	$15,409	50	0	0	0	8	42	0	0	32	32	27	9
Census Tract 5604, Wayne County, Michigan	21	$2,045	189	$9,885	1	0	1	0	0	98	0	0	0	9	24	67
Census Tract 5760.01, Wayne County, Michigan	21	$2,210	169	$10,309	6	0	1	0	3	81	4	4	26	37	26	11
Census Tract 1501, Oakland County, Michigan	20	$2,307	169	$11,552	9	0	1	0	1	89	1	0	21	6	10	63
Census Tract 1509, Oakland County, Michigan	20	$2,159	153	$10,750	4	0	1	0	0	93	1	0	19	3	11	67
Census Tract 1520, Oakland County, Michigan	20	$2,421	29	$12,398	1	0	1	0	0	96	2	0	0	9	8	83
Census Tract 1569, Oakland County, Michigan	20	$2,814	108	$13,819	5	0	2	0	0	92	0	0	4	2	15	79
Census Tract 1962, Oakland County, Michigan	20	$2,014	153	$10,051	0	0	5	0	1	93	0	0	0	7	34	58
Census Tract 5016, Wayne County, Michigan	20	$3,160	276	$15,563	86	0	0	0	0	10	0	4	16	35	44	5
Census Tract 5019, Wayne County, Michigan	20	$3,215	433	$16,422	97	0	0	0	0	3	0	0	16	46	35	4
Census Tract 5031, Wayne County, Michigan	20	$3,377	326	$16,883	97	0	0	0	0	2	1	0	7	33	52	9
Census Tract 5044, Wayne County, Michigan	20	$3,103	261	$15,176	99	0	0	0	0	1	0	0	23	47	28	2
Census Tract 5054, Wayne County, Michigan	20	$3,210	291	$16,189	90	1	0	0	0	6	2	1	16	54	23	7
Census Tract 5069, Wayne County, Michigan	20	$3,287	441	$16,324	97	0	0	0	0	1	2	0	19	37	29	15
Census Tract 5090, Wayne County, Michigan	20	$2,573	227	$13,027	86	0	0	0	0	10	4	0	34	31	14	21
Census Tract 5114, Wayne County, Michigan	20	$2,811	412	$13,895	89	0	0	0	0	9	1	1	17	46	26	10
Census Tract 5133, Wayne County, Michigan	20	$2,919	177	$14,637	83	0	0	0	0	17	0	0	14	26	40	21
Census Tract 5141, Wayne County, Michigan	20	$2,645	608	$13,096	99	0	0	0	0	1	0	0	48	16	31	5
Census Tract 5152, Wayne County, Michigan	20	$3,256	230	$16,465	88	0	0	0	0	12	0	0	17	40	36	7
Census Tract 5154, Wayne County, Michigan	20	$2,535	21	$12,612	56	0	1	0	0	42	0	0	6	18	32	45
Census Tract 5193, Wayne County, Michigan	20	$2,874	242	$14,165	80	0	0	0	0	18	1	1	27	28	34	12
Census Tract 5240.01, Wayne County, Michigan	20	$2,750	368	$14,030	5	0	0	0	16	15	4	60	39	38	16	7
Census Tract 5309, Wayne County, Michigan	20	$2,611	212	$12,905	95	0	0	0	0	3	2	0	36	33	31	0
Census Tract 5317, Wayne County, Michigan	20	$2,505	289	$12,707	97	0	2	0	0	0	0	0	25	27	34	13
Census Tract 5319, Wayne County, Michigan	20	$2,574	86	$12,652	91	0	0	0	2	4	2	1	16	7	54	24
Census Tract 5344, Wayne County, Michigan	20	$2,481	341	$12,127	92	0	0	0	2	6	0	0	30	40	30	0
Census Tract 5350, Wayne County, Michigan	20	$3,030	320	$15,192	95	0	0	0	2	0	0	3	25	26	32	16
Census Tract 5361, Wayne County, Michigan	20	$3,121	532	$15,941	97	0	0	0	0	3	0	0	29	32	30	8
Census Tract 5385, Wayne County, Michigan	20	$2,910	691	$14,288	98	0	0	0	0	1	0	0	7	25	53	15
Census Tract 5392, Wayne County, Michigan	20	$3,329	657	$16,842	100	0	0	0	0	0	0	0	11	39	41	9
Census Tract 5395, Wayne County, Michigan	20	$2,886	283	$14,220	99	0	0	0	0	1	0	0	6	47	43	3

Census Tract 5396, Wayne County, Michigan	20	$3,119	391	$15,215	98	0	0	0	0	0	1	0	7	31	45	18
Census Tract 5418, Wayne County, Michigan	20	$2,657	210	$13,063	72	0	6	0	0	17	1	4	18	38	37	7
Census Tract 5443, Wayne County, Michigan	20	$3,201	372	$15,730	79	0	0	0	0	18	2	0	7	31	53	10
Census Tract 5448, Wayne County, Michigan	20	$2,852	320	$14,459	88	0	0	0	0	11	1	0	24	35	34	7
Census Tract 5462.01, Wayne County, Michigan	20	$3,350	239	$16,942	57	0	0	0	0	41	0	1	21	25	42	12
Census Tract 5637, Wayne County, Michigan	20	$2,131	26	$10,741	7	0	2	0	0	91	0	0	12	14	43	31
Census Tract 2406.02, Macomb County, Michigan	**19**	$2,812	187	$14,631	0	0	0	0	0	100	0	0	6	48	30	16
Census Tract 2408.02, Macomb County, Michigan	**19**	$2,869	494	$15,410	14	0	0	0	0	84	1	0	16	34	47	4
Census Tract 1504, Oakland County, Michigan	**19**	$2,724	38	$13,989	3	0	4	0	1	92	1	0	0	2	14	83
Census Tract 1526, Oakland County, Michigan	**19**	$2,325	76	$12,404	4	0	1	0	1	94	1	0	0	6	10	84
Census Tract 1570, Oakland County, Michigan	**19**	$2,824	29	$14,940	3	0	1	0	0	95	2	0	2	8	15	74
Census Tract 1839, Oakland County, Michigan	**19**	$1,500	202	$8,028	2	0	1	0	6	89	1	0	0	25	19	57
Census Tract 1870, Oakland County, Michigan	**19**	$1,911	38	$10,166	2	0	0	0	0	96	2	0	1	8	11	81
Census Tract 1968, Oakland County, Michigan	**19**	$3,010	21	$15,505	0	0	56	0	0	44	0	0	0	4	37	60
Census Tract 5003, Wayne County, Michigan	**19**	$3,092	167	$16,542	91	0	4	0	0	4	0	0	14	36	47	2
Census Tract 5020, Wayne County, Michigan	**19**	$3,425	176	$17,867	97	0	0	0	0	2	1	0	20	22	45	12
Census Tract 5026, Wayne County, Michigan	**19**	$2,714	650	$14,393	99	0	0	0	0	1	0	0	26	46	24	5
Census Tract 5036, Wayne County, Michigan	**19**	$2,958	196	$15,634	96	0	3	0	0	1	0	0	7	51	38	3
Census Tract 5039, Wayne County, Michigan	**19**	$3,131	298	$16,282	98	0	0	0	0	2	0	0	32	30	36	3
Census Tract 5040, Wayne County, Michigan	**19**	$3,217	218	$17,140	98	1	0	0	0	1	0	0	18	48	31	3
Census Tract 5051, Wayne County, Michigan	**19**	$2,260	787	$11,592	93	0	0	0	0	7	0	0	23	46	27	4
Census Tract 5052, Wayne County, Michigan	**19**	$2,535	476	$13,086	95	0	0	0	0	1	0	4	5	58	35	2
Census Tract 5075, Wayne County, Michigan	**19**	$2,825	373	$14,515	96	0	0	0	0	4	0	0	23	35	36	6
Census Tract 5091, Wayne County, Michigan	**19**	$3,204	744	$17,152	18	0	74	0	0	7	0	0	27	32	31	10
Census Tract 5137, Wayne County, Michigan	**19**	$2,386	488	$12,603	99	0	0	0	0	1	0	0	30	29	37	4
Census Tract 5143, Wayne County, Michigan	**19**	$2,418	477	$12,447	96	0	0	0	0	3	0	0	21	33	43	3
Census Tract 5168, Wayne County, Michigan	**19**	$3,342	118	$17,483	89	0	0	0	0	10	0	1	8	59	23	10
Census Tract 5191, Wayne County, Michigan	**19**	$2,900	182	$15,132	78	0	8	0	0	13	1	0	17	36	41	6
Census Tract 5233, Wayne County, Michigan	**19**	$3,423	348	$18,058	3	0	0	0	38	10	1	49	49	24	18	8
Census Tract 5234, Wayne County, Michigan	**19**	$2,436	278	$12,493	42	1	0	0	22	17	4	14	27	22	39	12
Census Tract 5308, Wayne County, Michigan	**19**	$2,898	237	$15,367	94	0	0	0	0	4	1	0	36	32	27	5
Census Tract 5348, Wayne County, Michigan	**19**	$2,909	356	$14,983	84	0	0	0	9	5	2	0	10	33	50	7
Census Tract 5362, Wayne County, Michigan	**19**	$3,492	371	$18,244	97	0	0	0	0	3	1	0	9	16	62	13
Census Tract 5365, Wayne County, Michigan	**19**	$2,976	259	$15,504	79	0	0	0	0	12	9	0	14	18	58	10
Census Tract 5372, Wayne County, Michigan	**19**	$2,809	104	$14,502	98	0	0	0	0	2	1	0	20	35	44	1
Census Tract 5376, Wayne County, Michigan	**19**	$3,319	546	$17,147	99	0	0	0	0	1	0	0	16	54	23	8
Census Tract 5429, Wayne County, Michigan	**19**	$3,108	322	$15,972	89	0	0	0	0	10	1	0	7	21	39	34
Census Tract 5437, Wayne County, Michigan	**19**	$2,801	468	$15,117	97	0	0	0	1	2	1	0	30	45	21	4
Census Tract 5442, Wayne County, Michigan	**19**	$2,645	341	$13,609	91	0	0	0	0	8	0	0	20	26	48	6
Census Tract 5472, Wayne County, Michigan	**19**	$2,495	589	$12,947	92	0	0	0	0	4	3	0	20	34	37	9
Census Tract 5506, Wayne County, Michigan	**19**	$2,871	24	$14,804	0	0	1	0	0	96	3	0	0	5	7	89
Census Tract 5731, Wayne County, Michigan	**19**	$3,031	316	$15,674	6	0	2	0	2	89	0	0	9	41	21	28
Census Tract 5746, Wayne County, Michigan	**19**	$2,581	298	$13,915	2	0	0	0	4	94	0	0	4	21	31	44
Census Tract 5749, Wayne County, Michigan	**19**	$1,935	177	$10,257	2	0	1	0	3	95	0	0	12	14	48	26
Census Tract 2566, Macomb County, Michigan	**18**	$2,204	376	$12,426	25	0	2	0	1	67	4	1	10	45	36	9
Census Tract 1348, Oakland County, Michigan	**18**	$1,851	121	$10,324	0	0	3	0	0	97	0	0	36	21	10	33
Census Tract 1507, Oakland County, Michigan	**18**	$2,588	49	$14,385	1	0	2	0	0	95	2	0	1	2	8	88
Census Tract 1541, Oakland County, Michigan	**18**	$2,705	108	$14,817	1	0	0	0	0	98	0	0	0	53	12	35
Census Tract 1578, Oakland County, Michigan	**18**	$1,701	118	$9,448	28	0	1	0	1	69	0	0	0	15	25	60
Census Tract 1612, Oakland County, Michigan	**18**	$2,165	201	$11,711	86	3	0	0	0	10	1	0	1	15	29	55
Census Tract 1662, Oakland County, Michigan	**18**	$2,146	33	$11,795	5	0	0	0	0	92	1	1	3	5	22	71
Census Tract 5001, Wayne County, Michigan	**18**	$3,408	242	$19,474	97	0	0	0	0	2	0	0	9	28	57	7
Census Tract 5008, Wayne County, Michigan	**18**	$2,835	515	$15,757	93	1	0	0	0	5	0	0	18	43	35	4
Census Tract 5012, Wayne County, Michigan	**18**	$3,093	188	$17,652	99	0	0	0	0	1	1	0	19	49	30	1
Census Tract 5013, Wayne County, Michigan	**18**	$3,377	364	$18,416	99	0	0	0	0	1	0	0	21	51	25	3
Census Tract 5033, Wayne County, Michigan	**18**	$3,325	471	$18,119	98	0	1	0	0	1	0	0	10	38	49	3
Census Tract 5042, Wayne County, Michigan	**18**	$3,324	237	$18,856	97	0	0	0	0	3	0	0	23	43	27	7
Census Tract 5072, Wayne County, Michigan	**18**	$3,156	154	$17,747	88	1	0	0	0	1	10	0	21	42	27	10
Census Tract 5106, Wayne County, Michigan	**18**	$3,521	873	$19,742	21	0	46	0	0	31	1	1	29	37	23	11
Census Tract 5166, Wayne County, Michigan	**18**	$2,103	696	$11,605	96	0	0	0	0	3	0	1	32	25	33	10
Census Tract 5204, Wayne County, Michigan	**18**	$1,831	273	$10,444	68	0	14	0	0	16	2	1	39	9	37	16
Census Tract 5228, Wayne County, Michigan	**18**	$2,754	355	$15,580	73	0	0	0	15	9	0	2	18	29	40	13

Census Tract 5316, Wayne County, Michigan	**18**	$2,429	291	$13,355	95	0	0	0	0	2	2	0	10	30	53	8
Census Tract 5353, Wayne County, Michigan	**18**	$3,164	605	$17,118	98	0	0	0	0	1	1	0	14	42	36	8
Census Tract 5363, Wayne County, Michigan	**18**	$3,141	344	$17,155	99	0	0	0	0	0	1	0	30	20	41	9
Census Tract 5390, Wayne County, Michigan	**18**	$3,006	395	$16,488	95	0	0	0	0	3	1	1	14	28	51	7
Census Tract 5410, Wayne County, Michigan	**18**	$2,423	461	$13,814	99	0	0	0	0	0	1	0	25	20	51	5
Census Tract 5431, Wayne County, Michigan	**18**	$3,095	91	$16,755	85	0	0	0	0	11	3	0	5	22	53	20
Census Tract 5433, Wayne County, Michigan	**18**	$2,899	295	$16,221	88	0	0	0	0	10	2	0	5	33	43	19
Census Tract 5439, Wayne County, Michigan	**18**	$2,587	197	$14,047	77	1	0	0	1	17	3	0	24	35	39	2
Census Tract 5467, Wayne County, Michigan	**18**	$2,868	285	$15,739	86	0	0	0	0	7	1	6	7	27	54	12
Census Tract 5470, Wayne County, Michigan	**18**	$2,661	520	$14,428	95	0	0	0	0	5	0	0	24	28	38	10
Census Tract 5471, Wayne County, Michigan	**18**	$2,790	592	$15,351	96	0	0	0	0	2	2	0	17	28	37	18
Census Tract 5502, Wayne County, Michigan	**18**	$2,703	162	$15,179	13	0	6	0	0	76	5	0	4	11	40	46
Census Tract 5511, Wayne County, Michigan	**18**	$2,977	96	$16,493	2	0	4	0	0	93	1	0	3	8	36	53
Census Tract 5531, Wayne County, Michigan	**18**	$2,917	206	$15,802	89	0	0	0	0	11	0	0	2	42	50	6
Census Tract 5603, Wayne County, Michigan	**18**	$1,843	152	$10,251	2	0	3	0	1	94	1	0	0	9	44	47
Census Tract 5689, Wayne County, Michigan	**18**	$2,033	330	$11,211	6	0	6	0	3	81	4	1	20	38	32	10
Census Tract 5706, Wayne County, Michigan	**18**	$2,187	237	$11,943	93	0	0	0	0	4	3	1	30	29	32	9
Census Tract 5718, Wayne County, Michigan	**18**	$3,253	185	$18,264	13	0	1	0	3	79	4	1	5	36	40	19
Census Tract 5722, Wayne County, Michigan	**18**	$2,756	534	$14,989	1	0	2	0	1	95	1	0	7	40	33	20
Census Tract 5766, Wayne County, Michigan	**18**	$1,915	214	$10,458	3	0	0	0	5	90	1	0	5	21	59	15
Census Tract 5832, Wayne County, Michigan	**18**	$2,764	218	$15,445	3	1	0	0	1	88	7	1	31	32	36	1
Census Tract 2408.01, Macomb County, Michigan	**17**	$2,532	63	$14,609	6	0	0	0	0	94	0	0	3	45	38	14
Census Tract 2412, Macomb County, Michigan	**17**	$2,901	373	$17,347	17	0	0	0	0	81	1	1	13	47	38	3
Census Tract 2683, Macomb County, Michigan	**17**	$2,020	468	$11,985	50	0	0	0	2	47	2	0	29	36	33	2
Census Tract 1563, Oakland County, Michigan	**17**	$2,470	46	$14,283	4	0	4	0	0	91	1	0	0	1	11	88
Census Tract 1579, Oakland County, Michigan	**17**	$2,337	72	$14,159	11	0	6	0	0	82	1	0	10	15	28	46
Census Tract 1980, Oakland County, Michigan	**17**	$2,167	123	$12,435	0	0	21	0	2	77	0	0	0	6	26	68
Census Tract 5007, Wayne County, Michigan	**17**	$3,405	429	$19,809	97	0	0	0	0	2	0	0	23	37	33	7
Census Tract 5011, Wayne County, Michigan	**17**	$2,906	457	$17,278	97	0	0	0	0	2	0	0	22	30	45	3
Census Tract 5058, Wayne County, Michigan	**17**	$3,227	691	$18,792	53	0	1	0	0	35	8	2	35	33	28	4
Census Tract 5139, Wayne County, Michigan	**17**	$2,868	257	$16,923	100	0	0	0	0	0	0	0	43	30	22	6
Census Tract 5219, Wayne County, Michigan	**17**	$2,331	444	$13,347	74	0	0	0	0	23	1	2	26	21	36	17
Census Tract 5232, Wayne County, Michigan	**17**	$2,972	466	$17,969	2	0	0	0	25	20	5	48	42	35	20	3
Census Tract 5241.01, Wayne County, Michigan	**17**	$2,576	636	$15,224	16	1	0	0	15	23	1	44	39	44	16	0
Census Tract 5260, Wayne County, Michigan	**17**	$3,430	428	$19,908	3	0	0	0	18	59	4	17	68	21	10	1
Census Tract 5261, Wayne County, Michigan	**17**	$3,368	464	$20,017	1	0	0	0	10	65	10	13	38	28	28	5
Census Tract 5324, Wayne County, Michigan	**17**	$2,479	262	$14,376	92	0	0	0	0	7	1	0	14	28	53	5
Census Tract 5326, Wayne County, Michigan	**17**	$1,936	223	$11,562	81	3	0	0	0	9	5	2	12	33	33	22
Census Tract 5388, Wayne County, Michigan	**17**	$3,527	184	$20,972	97	0	0	0	0	0	2	0	2	34	54	9
Census Tract 5409, Wayne County, Michigan	**17**	$3,190	295	$18,789	98	0	0	0	0	2	0	0	12	28	48	12
Census Tract 5414, Wayne County, Michigan	**17**	$2,782	247	$16,347	82	0	0	0	0	8	2	8	14	41	42	4
Census Tract 5434, Wayne County, Michigan	**17**	$3,121	300	$17,934	96	0	0	0	0	3	1	0	21	24	47	8
Census Tract 5441, Wayne County, Michigan	**17**	$2,753	417	$16,277	95	1	0	0	0	3	0	1	7	35	46	12
Census Tract 5459, Wayne County, Michigan	**17**	$2,963	622	$16,995	84	0	0	0	4	10	1	1	12	38	38	11
Census Tract 5463.01, Wayne County, Michigan	**17**	$3,262	167	$19,567	90	0	0	0	0	5	1	4	22	45	29	3
Census Tract 5503, Wayne County, Michigan	**17**	$2,602	14	$15,064	5	0	0	0	0	93	1	0	7	5	25	64
Census Tract 5504, Wayne County, Michigan	**17**	$2,309	74	$13,959	7	0	0	0	0	90	3	0	6	7	43	44
Census Tract 5532, Wayne County, Michigan	**17**	$2,488	154	$14,538	80	0	0	0	0	9	10	1	8	58	30	3
Census Tract 5568, Wayne County, Michigan	**17**	$2,376	53	$14,189	0	0	4	0	0	95	0	0	4	26	45	25
Census Tract 5571, Wayne County, Michigan	**17**	$1,900	109	$10,971	5	0	4	0	0	90	1	0	1	22	50	27
Census Tract 5577, Wayne County, Michigan	**17**	$1,975	84	$11,572	0	0	0	0	0	100	0	0	2	19	41	38
Census Tract 5627, Wayne County, Michigan	**17**	$2,162	83	$12,644	1	0	0	0	0	99	0	0	4	24	17	55
Census Tract 5640, Wayne County, Michigan	**17**	$1,721	168	$10,423	11	0	10	0	1	66	12	0	11	45	21	23
Census Tract 5785, Wayne County, Michigan	**17**	$2,122	692	$12,724	11	0	0	0	9	72	2	5	23	36	30	11
Census Tract 5857, Wayne County, Michigan	**17**	$2,545	131	$14,978	41	0	0	0	0	59	0	0	10	44	44	2
Census Tract 5951, Wayne County, Michigan	**17**	$1,830	341	$10,688	16	0	0	0	1	83	0	0	4	46	27	23
Census Tract 2413, Macomb County, Michigan	**16**	$2,841	123	$17,876	23	0	0	0	0	74	3	0	15	48	29	9
Census Tract 2421, Macomb County, Michigan	**16**	$2,336	144	$14,885	25	0	0	0	0	65	2	8	14	20	49	17
Census Tract 2425, Macomb County, Michigan	**16**	$2,309	380	$14,730	17	0	0	0	0	82	1	0	5	46	44	5
Census Tract 2430, Macomb County, Michigan	**16**	$2,470	85	$15,219	4	0	1	0	0	94	0	0	7	16	68	10
Census Tract 2440, Macomb County, Michigan	**16**	$2,594	56	$16,276	2	0	0	0	0	97	0	0	21	35	32	13
Census Tract 2471, Macomb County, Michigan	**16**	$1,763	155	$11,111	1	0	0	0	0	84	16	0	38	10	29	24

Census Tract 1510, Oakland County, Michigan	**16**	$2,428	55	$14,821	0	0	0	0	0	100	0	0	0	7	10	82
Census Tract 1529, Oakland County, Michigan	**16**	$2,034	179	$12,701	1	0	1	0	0	97	1	0	10	10	15	65
Census Tract 1531, Oakland County, Michigan	**16**	$2,524	50	$15,377	1	0	1	0	2	95	0	0	1	8	9	83
Census Tract 1533, Oakland County, Michigan	**16**	$2,592	94	$16,398	2	0	2	0	0	96	0	0	0	9	7	84
Census Tract 1560, Oakland County, Michigan	**16**	$2,225	75	$14,083	4	0	4	0	2	89	1	0	1	6	20	73
Census Tract 1571, Oakland County, Michigan	**16**	$2,882	37	$17,639	5	0	7	0	0	85	3	0	2	8	22	68
Census Tract 1577, Oakland County, Michigan	**16**	$3,107	54	$19,441	7	0	3	0	0	90	0	0	11	7	15	66
Census Tract 1582, Oakland County, Michigan	**16**	$2,216	64	$14,220	1	0	0	0	1	98	0	0	0	3	12	85
Census Tract 1590, Oakland County, Michigan	**16**	$2,468	94	$15,050	4	0	2	0	1	93	1	0	1	7	15	78
Census Tract 1619, Oakland County, Michigan	**16**	$2,227	101	$13,789	76	0	0	0	0	17	6	0	9	17	40	34
Census Tract 1965, Oakland County, Michigan	**16**	$1,651	127	$10,635	0	0	8	0	3	86	3	0	16	13	14	58
Census Tract 1969, Oakland County, Michigan	**16**	$1,616	96	$10,220	0	0	34	0	0	65	0	0	0	12	39	49
Census Tract 1971, Oakland County, Michigan	**16**	$2,303	56	$14,617	0	0	23	0	2	75	1	0	0	13	12	75
Census Tract 5004, Wayne County, Michigan	**16**	$2,871	195	$17,900	97	0	0	0	0	2	1	0	22	57	20	1
Census Tract 5006, Wayne County, Michigan	**16**	$3,664	158	$23,499	100	0	0	0	0	0	0	0	5	40	47	8
Census Tract 5010, Wayne County, Michigan	**16**	$2,972	346	$19,090	99	0	0	0	0	1	0	0	37	36	26	1
Census Tract 5142, Wayne County, Michigan	**16**	$1,893	368	$11,830	97	0	0	0	0	3	0	0	24	40	27	9
Census Tract 5160, Wayne County, Michigan	**16**	$3,456	194	$21,516	95	0	0	0	0	4	0	1	26	33	29	12
Census Tract 5203, Wayne County, Michigan	**16**	$1,143	193	$7,009	22	0	49	0	9	16	3	0	13	25	24	38
Census Tract 5242, Wayne County, Michigan	**16**	$3,080	717	$19,464	6	0	0	0	19	30	2	42	58	23	15	4
Census Tract 5304, Wayne County, Michigan	**16**	$1,934	173	$11,815	98	0	0	0	0	2	0	0	38	24	38	0
Census Tract 5315.02, Wayne County, Michigan	**16**	$2,635	95	$16,095	90	0	0	0	0	0	10	0	13	33	48	6
Census Tract 5327, Wayne County, Michigan	**16**	$2,920	79	$18,166	98	0	0	0	0	2	0	0	13	42	30	15
Census Tract 5384, Wayne County, Michigan	**16**	$3,548	96	$21,990	91	0	0	0	0	5	0	4	1	34	40	26
Census Tract 5408, Wayne County, Michigan	**16**	$3,232	224	$19,924	99	0	0	0	0	1	0	0	15	23	46	17
Census Tract 5512, Wayne County, Michigan	**16**	$2,855	61	$17,734	16	0	0	0	0	82	2	0	0	15	37	48
Census Tract 5579.01, Wayne County, Michigan	**16**	$1,950	118	$12,147	1	0	2	0	1	96	0	0	2	30	20	48
Census Tract 5592, Wayne County, Michigan	**16**	$2,051	102	$12,922	2	0	2	0	1	95	1	0	3	22	46	29
Census Tract 5648, Wayne County, Michigan	**16**	$2,489	167	$15,768	9	0	13	0	1	77	0	0	3	8	28	61
Census Tract 5708, Wayne County, Michigan	**16**	$2,158	447	$13,347	89	0	0	0	1	10	0	1	29	40	28	4
Census Tract 5715, Wayne County, Michigan	**16**	$2,791	495	$17,731	5	0	0	0	1	90	3	1	14	13	48	25
Census Tract 5719, Wayne County, Michigan	**16**	$2,861	278	$17,345	14	0	1	0	0	85	0	0	36	21	24	18
Census Tract 5720, Wayne County, Michigan	**16**	$3,058	131	$19,111	2	0	1	0	1	94	1	0	15	15	40	31
Census Tract 5721, Wayne County, Michigan	**16**	$2,655	603	$16,646	4	0	0	0	0	95	0	0	15	36	32	17
Census Tract 5830.01, Wayne County, Michigan	**16**	$2,946	239	$18,457	6	0	0	0	1	93	1	0	13	44	37	6
Census Tract 5841, Wayne County, Michigan	**16**	$2,446	133	$14,853	3	2	0	0	0	94	1	0	12	57	30	1
Census Tract 5848.01, Wayne County, Michigan	**16**	$1,825	780	$11,646	69	4	0	0	0	27	0	0	18	58	19	5
Census Tract 5855, Wayne County, Michigan	**16**	$2,581	190	$16,551	9	0	0	0	6	82	1	2	18	50	27	5
Census Tract 2417, Macomb County, Michigan	**15**	$2,792	344	$18,436	18	0	4	0	0	71	3	5	12	53	34	2
Census Tract 2512, Macomb County, Michigan	**15**	$1,933	188	$12,913	2	0	0	0	1	95	3	0	2	36	32	30
Census Tract 1340, Oakland County, Michigan	**15**	$1,937	154	$13,042	0	0	1	0	0	99	0	0	3	26	34	37
Census Tract 1360, Oakland County, Michigan	**15**	$1,732	129	$11,401	0	0	0	0	0	99	1	0	12	27	12	49
Census Tract 1503, Oakland County, Michigan	**15**	$2,291	79	$15,331	1	0	3	0	0	95	0	0	0	9	22	69
Census Tract 1540, Oakland County, Michigan	**15**	$2,273	53	$15,115	2	0	0	0	1	97	0	0	0	12	22	66
Census Tract 1546, Oakland County, Michigan	**15**	$3,117	72	$20,462	4	0	1	0	0	94	0	0	1	13	22	63
Census Tract 1561, Oakland County, Michigan	**15**	$3,054	69	$20,541	5	0	3	0	0	91	1	0	2	4	26	67
Census Tract 1574, Oakland County, Michigan	**15**	$2,708	94	$18,566	8	0	2	0	0	89	1	0	2	28	19	52
Census Tract 1606, Oakland County, Michigan	**15**	$2,054	152	$13,744	49	0	0	0	0	48	2	1	5	6	35	54
Census Tract 1620, Oakland County, Michigan	**15**	$2,108	218	$13,938	69	0	0	0	0	28	0	2	5	22	41	31
Census Tract 1670, Oakland County, Michigan	**15**	$1,897	155	$12,777	14	2	2	0	0	82	0	0	1	23	19	58
Census Tract 1687, Oakland County, Michigan	**15**	$2,012	129	$13,013	28	0	3	0	0	68	0	0	2	9	36	53
Census Tract 1735, Oakland County, Michigan	**15**	$1,572	163	$10,409	8	0	1	0	0	88	3	0	2	11	57	30
Census Tract 1802, Oakland County, Michigan	**15**	$1,545	122	$10,476	1	0	1	0	1	96	2	0	6	21	35	38
Census Tract 1967, Oakland County, Michigan	**15**	$1,996	27	$13,144	0	0	3	0	1	95	0	0	0	4	13	83
Census Tract 6480, St. Clair County, Michigan	**15**	$1,526	65	$10,220	0	0	0	0	0	98	2	0	20	26	38	16
Census Tract 5009, Wayne County, Michigan	**15**	$2,716	334	$18,542	96	0	0	0	0	3	1	0	28	39	30	4
Census Tract 5018, Wayne County, Michigan	**15**	$2,646	291	$17,869	83	0	0	0	0	15	2	0	4	12	66	18
Census Tract 5034, Wayne County, Michigan	**15**	$2,564	166	$16,733	87	0	11	0	0	2	1	0	10	65	21	4
Census Tract 5167, Wayne County, Michigan	**15**	$1,707	461	$11,275	98	0	0	0	0	0	2	0	27	29	32	12
Census Tract 5180, Wayne County, Michigan	**15**	$1,702	307	$11,361	67	0	7	0	1	23	2	0	7	27	31	35
Census Tract 5245, Wayne County, Michigan	**15**	$2,967	24	$19,742	7	0	0	0	71	22	0	0	5	27	68	0
Census Tract 5254, Wayne County, Michigan	**15**	$2,488	369	$16,542	48	0	0	0	21	15	7	9	42	31	25	3

Census Tract 5347, Wayne County, Michigan	**15**	$2,613	527	$17,721	80	4	0	0	0	4	13	0	7	55	30	8
Census Tract 5417, Wayne County, Michigan	**15**	$1,801	303	$11,925	98	0	0	0	0	1	0	0	8	31	41	20
Census Tract 5440, Wayne County, Michigan	**15**	$2,517	340	$16,524	88	0	0	0	0	8	1	2	19	24	46	10
Census Tract 5501, Wayne County, Michigan	**15**	$2,979	101	$19,768	7	0	1	0	0	91	0	0	0	12	66	22
Census Tract 5507, Wayne County, Michigan	**15**	$3,060	99	$20,045	1	0	2	0	2	94	1	0	27	20	13	40
Census Tract 5514, Wayne County, Michigan	**15**	$2,705	315	$17,823	63	0	8	0	0	28	1	0	7	32	33	29
Census Tract 5516, Wayne County, Michigan	**15**	$2,946	430	$19,373	79	1	0	0	0	18	2	0	9	36	44	11
Census Tract 5521, Wayne County, Michigan	**15**	$2,509	633	$16,737	23	0	26	0	0	41	9	1	19	36	36	9
Census Tract 5523, Wayne County, Michigan	**15**	$2,631	474	$18,132	2	0	45	0	0	48	1	5	22	44	24	10
Census Tract 5538, Wayne County, Michigan	**15**	$1,758	417	$12,118	84	0	0	0	0	4	11	0	8	13	23	55
Census Tract 5551, Wayne County, Michigan	**15**	$2,320	308	$15,954	23	0	0	0	0	76	1	0	5	30	44	21
Census Tract 5626, Wayne County, Michigan	**15**	$1,887	81	$12,765	1	0	1	0	0	98	1	0	10	22	29	39
Census Tract 5629, Wayne County, Michigan	**15**	$2,351	144	$15,866	1	0	0	0	0	98	1	0	15	38	28	19
Census Tract 5633, Wayne County, Michigan	**15**	$2,381	151	$16,182	6	0	3	0	0	87	4	0	3	32	33	32
Census Tract 5687, Wayne County, Michigan	**15**	$2,818	290	$18,926	20	0	0	0	0	49	30	0	11	13	31	45
Census Tract 5694, Wayne County, Michigan	**15**	$2,279	218	$15,068	6	0	1	0	0	93	0	0	13	33	47	8
Census Tract 5710, Wayne County, Michigan	**15**	$2,163	232	$14,149	92	0	0	0	0	6	2	0	25	38	34	3
Census Tract 5724, Wayne County, Michigan	**15**	$2,693	97	$18,157	5	0	0	0	1	93	2	0	6	49	23	23
Census Tract 5726, Wayne County, Michigan	**15**	$2,469	535	$16,229	8	0	0	0	1	89	2	0	9	31	43	17
Census Tract 5727, Wayne County, Michigan	**15**	$2,498	266	$16,273	3	0	1	0	4	90	1	1	14	31	39	16
Census Tract 5743.01, Wayne County, Michigan	**15**	$2,628	241	$17,578	1	0	1	0	1	97	0	0	12	14	38	36
Census Tract 5748, Wayne County, Michigan	**15**	$2,720	94	$17,563	0	0	0	0	1	97	1	0	14	13	21	53
Census Tract 5750, Wayne County, Michigan	**15**	$1,982	167	$13,633	1	0	0	0	0	98	0	0	32	21	20	27
Census Tract 5755, Wayne County, Michigan	**15**	$2,473	179	$16,571	3	0	0	0	1	87	8	0	6	21	45	28
Census Tract 5773, Wayne County, Michigan	**15**	$2,305	321	$15,130	2	0	0	0	11	82	2	3	24	38	29	9
Census Tract 5796, Wayne County, Michigan	**15**	$2,038	264	$13,610	72	0	0	0	2	2	15	9	12	52	24	13
Census Tract 5797, Wayne County, Michigan	**15**	$1,989	617	$13,428	16	6	0	0	11	54	3	10	39	33	26	2
Census Tract 5818, Wayne County, Michigan	**15**	$2,239	208	$15,418	2	0	0	0	1	97	0	0	7	36	53	5
Census Tract 5862.01, Wayne County, Michigan	**15**	$2,571	347	$17,314	46	0	0	0	0	53	1	0	17	20	56	8
Census Tract 5950, Wayne County, Michigan	**15**	$2,104	326	$14,081	0	0	0	0	1	94	3	2	13	33	47	7
Census Tract 2324, Macomb County, Michigan	**14**	$2,056	433	$14,611	0	0	8	0	0	91	1	0	9	38	34	20
Census Tract 2419, Macomb County, Michigan	**14**	$2,765	257	$20,012	14	0	0	0	1	80	2	3	8	49	42	2
Census Tract 2473.01, Macomb County, Michigan	**14**	$1,734	98	$12,056	4	0	4	0	0	92	0	0	2	27	61	10
Census Tract 2507, Macomb County, Michigan	**14**	$1,849	167	$12,907	4	0	0	0	2	93	1	0	4	37	47	12
Census Tract 2587, Macomb County, Michigan	**14**	$2,776	212	$19,461	47	0	2	0	1	44	5	1	11	42	37	10
Census Tract 1366.02, Oakland County, Michigan	**14**	$2,199	48	$15,674	0	0	2	0	0	98	0	0	8	21	26	45
Census Tract 1502, Oakland County, Michigan	**14**	$2,683	31	$19,779	4	0	6	0	0	90	0	0	0	5	14	81
Census Tract 1505, Oakland County, Michigan	**14**	$2,527	29	$18,103	2	0	2	0	0	96	0	0	0	5	18	77
Census Tract 1542, Oakland County, Michigan	**14**	$2,368	216	$16,829	1	0	2	0	7	90	0	0	9	28	24	39
Census Tract 1623, Oakland County, Michigan	**14**	$1,773	211	$12,602	91	0	0	0	0	6	2	0	3	20	38	38
Census Tract 1678, Oakland County, Michigan	**14**	$1,950	98	$13,745	12	0	3	0	0	81	0	4	3	16	21	60
Census Tract 1734, Oakland County, Michigan	**14**	$1,712	253	$12,055	5	0	1	0	0	93	1	0	16	8	42	33
Census Tract 1837, Oakland County, Michigan	**14**	$1,445	146	$9,980	1	0	1	0	1	96	1	0	1	32	17	50
Census Tract 1964, Oakland County, Michigan	**14**	$2,054	43	$15,149	0	0	17	0	0	82	0	0	0	10	14	75
Census Tract 5119, Wayne County, Michigan	**14**	$1,438	273	$10,425	87	0	1	0	1	11	0	0	24	33	27	16
Census Tract 5238, Wayne County, Michigan	**14**	$2,814	485	$20,507	12	0	0	0	20	29	3	36	53	17	25	4
Census Tract 5257, Wayne County, Michigan	**14**	$2,863	453	$20,560	4	0	0	0	50	19	4	23	44	35	8	13
Census Tract 5262, Wayne County, Michigan	**14**	$2,869	424	$20,017	3	0	0	0	42	36	5	14	59	22	14	4
Census Tract 5312, Wayne County, Michigan	**14**	$3,009	110	$21,726	82	1	0	0	0	16	2	0	3	25	33	39
Census Tract 5513, Wayne County, Michigan	**14**	$2,164	265	$15,719	52	0	1	0	0	37	10	0	17	24	40	19
Census Tract 5515, Wayne County, Michigan	**14**	$3,421	67	$25,253	68	0	2	0	0	28	2	0	5	35	50	10
Census Tract 5518, Wayne County, Michigan	**14**	$2,611	153	$18,978	9	0	2	0	0	89	0	0	2	15	35	48
Census Tract 5524, Wayne County, Michigan	**14**	$2,934	377	$20,380	12	0	28	0	0	53	6	1	34	30	24	11
Census Tract 5528.01, Wayne County, Michigan	**14**	$2,700	546	$18,935	4	0	13	0	0	68	14	0	43	35	14	8
Census Tract 5541, Wayne County, Michigan	**14**	$2,334	364	$16,829	54	0	0	0	0	44	2	0	4	38	49	9
Census Tract 5545, Wayne County, Michigan	**14**	$2,222	279	$15,422	37	0	0	0	0	61	1	0	9	43	36	12
Census Tract 5567, Wayne County, Michigan	**14**	$2,153	41	$15,425	1	0	1	0	0	98	0	0	1	43	30	26
Census Tract 5583.01, Wayne County, Michigan	**14**	$1,934	87	$13,439	3	0	0	0	0	96	1	0	15	30	44	10
Census Tract 5584, Wayne County, Michigan	**14**	$2,124	76	$15,675	2	0	2	0	0	95	0	0	2	16	58	25
Census Tract 5588, Wayne County, Michigan	**14**	$2,137	84	$15,634	1	0	3	0	0	94	1	0	11	21	37	30
Census Tract 5602.02, Wayne County, Michigan	**14**	$1,705	91	$12,093	2	0	5	0	1	92	0	0	0	22	30	48
Census Tract 5638, Wayne County, Michigan	**14**	$2,917	84	$21,605	20	0	2	0	0	77	1	0	0	17	52	31

Census Tract 5646, Wayne County, Michigan	**14**	$2,412	112	$17,251	1	0	17	0	0	80	1	0	0	13	20	66
Census Tract 5651, Wayne County, Michigan	**14**	$2,067	309	$14,546	40	0	4	0	0	53	1	1	7	30	51	12
Census Tract 5656, Wayne County, Michigan	**14**	$2,409	41	$17,031	1	0	0	0	0	97	1	0	11	26	54	9
Census Tract 5658, Wayne County, Michigan	**14**	$2,033	284	$14,069	12	0	0	0	2	84	0	1	20	35	37	7
Census Tract 5666, Wayne County, Michigan	**14**	$2,096	88	$15,079	24	3	0	0	2	70	1	0	12	35	38	16
Census Tract 5696, Wayne County, Michigan	**14**	$2,209	153	$15,456	3	0	1	0	0	95	0	0	7	41	44	8
Census Tract 5709, Wayne County, Michigan	**14**	$2,191	296	$15,405	95	0	0	0	0	3	1	1	26	27	41	6
Census Tract 5725, Wayne County, Michigan	**14**	$2,624	119	$18,419	9	0	0	0	2	87	2	0	9	42	39	9
Census Tract 5729, Wayne County, Michigan	**14**	$2,411	210	$16,925	8	0	0	0	0	91	0	0	13	42	33	13
Census Tract 5734, Wayne County, Michigan	**14**	$2,567	378	$18,224	2	0	0	0	0	97	1	0	19	27	38	16
Census Tract 5735.01, Wayne County, Michigan	**14**	$2,599	567	$18,665	3	0	1	0	0	90	6	0	54	15	22	10
Census Tract 5737.01, Wayne County, Michigan	**14**	$2,886	164	$20,489	3	0	0	0	1	86	11	0	34	20	19	26
Census Tract 5737.02, Wayne County, Michigan	**14**	$2,831	644	$20,426	1	0	0	0	0	98	1	0	33	32	22	13
Census Tract 5752, Wayne County, Michigan	**14**	$2,483	225	$18,367	3	0	1	0	2	91	2	0	6	28	47	19
Census Tract 5753, Wayne County, Michigan	**14**	$2,256	127	$15,570	4	0	0	0	2	92	1	0	6	21	49	24
Census Tract 5754.01, Wayne County, Michigan	**14**	$2,406	149	$17,699	1	0	0	0	2	94	3	0	2	22	55	22
Census Tract 5761, Wayne County, Michigan	**14**	$2,100	450	$14,630	2	0	0	0	11	82	2	4	8	28	44	20
Census Tract 5771, Wayne County, Michigan	**14**	$1,828	336	$13,299	8	1	0	0	10	58	9	14	28	49	22	1
Census Tract 5777, Wayne County, Michigan	**14**	$2,105	98	$14,864	1	1	0	0	1	85	2	10	11	45	32	12
Census Tract 5799, Wayne County, Michigan	**14**	$1,886	283	$13,360	2	0	5	0	1	91	1	0	13	21	26	40
Census Tract 5806, Wayne County, Michigan	**14**	$1,633	218	$11,853	2	1	0	0	3	85	0	9	12	45	32	11
Census Tract 5811.01, Wayne County, Michigan	**14**	$2,005	201	$14,842	13	0	11	0	0	75	1	0	6	26	53	15
Census Tract 5821, Wayne County, Michigan	**14**	$2,381	119	$16,790	0	0	0	0	1	97	1	0	5	36	46	13
Census Tract 5834, Wayne County, Michigan	**14**	$2,387	283	$16,534	4	0	0	0	2	92	1	1	9	41	44	6
Census Tract 5835, Wayne County, Michigan	**14**	$2,663	133	$18,858	2	0	0	0	1	97	0	0	7	59	27	8
Census Tract 5836, Wayne County, Michigan	**14**	$2,450	121	$17,942	1	0	0	0	0	97	1	0	17	32	33	18
Census Tract 5845.01, Wayne County, Michigan	**14**	$2,334	125	$16,565	30	2	0	0	0	64	0	3	15	54	29	3
Census Tract 5848.02, Wayne County, Michigan	**14**	$2,118	356	$15,459	48	0	0	0	0	51	0	0	16	44	26	14
Census Tract 5859, Wayne County, Michigan	**14**	$1,471	334	$10,357	34	0	0	0	0	61	1	3	30	36	12	21
Census Tract 5879, Wayne County, Michigan	**14**	$2,022	468	$14,841	52	0	2	0	0	45	1	0	27	40	16	17
Census Tract 5880.02, Wayne County, Michigan	**14**	$2,541	104	$18,557	8	0	0	0	0	87	5	0	4	36	31	29
Census Tract 5884, Wayne County, Michigan	**14**	$3,029	112	$21,662	3	1	1	0	0	95	1	0	22	17	24	37
Census Tract 2406.01, Macomb County, Michigan	**13**	$2,186	200	$16,427	15	0	5	0	5	69	6	0	7	49	37	7
Census Tract 2418, Macomb County, Michigan	**13**	$1,798	451	$13,572	40	0	3	0	0	54	0	3	9	46	38	6
Census Tract 2420.01, Macomb County, Michigan	**13**	$2,105	66	$16,676	4	0	0	0	0	93	3	0	13	39	46	1
Census Tract 2508, Macomb County, Michigan	**13**	$1,945	124	$14,905	2	0	0	0	1	96	1	0	9	34	42	15
Census Tract 2511, Macomb County, Michigan	**13**	$2,216	61	$16,444	4	0	0	0	0	94	1	0	2	24	52	22
Census Tract 2520, Macomb County, Michigan	**13**	$1,803	123	$14,056	3	0	0	0	0	89	4	3	6	14	58	22
Census Tract 2561, Macomb County, Michigan	**13**	$1,985	231	$15,052	20	0	0	0	2	72	2	4	15	39	40	6
Census Tract 2564, Macomb County, Michigan	**13**	$1,941	79	$14,519	23	0	0	0	1	69	7	0	10	53	34	3
Census Tract 2586, Macomb County, Michigan	**13**	$2,183	402	$16,517	57	0	0	0	0	39	3	0	12	31	42	15
Census Tract 2621, Macomb County, Michigan	**13**	$2,046	95	$15,175	16	0	0	0	0	76	9	0	31	29	23	17
Census Tract 1345, Oakland County, Michigan	**13**	$2,339	34	$18,040	0	0	0	0	0	100	0	0	67	7	14	12
Census Tract 1423, Oakland County, Michigan	**13**	$1,469	408	$11,626	81	0	4	0	0	13	2	0	31	35	26	8
Census Tract 1500, Oakland County, Michigan	**13**	$2,057	232	$15,497	5	0	3	0	1	91	0	0	10	7	14	69
Census Tract 1562, Oakland County, Michigan	**13**	$2,310	260	$17,964	0	0	1	0	1	98	0	0	1	16	56	28
Census Tract 1564, Oakland County, Michigan	**13**	$2,594	96	$20,181	2	0	2	0	0	95	0	0	3	10	11	76
Census Tract 1573, Oakland County, Michigan	**13**	$2,115	79	$16,299	10	0	2	0	0	88	0	0	4	6	16	75
Census Tract 1576, Oakland County, Michigan	**13**	$2,519	123	$19,272	10	0	6	0	0	84	1	0	10	17	9	63
Census Tract 1600, Oakland County, Michigan	**13**	$2,028	65	$15,573	63	0	0	0	1	36	0	0	2	15	26	58
Census Tract 1607, Oakland County, Michigan	**13**	$2,706	19	$20,324	81	0	0	0	0	19	1	0	4	8	22	65
Census Tract 1610, Oakland County, Michigan	**13**	$1,510	149	$12,025	85	0	1	0	0	14	1	0	26	15	27	32
Census Tract 1613, Oakland County, Michigan	**13**	$1,985	187	$15,273	60	0	0	0	0	40	0	0	6	28	23	43
Census Tract 1616, Oakland County, Michigan	**13**	$1,521	147	$11,319	74	0	1	0	1	21	3	0	4	31	43	22
Census Tract 1625, Oakland County, Michigan	**13**	$1,656	311	$12,864	76	0	0	0	0	23	0	0	7	33	46	14
Census Tract 1661, Oakland County, Michigan	**13**	$1,701	112	$13,024	28	0	1	0	0	71	0	0	6	16	45	32
Census Tract 1667, Oakland County, Michigan	**13**	$2,389	56	$18,260	35	1	3	0	1	50	10	0	2	29	16	53
Census Tract 1669, Oakland County, Michigan	**13**	$2,386	109	$18,298	28	0	0	0	0	65	6	0	5	5	23	67
Census Tract 1686.02, Oakland County, Michigan	**13**	$1,782	135	$13,799	16	0	10	0	0	74	0	0	1	23	34	42
Census Tract 1689.01, Oakland County, Michigan	**13**	$1,440	81	$11,496	27	0	27	0	1	37	8	0	0	15	36	48
Census Tract 1833, Oakland County, Michigan	**13**	$1,504	105	$11,375	3	0	1	0	1	95	0	0	3	15	32	51
Census Tract 1836, Oakland County, Michigan	**13**	$1,438	120	$11,259	3	0	1	0	0	96	0	0	4	12	24	60

Census Tract 1842, Oakland County, Michigan	**13**	$1,453	194	$11,235	6	0	2	0	5	83	5	0	14	7	23	56
Census Tract 1961, Oakland County, Michigan	**13**	$1,948	115	$15,431	0	0	9	0	0	90	0	0	0	9	22	69
Census Tract 1979, Oakland County, Michigan	**13**	$1,968	43	$15,558	0	0	4	0	1	95	0	0	0	5	22	73
Census Tract 5067, Wayne County, Michigan	**13**	$3,160	49	$24,484	98	0	0	0	1	2	0	0	13	36	46	4
Census Tract 5208, Wayne County, Michigan	**13**	$500	46	$3,812	50	0	49	0	0	1	0	0	0	0	45	55
Census Tract 5218, Wayne County, Michigan	**13**	$1,237	427	$9,581	94	0	0	0	0	5	1	1	25	26	44	6
Census Tract 5243, Wayne County, Michigan	**13**	$2,971	372	$23,121	4	0	0	0	23	21	5	47	55	29	14	2
Census Tract 5259, Wayne County, Michigan	**13**	$3,125	299	$23,552	22	0	0	0	23	13	7	36	45	25	24	6
Census Tract 5339, Wayne County, Michigan	**13**	$1,303	418	$10,374	64	0	12	0	1	22	1	0	11	25	46	18
Census Tract 5383, Wayne County, Michigan	**13**	$1,238	216	$9,839	93	0	5	0	0	2	0	0	11	23	21	45
Census Tract 5505, Wayne County, Michigan	**13**	$2,693	61	$20,494	2	0	2	0	0	94	2	0	2	36	16	45
Census Tract 5522, Wayne County, Michigan	**13**	$2,682	368	$20,080	3	0	26	0	0	66	4	0	26	37	23	14
Census Tract 5542, Wayne County, Michigan	**13**	$2,069	235	$16,333	19	0	0	0	1	75	5	0	13	45	32	9
Census Tract 5544, Wayne County, Michigan	**13**	$2,341	207	$17,606	49	0	2	0	0	47	3	0	9	41	43	8
Census Tract 5546, Wayne County, Michigan	**13**	$1,953	124	$14,622	25	0	0	0	2	73	1	0	7	26	48	19
Census Tract 5547, Wayne County, Michigan	**13**	$1,918	65	$14,911	37	0	0	0	0	62	0	0	24	36	23	17
Census Tract 5562, Wayne County, Michigan	**13**	$1,686	166	$13,213	6	0	1	0	0	93	0	0	52	15	21	13
Census Tract 5569, Wayne County, Michigan	**13**	$1,991	84	$15,517	1	0	3	0	1	95	0	0	2	25	45	29
Census Tract 5580, Wayne County, Michigan	**13**	$1,920	125	$15,326	1	0	0	0	0	96	2	0	1	27	42	30
Census Tract 5581, Wayne County, Michigan	**13**	$2,121	115	$16,908	4	0	1	0	1	92	2	0	11	27	36	26
Census Tract 5582, Wayne County, Michigan	**13**	$2,387	93	$18,592	5	0	0	0	0	93	1	0	11	23	38	28
Census Tract 5586, Wayne County, Michigan	**13**	$2,063	25	$16,134	4	0	1	0	1	94	0	0	19	20	40	21
Census Tract 5598, Wayne County, Michigan	**13**	$1,562	845	$12,391	95	0	0	0	0	3	1	0	40	21	30	9
Census Tract 5616, Wayne County, Michigan	**13**	$1,722	254	$13,662	3	0	1	0	0	96	0	0	9	25	27	39
Census Tract 5639, Wayne County, Michigan	**13**	$2,652	38	$20,329	4	0	15	0	0	80	2	0	1	18	29	52
Census Tract 5642, Wayne County, Michigan	**13**	$2,112	216	$16,492	5	0	4	0	0	90	1	0	26	26	18	30
Census Tract 5649, Wayne County, Michigan	**13**	$2,231	207	$17,126	1	0	0	0	1	86	13	0	10	44	43	3
Census Tract 5665, Wayne County, Michigan	**13**	$1,420	231	$10,737	31	0	4	0	0	64	1	0	42	19	38	1
Census Tract 5668, Wayne County, Michigan	**13**	$2,005	196	$15,756	43	1	0	0	2	54	0	1	22	21	45	12
Census Tract 5692, Wayne County, Michigan	**13**	$1,859	237	$14,002	8	0	0	0	2	89	1	0	37	27	27	9
Census Tract 5699, Wayne County, Michigan	**13**	$2,168	181	$16,432	2	0	1	0	3	93	2	0	13	42	37	7
Census Tract 5701, Wayne County, Michigan	**13**	$1,859	536	$14,331	70	0	1	0	0	27	2	0	21	23	47	9
Census Tract 5704, Wayne County, Michigan	**13**	$2,136	661	$16,160	80	0	0	0	0	19	1	0	41	34	23	1
Census Tract 5716, Wayne County, Michigan	**13**	$1,819	263	$14,274	13	0	0	0	0	87	0	0	18	38	31	13
Census Tract 5717, Wayne County, Michigan	**13**	$2,454	237	$18,685	14	0	0	0	1	83	2	0	35	15	40	10
Census Tract 5730, Wayne County, Michigan	**13**	$2,827	98	$21,126	1	0	1	0	2	94	1	0	14	18	42	26
Census Tract 5733, Wayne County, Michigan	**13**	$2,780	376	$21,939	0	0	0	0	0	95	4	0	38	17	21	24
Census Tract 5741, Wayne County, Michigan	**13**	$2,618	492	$19,922	1	0	1	0	0	93	5	0	24	22	28	26
Census Tract 5763, Wayne County, Michigan	**13**	$2,325	60	$18,100	1	0	0	0	2	92	3	1	5	38	35	21
Census Tract 5764, Wayne County, Michigan	**13**	$1,887	150	$14,169	3	0	0	0	4	87	5	1	3	27	43	27
Census Tract 5776, Wayne County, Michigan	**13**	$2,190	344	$17,264	1	1	0	0	6	86	2	4	9	37	40	14
Census Tract 5786, Wayne County, Michigan	**13**	$1,831	669	$14,593	8	1	0	0	7	77	3	5	26	43	24	7
Census Tract 5792, Wayne County, Michigan	**13**	$1,652	621	$12,740	36	0	0	0	5	53	1	5	20	52	24	4
Census Tract 5793, Wayne County, Michigan	**13**	$1,780	500	$13,664	93	0	0	0	0	3	3	0	24	23	47	5
Census Tract 5815, Wayne County, Michigan	**13**	$2,147	91	$16,193	0	1	0	0	1	95	1	2	6	44	42	8
Census Tract 5816, Wayne County, Michigan	**13**	$1,810	203	$13,930	6	0	8	0	0	79	5	1	7	32	45	16
Census Tract 5820, Wayne County, Michigan	**13**	$1,708	264	$12,972	10	0	3	0	4	68	1	14	7	51	35	7
Census Tract 5831.01, Wayne County, Michigan	**13**	$2,475	309	$19,638	7	2	0	0	1	89	1	0	32	44	21	3
Census Tract 5833, Wayne County, Michigan	**13**	$2,369	162	$18,271	3	0	0	0	0	93	3	1	17	46	34	3
Census Tract 5842, Wayne County, Michigan	**13**	$2,040	289	$15,196	21	0	1	0	0	77	0	0	12	46	40	2
Census Tract 5844, Wayne County, Michigan	**13**	$2,107	190	$16,506	15	0	0	0	0	82	2	0	17	57	18	8
Census Tract 5856, Wayne County, Michigan	**13**	$1,929	312	$14,821	87	0	1	0	0	10	1	0	30	30	35	6
Census Tract 5916, Wayne County, Michigan	**13**	$2,257	33	$17,993	7	0	3	0	2	86	0	2	18	26	36	21
Census Tract 2306.04, Macomb County, Michigan	**12**	$1,871	100	$15,454	1	0	2	0	0	98	0	0	23	8	36	33
Census Tract 2315, Macomb County, Michigan	**12**	$2,329	245	$18,640	0	0	4	0	0	95	1	0	28	23	28	21
Census Tract 2325, Macomb County, Michigan	**12**	$2,203	178	$18,479	2	0	1	0	0	96	0	0	9	20	40	31
Census Tract 2407, Macomb County, Michigan	**12**	$2,181	82	$18,354	1	0	1	0	0	97	1	0	8	24	52	16
Census Tract 2453, Macomb County, Michigan	**12**	$1,651	373	$13,626	9	0	0	0	0	90	0	0	27	38	30	5
Census Tract 2472.01, Macomb County, Michigan	**12**	$1,565	95	$12,956	7	0	0	0	1	92	0	0	5	46	40	9
Census Tract 2474, Macomb County, Michigan	**12**	$1,848	76	$16,041	0	0	0	0	0	99	0	0	6	33	56	6
Census Tract 2505, Macomb County, Michigan	**12**	$1,917	105	$15,870	2	0	0	0	0	96	2	0	12	23	37	28
Census Tract 2515, Macomb County, Michigan	**12**	$1,918	136	$15,947	9	0	0	0	1	90	0	0	12	21	48	19

Census Tract 2516, Macomb County, Michigan	**12**	$1,622	219	$13,040	3	0	0	0	0	94	2	0	2	51	39	9
Census Tract 2517, Macomb County, Michigan	**12**	$1,498	238	$12,907	10	0	1	0	1	87	1	0	9	31	43	17
Census Tract 2540, Macomb County, Michigan	**12**	$2,213	53	$19,015	2	0	0	0	0	97	0	0	3	18	60	18
Census Tract 2584, Macomb County, Michigan	**12**	$2,175	362	$18,017	45	0	1	0	1	48	5	0	18	31	43	7
Census Tract 2629, Macomb County, Michigan	**12**	$2,034	390	$17,493	16	0	2	0	1	79	2	0	26	39	31	4
Census Tract 2684, Macomb County, Michigan	**12**	$1,909	458	$16,309	24	0	0	0	0	72	4	0	9	54	37	1
Census Tract 1508, Oakland County, Michigan	**12**	$2,158	64	$17,525	5	0	4	0	0	90	1	0	1	6	10	84
Census Tract 1530, Oakland County, Michigan	**12**	$1,796	114	$14,785	0	0	1	0	2	97	0	0	3	5	13	79
Census Tract 1605, Oakland County, Michigan	**12**	$2,051	176	$17,232	52	0	0	0	0	46	1	0	18	12	28	42
Census Tract 1650, Oakland County, Michigan	**12**	$1,397	167	$11,594	7	0	1	0	0	91	1	0	3	18	45	34
Census Tract 1652, Oakland County, Michigan	**12**	$1,917	108	$16,085	36	0	6	0	0	47	10	1	0	14	28	58
Census Tract 1665, Oakland County, Michigan	**12**	$1,956	89	$16,399	8	1	3	0	0	87	0	0	4	20	26	51
Census Tract 1668, Oakland County, Michigan	**12**	$1,934	83	$16,644	47	0	0	0	0	51	2	0	11	18	13	57
Census Tract 1673, Oakland County, Michigan	**12**	$1,597	159	$12,848	22	0	5	0	1	71	1	0	6	17	42	36
Census Tract 1675, Oakland County, Michigan	**12**	$1,625	680	$12,994	11	0	1	0	1	86	2	0	6	65	14	14
Census Tract 1701, Oakland County, Michigan	**12**	$1,693	57	$13,544	2	0	0	0	1	88	9	0	0	14	36	49
Census Tract 1730, Oakland County, Michigan	**12**	$1,564	324	$12,793	4	0	0	0	0	92	3	0	4	16	42	38
Census Tract 1731, Oakland County, Michigan	**12**	$1,688	79	$14,074	7	0	0	0	0	90	2	0	10	10	34	46
Census Tract 1752, Oakland County, Michigan	**12**	$1,841	557	$15,398	17	0	1	0	0	77	5	0	7	45	35	13
Census Tract 1803, Oakland County, Michigan	**12**	$1,343	210	$11,660	0	0	0	0	1	97	1	0	4	35	30	31
Census Tract 1834, Oakland County, Michigan	**12**	$1,408	116	$11,959	3	0	1	0	2	92	2	0	13	9	15	64
Census Tract 1960, Oakland County, Michigan	**12**	$2,107	81	$17,147	0	0	14	0	0	85	1	0	0	12	31	58
Census Tract 1972, Oakland County, Michigan	**12**	$2,202	56	$18,824	0	0	19	0	0	81	0	0	0	13	20	67
Census Tract 1973, Oakland County, Michigan	**12**	$1,864	151	$15,924	0	0	6	0	0	92	1	0	16	25	20	38
Census Tract 1977.01, Oakland County, Michigan	**12**	$1,181	102	$9,954	1	0	10	0	3	85	1	0	4	1	15	79
Census Tract 5080, Wayne County, Michigan	**12**	$1,506	434	$12,619	79	0	0	0	0	20	0	1	28	48	23	2
Census Tract 5153, Wayne County, Michigan	**12**	$1,335	532	$10,702	72	0	0	0	0	21	4	2	32	37	18	13
Census Tract 5175, Wayne County, Michigan	**12**	$1,129	722	$9,634	77	0	7	0	0	14	1	1	20	40	21	19
Census Tract 5561, Wayne County, Michigan	**12**	$2,607	176	$21,444	5	0	2	0	1	87	5	0	13	33	36	17
Census Tract 5564, Wayne County, Michigan	**12**	$1,715	140	$14,351	0	0	0	0	0	99	0	0	0	23	50	27
Census Tract 5572, Wayne County, Michigan	**12**	$1,923	107	$15,842	1	0	1	0	1	97	1	0	3	27	46	24
Census Tract 5573, Wayne County, Michigan	**12**	$2,117	45	$17,336	3	0	0	0	1	96	0	0	21	24	44	12
Census Tract 5576, Wayne County, Michigan	**12**	$1,954	47	$16,932	0	0	0	0	1	99	1	0	3	21	37	39
Census Tract 5585, Wayne County, Michigan	**12**	$2,056	149	$17,261	1	0	0	0	1	98	0	0	2	29	49	20
Census Tract 5587, Wayne County, Michigan	**12**	$2,614	61	$21,197	2	0	1	0	0	96	0	0	1	19	44	36
Census Tract 5591, Wayne County, Michigan	**12**	$2,422	93	$20,336	6	0	0	0	3	90	1	0	1	30	34	35
Census Tract 5643, Wayne County, Michigan	**12**	$2,151	66	$17,485	1	0	6	0	1	92	0	0	18	12	29	42
Census Tract 5667, Wayne County, Michigan	**12**	$2,242	326	$18,250	3	0	0	0	0	92	3	1	14	41	41	3
Census Tract 5669, Wayne County, Michigan	**12**	$1,885	438	$15,388	33	0	0	0	0	65	1	0	14	41	42	3
Census Tract 5672.02, Wayne County, Michigan	**12**	$1,718	130	$14,406	32	0	1	0	0	62	4	0	21	21	35	23
Census Tract 5678, Wayne County, Michigan	**12**	$1,721	393	$14,698	24	0	1	0	0	73	1	0	13	33	37	17
Census Tract 5682, Wayne County, Michigan	**12**	$2,376	153	$19,461	11	0	0	0	1	86	2	0	33	35	24	7
Census Tract 5683, Wayne County, Michigan	**12**	$2,031	269	$16,966	23	0	0	0	1	72	3	1	20	35	38	7
Census Tract 5684, Wayne County, Michigan	**12**	$2,377	231	$19,452	13	0	1	0	1	76	8	1	12	38	47	4
Census Tract 5685, Wayne County, Michigan	**12**	$1,970	531	$16,370	21	0	0	0	1	71	3	4	25	29	44	2
Census Tract 5693, Wayne County, Michigan	**12**	$1,881	185	$15,756	1	0	0	0	1	96	1	0	7	46	39	8
Census Tract 5695, Wayne County, Michigan	**12**	$2,201	200	$18,832	0	0	0	0	0	94	5	0	9	39	47	6
Census Tract 5705, Wayne County, Michigan	**12**	$1,987	264	$16,423	76	0	0	0	1	20	3	0	18	34	43	5
Census Tract 5728, Wayne County, Michigan	**12**	$2,461	372	$20,821	4	0	1	0	2	93	0	0	11	44	28	17
Census Tract 5736, Wayne County, Michigan	**12**	$2,333	873	$19,667	3	0	0	0	1	96	1	0	49	21	16	14
Census Tract 5738, Wayne County, Michigan	**12**	$2,562	599	$20,950	0	0	1	0	0	89	9	0	43	24	19	13
Census Tract 5739, Wayne County, Michigan	**12**	$2,807	509	$23,037	0	0	0	0	0	100	0	0	29	33	18	19
Census Tract 5740, Wayne County, Michigan	**12**	$2,427	584	$20,893	0	0	0	0	0	97	3	0	30	29	28	12
Census Tract 5747, Wayne County, Michigan	**12**	$2,895	132	$24,066	0	0	0	0	2	97	1	0	3	12	47	38
Census Tract 5756, Wayne County, Michigan	**12**	$2,602	115	$21,246	4	0	5	0	1	90	0	0	6	25	43	27
Census Tract 5762, Wayne County, Michigan	**12**	$1,707	70	$14,206	2	0	0	0	2	95	0	0	15	42	34	9
Census Tract 5767, Wayne County, Michigan	**12**	$2,081	164	$17,757	5	0	0	0	2	89	3	1	12	22	45	22
Census Tract 5778, Wayne County, Michigan	**12**	$2,081	280	$17,676	2	0	0	0	5	90	0	3	26	36	33	5
Census Tract 5791, Wayne County, Michigan	**12**	$1,704	318	$14,430	31	1	0	0	1	63	1	3	16	47	37	0
Census Tract 5798, Wayne County, Michigan	**12**	$1,959	256	$16,280	53	3	0	0	4	31	9	0	13	31	42	14
Census Tract 5837, Wayne County, Michigan	**12**	$2,093	142	$17,469	10	0	0	0	1	87	1	1	18	37	31	14
Census Tract 5863, Wayne County, Michigan	**12**	$2,554	59	$21,585	4	0	0	0	0	95	0	0	13	44	39	5

Census Tract 9851, Wayne County, Michigan	**12**	$1,406	10	$11,880	74	0	0	0	0	0	26	0	16	3	0	81
Census Tract 9853, Wayne County, Michigan	**12**	$1,160	13	$9,464	27	0	0	0	64	9	0	0	40	11	35	14
Census Tract 2304, Macomb County, Michigan	**11**	$1,821	186	$16,542	0	0	0	0	0	95	5	0	4	27	37	32
Census Tract 2305.02, Macomb County, Michigan	**11**	$790	20	$7,148	0	0	0	0	0	100	0	0	0	100	0	0
Census Tract 2306.02, Macomb County, Michigan	**11**	$2,194	387	$19,198	1	0	5	0	0	93	0	0	24	22	35	19
Census Tract 2307, Macomb County, Michigan	**11**	$2,406	190	$22,199	0	0	7	0	0	91	1	0	24	17	31	29
Census Tract 2311, Macomb County, Michigan	**11**	$1,627	279	$15,227	2	0	3	0	0	93	3	0	14	40	23	24
Census Tract 2323.01, Macomb County, Michigan	**11**	$1,808	356	$17,005	1	0	4	0	0	94	1	0	22	32	30	16
Census Tract 2400, Macomb County, Michigan	**11**	$1,626	612	$14,526	34	0	0	0	0	60	5	0	17	47	31	5
Census Tract 2404, Macomb County, Michigan	**11**	$1,665	330	$15,048	5	0	0	0	0	94	0	0	12	42	38	8
Census Tract 2435.01, Macomb County, Michigan	**11**	$1,827	93	$17,000	1	0	0	0	4	95	0	0	17	17	34	32
Census Tract 2450, Macomb County, Michigan	**11**	$1,575	558	$14,858	37	0	0	0	0	60	2	0	29	42	24	6
Census Tract 2452, Macomb County, Michigan	**11**	$1,892	144	$17,287	22	0	0	0	0	77	1	0	7	44	46	3
Census Tract 2476.02, Macomb County, Michigan	**11**	$1,354	487	$12,654	4	0	0	0	0	95	0	0	9	38	41	12
Census Tract 2501, Macomb County, Michigan	**11**	$1,958	117	$18,319	7	0	0	0	0	91	2	0	4	28	43	24
Census Tract 2506, Macomb County, Michigan	**11**	$2,067	128	$19,583	0	0	0	0	0	97	2	0	5	34	46	16
Census Tract 2510, Macomb County, Michigan	**11**	$1,938	61	$17,884	1	0	0	0	0	96	3	0	9	20	50	21
Census Tract 2513, Macomb County, Michigan	**11**	$2,125	99	$18,586	0	0	0	0	2	97	1	0	5	25	50	20
Census Tract 2514, Macomb County, Michigan	**11**	$2,024	153	$18,835	1	0	0	0	1	97	1	0	5	33	52	10
Census Tract 2542, Macomb County, Michigan	**11**	$1,646	305	$14,352	1	0	0	0	0	98	1	0	15	49	28	8
Census Tract 2551, Macomb County, Michigan	**11**	$1,622	271	$15,268	6	0	0	0	2	89	0	2	19	41	32	8
Census Tract 2553, Macomb County, Michigan	**11**	$1,785	344	$15,576	24	0	1	2	0	68	1	5	13	35	43	9
Census Tract 2554, Macomb County, Michigan	**11**	$2,168	91	$20,375	5	0	0	0	0	91	4	0	30	26	43	2
Census Tract 2555, Macomb County, Michigan	**11**	$1,750	88	$15,440	14	0	0	0	0	84	0	1	12	29	49	10
Census Tract 2556, Macomb County, Michigan	**11**	$1,998	255	$18,099	8	0	0	0	0	85	7	0	14	35	39	12
Census Tract 2557, Macomb County, Michigan	**11**	$2,021	111	$18,249	21	0	0	0	0	78	1	0	24	27	44	5
Census Tract 2558, Macomb County, Michigan	**11**	$1,901	124	$18,002	19	0	0	0	0	79	1	0	16	47	33	4
Census Tract 2559, Macomb County, Michigan	**11**	$2,126	164	$19,975	16	0	0	1	4	77	2	1	12	28	57	2
Census Tract 2562, Macomb County, Michigan	**11**	$1,761	157	$15,632	15	0	0	0	0	78	7	0	16	37	38	9
Census Tract 2568, Macomb County, Michigan	**11**	$2,005	140	$17,742	7	0	0	0	1	91	1	0	18	39	38	6
Census Tract 2581, Macomb County, Michigan	**11**	$2,169	196	$20,340	32	0	0	0	0	63	3	3	8	35	38	20
Census Tract 2583, Macomb County, Michigan	**11**	$1,768	224	$16,517	40	0	0	0	0	56	3	0	20	27	43	11
Census Tract 2604, Macomb County, Michigan	**11**	$1,644	179	$15,636	4	0	7	0	1	88	1	0	7	35	44	14
Census Tract 2606, Macomb County, Michigan	**11**	$2,060	233	$19,470	3	0	6	0	0	89	2	0	16	38	31	15
Census Tract 2612, Macomb County, Michigan	**11**	$1,717	111	$14,961	8	0	2	0	0	88	1	0	11	28	50	10
Census Tract 2613, Macomb County, Michigan	**11**	$1,893	133	$16,947	5	0	1	0	2	92	0	0	8	40	41	10
Census Tract 2625, Macomb County, Michigan	**11**	$1,569	572	$14,785	13	0	17	0	1	68	1	0	20	36	34	10
Census Tract 2628, Macomb County, Michigan	**11**	$1,813	190	$16,325	22	0	4	0	4	70	1	0	23	27	47	2
Census Tract 2636, Macomb County, Michigan	**11**	$2,304	600	$20,690	42	3	23	0	1	29	1	0	16	28	47	9
Census Tract 2639, Macomb County, Michigan	**11**	$2,030	363	$18,130	41	0	1	0	5	51	2	1	14	43	40	3
Census Tract 2642, Macomb County, Michigan	**11**	$1,957	597	$17,308	46	0	2	0	1	50	1	0	22	43	28	8
Census Tract 1349, Oakland County, Michigan	**11**	$1,466	279	$13,246	1	0	0	0	0	97	2	0	12	41	18	29
Census Tract 1363, Oakland County, Michigan	**11**	$1,950	61	$18,237	0	0	0	0	0	99	0	0	1	35	14	50
Census Tract 1365, Oakland County, Michigan	**11**	$1,986	101	$17,882	0	0	1	0	0	98	1	0	0	5	42	53
Census Tract 1367, Oakland County, Michigan	**11**	$1,892	70	$17,864	0	0	0	0	1	99	0	0	14	48	3	34
Census Tract 1575, Oakland County, Michigan	**11**	$1,351	238	$12,096	9	0	3	0	0	87	1	0	2	22	17	60
Census Tract 1581, Oakland County, Michigan	**11**	$1,933	92	$16,823	15	0	1	0	1	83	0	0	0	4	12	83
Census Tract 1615, Oakland County, Michigan	**11**	$2,109	28	$18,884	86	0	0	0	0	12	2	0	3	16	35	46
Census Tract 1618, Oakland County, Michigan	**11**	$1,736	228	$15,770	73	0	0	0	1	22	4	0	6	22	38	34
Census Tract 1624, Oakland County, Michigan	**11**	$2,033	110	$19,287	73	0	1	0	0	13	12	1	7	30	25	38
Census Tract 1651, Oakland County, Michigan	**11**	$1,811	137	$16,799	10	0	0	0	0	88	1	0	3	15	34	49
Census Tract 1664, Oakland County, Michigan	**11**	$2,392	39	$21,798	8	0	0	0	0	90	1	0	15	16	9	60
Census Tract 1679, Oakland County, Michigan	**11**	$2,151	23	$19,872	36	0	1	0	0	61	2	0	4	6	17	73
Census Tract 1702, Oakland County, Michigan	**11**	$1,829	57	$16,162	4	0	0	0	1	93	1	0	10	27	31	32
Census Tract 1711, Oakland County, Michigan	**11**	$1,840	100	$16,172	43	0	1	0	0	50	6	0	2	32	36	30
Census Tract 1712, Oakland County, Michigan	**11**	$1,739	143	$16,446	35	0	3	0	1	59	3	0	9	12	46	33
Census Tract 1716, Oakland County, Michigan	**11**	$1,886	193	$17,139	60	0	1	0	0	37	1	0	23	21	38	18
Census Tract 1751, Oakland County, Michigan	**11**	$1,523	637	$14,033	6	0	0	0	0	89	4	0	12	38	42	9
Census Tract 1753, Oakland County, Michigan	**11**	$1,975	339	$17,313	23	0	0	0	0	73	2	0	11	23	44	22
Census Tract 1801, Oakland County, Michigan	**11**	$1,737	133	$15,774	0	0	0	0	1	99	0	0	5	19	50	26
Census Tract 1815, Oakland County, Michigan	**11**	$1,747	201	$15,950	6	0	0	0	2	87	4	0	21	39	25	15
Census Tract 1816, Oakland County, Michigan	**11**	$1,800	463	$15,915	10	0	0	0	0	86	3	0	15	35	28	22

Census Tract 1831, Oakland County, Michigan	**11**	$1,679	199	$15,908	1	0	1	0	1	92	3	1	3	13	27	57
Census Tract 1840, Oakland County, Michigan	**11**	$1,593	39	$15,103	2	0	1	0	0	96	1	0	1	11	25	63
Census Tract 1841, Oakland County, Michigan	**11**	$1,795	51	$16,906	11	0	0	0	0	85	3	0	0	14	36	50
Census Tract 1844, Oakland County, Michigan	**11**	$1,383	178	$12,956	3	0	2	0	1	93	1	0	6	26	28	40
Census Tract 1845, Oakland County, Michigan	**11**	$1,648	44	$14,505	1	0	0	0	1	94	4	0	4	12	34	50
Census Tract 1847, Oakland County, Michigan	**11**	$1,703	57	$16,005	5	0	0	0	1	89	5	0	7	15	24	54
Census Tract 1963, Oakland County, Michigan	**11**	$1,962	73	$17,126	0	0	14	0	0	85	0	0	2	11	14	74
Census Tract 1970, Oakland County, Michigan	**11**	$1,961	94	$17,924	0	0	33	0	0	67	0	0	34	14	10	41
Census Tract 5170, Wayne County, Michigan	**11**	$836	178	$7,892	63	0	10	0	0	23	2	2	6	13	33	48
Census Tract 5189, Wayne County, Michigan	**11**	$1,519	317	$14,092	95	0	0	0	0	3	0	1	27	34	30	8
Census Tract 5430, Wayne County, Michigan	**11**	$2,637	111	$23,796	82	0	0	0	0	11	6	0	4	10	26	60
Census Tract 5520, Wayne County, Michigan	**11**	$2,858	343	$25,091	2	0	51	0	0	39	3	6	14	44	27	15
Census Tract 5536.01, Wayne County, Michigan	**11**	$1,897	165	$16,572	90	0	0	0	0	6	1	4	14	47	15	24
Census Tract 5543, Wayne County, Michigan	**11**	$2,162	164	$20,584	25	0	0	0	2	67	6	0	2	40	34	25
Census Tract 5548, Wayne County, Michigan	**11**	$2,381	120	$21,882	25	0	0	0	1	73	0	0	4	54	24	18
Census Tract 5553, Wayne County, Michigan	**11**	$2,380	226	$22,458	58	0	0	0	0	42	1	0	2	54	37	6
Census Tract 5555, Wayne County, Michigan	**11**	$1,780	295	$16,604	59	0	0	0	0	39	2	0	6	48	33	13
Census Tract 5556, Wayne County, Michigan	**11**	$1,967	187	$17,915	26	0	1	0	2	71	1	0	3	47	37	13
Census Tract 5565, Wayne County, Michigan	**11**	$1,342	167	$11,720	11	0	1	0	0	87	1	0	20	35	32	13
Census Tract 5566, Wayne County, Michigan	**11**	$2,184	68	$19,070	0	0	0	0	0	98	2	0	2	14	40	44
Census Tract 5589, Wayne County, Michigan	**11**	$2,312	30	$20,390	3	0	3	0	0	92	2	0	3	38	29	31
Census Tract 5602.01, Wayne County, Michigan	**11**	$1,588	54	$14,456	0	1	9	0	0	89	1	0	0	11	37	53
Census Tract 5628, Wayne County, Michigan	**11**	$2,322	113	$21,315	2	0	1	0	0	95	1	0	6	20	25	49
Census Tract 5653.01, Wayne County, Michigan	**11**	$1,044	410	$9,699	65	0	5	0	0	30	0	0	18	21	54	8
Census Tract 5670, Wayne County, Michigan	**11**	$2,678	312	$23,431	75	2	0	0	1	20	2	0	17	21	52	10
Census Tract 5674, Wayne County, Michigan	**11**	$1,777	148	$15,799	4	0	0	0	0	93	1	0	8	37	37	17
Census Tract 5680, Wayne County, Michigan	**11**	$1,680	201	$15,430	15	0	0	0	0	80	2	2	18	36	33	12
Census Tract 5691, Wayne County, Michigan	**11**	$2,325	116	$22,072	0	0	0	0	1	96	1	2	5	38	53	4
Census Tract 5698, Wayne County, Michigan	**11**	$2,435	149	$21,222	8	0	1	0	1	88	1	1	26	37	32	5
Census Tract 5702, Wayne County, Michigan	**11**	$2,365	337	$20,655	69	0	0	0	2	25	1	3	14	30	53	3
Census Tract 5770, Wayne County, Michigan	**11**	$1,620	477	$15,159	24	0	0	0	7	43	4	23	24	39	28	9
Census Tract 5772, Wayne County, Michigan	**11**	$2,005	342	$18,878	9	5	0	0	5	61	2	17	21	55	21	3
Census Tract 5775, Wayne County, Michigan	**11**	$2,071	229	$19,452	12	0	0	0	8	63	3	14	11	54	31	5
Census Tract 5807, Wayne County, Michigan	**11**	$1,374	494	$12,891	4	0	1	0	1	86	1	6	8	33	46	13
Census Tract 5812, Wayne County, Michigan	**11**	$1,520	322	$14,460	9	0	1	0	2	86	1	1	11	47	33	9
Census Tract 5838, Wayne County, Michigan	**11**	$1,829	206	$16,822	11	0	0	0	0	87	1	1	19	35	43	3
Census Tract 5843, Wayne County, Michigan	**11**	$1,769	140	$16,319	23	0	1	0	1	72	2	1	19	37	37	7
Census Tract 5846, Wayne County, Michigan	**11**	$1,539	196	$14,363	37	0	19	0	2	40	1	1	23	49	19	9
Census Tract 5858, Wayne County, Michigan	**11**	$2,343	257	$21,387	53	0	0	0	0	46	1	0	7	40	45	7
Census Tract 5915.01, Wayne County, Michigan	**11**	$2,185	333	$19,051	17	0	36	0	0	43	3	1	22	55	19	4
Census Tract 5963, Wayne County, Michigan	**11**	$2,392	9	$21,239	0	0	1	0	0	98	1	0	0	8	48	44
Census Tract 2308, Macomb County, Michigan	**10**	$2,158	380	$22,054	2	0	2	0	0	87	9	0	32	24	17	28
Census Tract 2309.01, Macomb County, Michigan	**10**	$2,098	249	$20,807	0	0	0	0	0	100	0	0	8	28	27	37
Census Tract 2314, Macomb County, Michigan	**10**	$2,402	324	$23,229	1	0	6	0	0	93	0	0	33	19	25	23
Census Tract 2316, Macomb County, Michigan	**10**	$1,774	349	$18,319	9	0	9	0	0	82	1	0	33	21	31	16
Census Tract 2321, Macomb County, Michigan	**10**	$1,999	358	$19,779	8	0	3	0	0	89	0	0	18	24	35	23
Census Tract 2409, Macomb County, Michigan	**10**	$1,975	72	$20,106	1	0	0	0	0	94	5	0	12	27	59	2
Census Tract 2416, Macomb County, Michigan	**10**	$1,923	163	$19,355	48	0	0	0	1	50	1	0	4	40	55	1
Census Tract 2451, Macomb County, Michigan	**10**	$1,651	399	$16,241	35	0	0	0	1	62	2	0	9	68	21	3
Census Tract 2454, Macomb County, Michigan	**10**	$1,790	118	$18,508	57	0	0	0	0	37	2	4	4	52	39	6
Census Tract 2500, Macomb County, Michigan	**10**	$1,850	70	$19,387	1	0	0	0	1	95	3	0	10	32	45	14
Census Tract 2502, Macomb County, Michigan	**10**	$1,882	122	$18,653	0	0	0	0	0	97	3	0	3	44	37	16
Census Tract 2509, Macomb County, Michigan	**10**	$2,201	150	$21,760	0	0	1	0	0	96	3	0	11	32	40	17
Census Tract 2518, Macomb County, Michigan	**10**	$1,550	262	$16,208	19	0	0	0	0	78	2	0	14	30	42	15
Census Tract 2550, Macomb County, Michigan	**10**	$1,464	454	$14,667	28	0	1	0	0	70	1	1	9	32	50	9
Census Tract 2567, Macomb County, Michigan	**10**	$1,880	164	$18,011	7	0	1	0	7	81	4	0	9	56	29	7
Census Tract 2580, Macomb County, Michigan	**10**	$1,925	133	$18,458	31	0	0	0	4	60	5	1	9	41	27	23
Census Tract 2617, Macomb County, Michigan	**10**	$1,637	272	$15,986	32	0	0	0	0	66	1	0	9	52	32	8
Census Tract 2619, Macomb County, Michigan	**10**	$1,755	192	$17,502	24	0	3	0	2	62	9	0	18	41	30	11
Census Tract 2620, Macomb County, Michigan	**10**	$1,858	146	$17,732	9	0	6	0	1	83	1	0	8	33	33	26
Census Tract 2622, Macomb County, Michigan	**10**	$1,727	253	$17,088	1	0	20	0	0	79	0	0	12	26	47	16
Census Tract 2624, Macomb County, Michigan	**10**	$1,828	340	$17,969	7	0	24	0	0	65	3	0	41	25	23	11

Census Tract 2627, Macomb County, Michigan	**10**	$1,775	308	$18,458	23	0	16	0	1	57	2	0	13	26	47	14
Census Tract 2632, Macomb County, Michigan	**10**	$1,810	402	$17,670	22	0	9	0	0	59	10	0	11	40	45	4
Census Tract 2634, Macomb County, Michigan	**10**	$2,045	286	$20,156	11	0	20	0	0	67	2	0	12	31	41	15
Census Tract 2635, Macomb County, Michigan	**10**	$1,646	578	$16,313	8	0	5	0	3	77	6	0	14	36	42	8
Census Tract 2637, Macomb County, Michigan	**10**	$1,904	423	$19,034	51	0	3	0	2	41	4	0	6	48	40	6
Census Tract 2676, Macomb County, Michigan	**10**	$1,759	57	$16,957	1	0	5	0	0	93	0	0	8	25	43	23
Census Tract 2681, Macomb County, Michigan	**10**	$1,751	213	$18,017	36	2	5	0	0	54	3	0	7	32	47	14
Census Tract 1344, Oakland County, Michigan	**10**	$1,795	103	$17,732	0	0	0	0	0	100	0	0	1	8	48	43
Census Tract 1347, Oakland County, Michigan	**10**	$1,533	210	$14,870	0	0	0	0	1	98	0	0	5	68	14	13
Census Tract 1368, Oakland County, Michigan	**10**	$2,093	248	$21,927	0	0	0	0	1	89	10	0	24	21	25	31
Census Tract 1608, Oakland County, Michigan	**10**	$1,670	79	$17,497	71	0	0	0	0	24	5	0	1	28	37	33
Census Tract 1614, Oakland County, Michigan	**10**	$1,317	384	$13,660	55	0	0	0	0	45	0	0	18	32	20	30
Census Tract 1622, Oakland County, Michigan	**10**	$1,013	62	$9,700	91	0	1	0	0	9	0	0	1	47	42	10
Census Tract 1666, Oakland County, Michigan	**10**	$1,199	382	$12,267	32	0	7	0	1	60	0	0	13	25	20	43
Census Tract 1688, Oakland County, Michigan	**10**	$2,513	20	$24,273	15	0	2	0	0	80	3	0	1	7	17	74
Census Tract 1704, Oakland County, Michigan	**10**	$1,336	167	$12,886	7	0	0	0	0	91	2	0	9	23	41	27
Census Tract 1713, Oakland County, Michigan	**10**	$1,847	232	$17,638	80	0	0	0	0	18	2	0	20	24	41	16
Census Tract 1725, Oakland County, Michigan	**10**	$1,451	331	$14,716	89	0	0	0	0	4	5	2	14	46	26	14
Census Tract 1732, Oakland County, Michigan	**10**	$1,471	67	$14,277	1	0	0	0	1	95	3	0	0	19	36	45
Census Tract 1800, Oakland County, Michigan	**10**	$1,669	88	$16,333	0	0	0	0	3	93	4	0	11	26	25	38
Census Tract 1811, Oakland County, Michigan	**10**	$1,561	149	$15,982	4	0	0	0	0	95	0	0	3	47	29	22
Census Tract 1813, Oakland County, Michigan	**10**	$1,580	318	$15,923	7	0	3	0	1	88	1	0	25	24	31	20
Census Tract 1814, Oakland County, Michigan	**10**	$1,658	158	$16,716	10	0	0	0	1	88	1	0	15	26	38	21
Census Tract 1830, Oakland County, Michigan	**10**	$1,565	133	$15,327	12	0	1	0	2	84	0	0	0	20	45	36
Census Tract 1832, Oakland County, Michigan	**10**	$1,384	141	$13,508	6	0	1	0	1	91	1	0	5	20	26	48
Census Tract 1838, Oakland County, Michigan	**10**	$1,586	150	$15,842	2	0	1	0	1	95	1	0	23	21	25	31
Census Tract 1977.02, Oakland County, Michigan	**10**	$982	42	$9,549	2	0	10	0	6	81	1	0	11	9	16	64
Census Tract 5169, Wayne County, Michigan	**10**	$1,054	227	$10,442	92	0	0	0	0	5	3	0	24	32	38	6
Census Tract 5202, Wayne County, Michigan	**10**	$1,214	236	$12,200	23	0	37	0	4	32	2	2	5	9	48	38
Census Tract 5225, Wayne County, Michigan	**10**	$1,172	453	$11,899	83	0	0	0	0	12	3	2	17	33	25	25
Census Tract 5549, Wayne County, Michigan	**10**	$2,694	94	$25,814	60	0	1	0	1	38	0	0	9	17	61	13
Census Tract 5570, Wayne County, Michigan	**10**	$2,532	48	$24,418	6	0	2	0	1	89	2	0	10	22	48	20
Census Tract 5575, Wayne County, Michigan	**10**	$2,231	78	$22,586	0	0	2	0	0	98	0	0	4	32	32	32
Census Tract 5625, Wayne County, Michigan	**10**	$1,412	84	$14,226	7	0	0	0	0	92	1	0	12	28	35	24
Census Tract 5641, Wayne County, Michigan	**10**	$1,522	225	$14,544	13	0	14	0	0	68	4	0	12	21	31	36
Census Tract 5647, Wayne County, Michigan	**10**	$2,073	77	$19,884	13	6	3	0	0	54	23	0	1	52	16	32
Census Tract 5650.01, Wayne County, Michigan	**10**	$1,957	129	$19,701	6	1	16	0	0	76	2	0	9	13	41	38
Census Tract 5657, Wayne County, Michigan	**10**	$2,081	130	$21,530	7	0	14	0	0	78	1	0	5	22	34	40
Census Tract 5671, Wayne County, Michigan	**10**	$1,614	251	$15,401	11	0	0	0	1	83	3	1	16	41	32	10
Census Tract 5672.01, Wayne County, Michigan	**10**	$2,272	208	$22,880	1	0	0	0	1	97	1	0	3	38	42	17
Census Tract 5679, Wayne County, Michigan	**10**	$1,885	164	$19,200	10	0	1	0	2	87	1	0	9	33	37	21
Census Tract 5742.03, Wayne County, Michigan	**10**	$1,772	188	$18,226	4	0	1	0	1	88	5	0	3	33	21	42
Census Tract 5774, Wayne County, Michigan	**10**	$2,105	272	$20,693	4	0	0	0	10	72	4	11	25	36	35	4
Census Tract 5780, Wayne County, Michigan	**10**	$1,637	308	$15,610	6	0	0	0	3	88	2	1	6	49	43	2
Census Tract 5804, Wayne County, Michigan	**10**	$1,620	155	$15,855	0	0	0	0	0	99	0	0	7	31	47	15
Census Tract 5809, Wayne County, Michigan	**10**	$1,663	228	$16,616	2	0	0	0	1	92	5	1	20	36	40	4
Census Tract 5839, Wayne County, Michigan	**10**	$1,721	451	$16,771	39	0	8	0	0	53	0	0	24	41	32	3
Census Tract 2302, Macomb County, Michigan	**9**	$2,203	111	$23,331	0	0	1	0	0	99	0	0	13	20	46	21
Census Tract 2310, Macomb County, Michigan	**9**	$2,403	148	$27,342	0	0	1	0	0	98	0	0	13	30	38	19
Census Tract 2312, Macomb County, Michigan	**9**	$1,724	135	$19,666	2	0	9	0	0	89	0	0	11	39	33	16
Census Tract 2317, Macomb County, Michigan	**9**	$2,026	352	$22,526	1	7	2	0	0	88	1	0	24	23	28	25
Census Tract 2319, Macomb County, Michigan	**9**	$2,141	187	$23,317	1	0	3	0	0	96	1	0	16	13	44	26
Census Tract 2322, Macomb County, Michigan	**9**	$1,792	354	$19,833	12	0	6	0	0	82	0	0	14	34	29	23
Census Tract 2415, Macomb County, Michigan	**9**	$1,571	187	$17,056	10	0	0	0	0	89	1	0	16	42	29	12
Census Tract 2475, Macomb County, Michigan	**9**	$1,291	211	$14,035	13	0	0	0	0	87	0	0	15	49	27	9
Census Tract 2476.01, Macomb County, Michigan	**9**	$1,273	237	$13,479	32	0	0	0	0	68	0	0	7	24	63	6
Census Tract 2504, Macomb County, Michigan	**9**	$1,750	62	$20,250	7	0	0	0	3	88	2	0	4	22	60	14
Census Tract 2519, Macomb County, Michigan	**9**	$1,706	129	$19,134	1	0	0	0	1	96	3	0	8	23	54	15
Census Tract 2521, Macomb County, Michigan	**9**	$1,614	107	$17,811	3	0	0	0	1	96	0	0	9	21	39	31
Census Tract 2541, Macomb County, Michigan	**9**	$1,500	292	$17,588	7	0	0	0	1	91	1	0	9	41	42	9
Census Tract 2560, Macomb County, Michigan	**9**	$1,929	126	$21,208	8	0	0	0	0	91	1	0	11	46	37	7
Census Tract 2563, Macomb County, Michigan	**9**	$1,775	139	$19,343	31	0	0	0	1	67	1	0	7	42	38	12

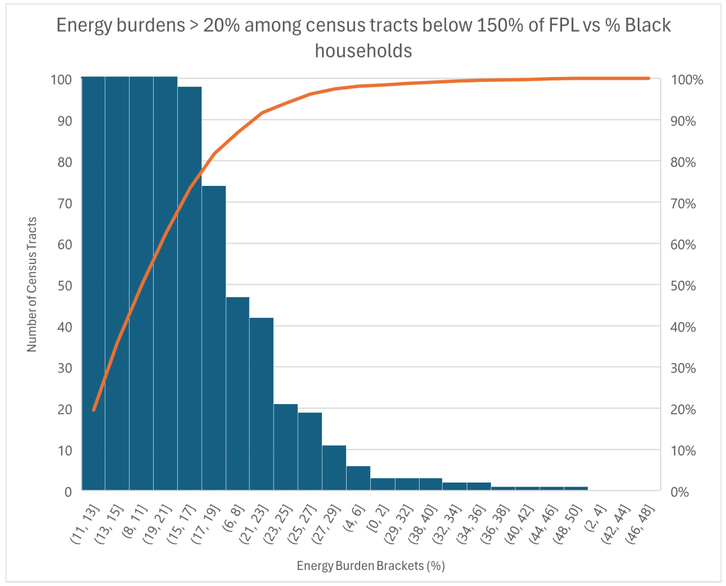
Census Tract 2582, Macomb County, Michigan	**9**	$1,944	214	$21,354	39	0	0	0	0	61	0	0	31	26	35	7
Census Tract 2589, Macomb County, Michigan	**9**	$2,271	138	$24,596	60	0	0	0	0	37	2	0	33	25	36	5
Census Tract 2600, Macomb County, Michigan	**9**	$1,900	138	$20,394	5	0	2	0	1	87	5	0	5	46	37	12
Census Tract 2602, Macomb County, Michigan	**9**	$1,765	120	$20,337	3	0	0	0	4	93	0	0	8	36	43	14
Census Tract 2608, Macomb County, Michigan	**9**	$1,931	168	$21,186	4	0	3	0	1	91	1	0	20	29	40	11
Census Tract 2611, Macomb County, Michigan	**9**	$1,619	485	$17,271	22	0	5	0	1	71	1	0	20	22	34	24
Census Tract 2615, Macomb County, Michigan	**9**	$1,538	220	$16,403	16	0	5	0	3	75	0	0	10	38	42	10
Census Tract 2618, Macomb County, Michigan	**9**	$1,825	87	$20,183	7	0	17	0	0	75	1	0	5	40	37	19
Census Tract 2623, Macomb County, Michigan	**9**	$1,536	240	$17,098	10	0	26	0	0	64	0	0	17	32	35	16
Census Tract 2638, Macomb County, Michigan	**9**	$1,940	239	$22,556	50	0	4	0	4	39	2	0	18	40	41	1
Census Tract 2640, Macomb County, Michigan	**9**	$1,893	205	$20,527	52	0	5	0	0	30	12	0	14	39	35	11
Census Tract 1366.01, Oakland County, Michigan	**9**	$1,456	140	$17,002	2	0	2	0	3	87	7	0	1	29	23	47
Census Tract 1611, Oakland County, Michigan	**9**	$969	226	$10,695	72	0	1	0	1	24	2	0	17	17	43	22
Census Tract 1617, Oakland County, Michigan	**9**	$1,933	101	$22,438	70	0	0	0	1	14	14	0	6	18	24	52
Census Tract 1621, Oakland County, Michigan	**9**	$1,047	281	$12,069	97	0	0	0	0	2	1	0	14	25	46	15
Census Tract 1674, Oakland County, Michigan	**9**	$1,437	327	$15,615	38	0	0	0	2	59	1	0	2	20	58	20
Census Tract 1681, Oakland County, Michigan	**9**	$1,525	124	$16,846	11	0	1	0	2	85	0	0	0	76	11	13
Census Tract 1710, Oakland County, Michigan	**9**	$1,343	361	$14,736	28	0	3	0	0	65	2	1	7	40	28	26
Census Tract 1714, Oakland County, Michigan	**9**	$1,825	521	$20,111	68	0	0	0	0	30	2	0	4	19	40	38
Census Tract 1715, Oakland County, Michigan	**9**	$1,661	317	$17,663	95	0	0	0	0	3	2	0	16	22	47	15
Census Tract 1812, Oakland County, Michigan	**9**	$1,455	343	$16,306	5	0	4	0	0	90	2	0	16	30	37	18
Census Tract 1880.01, Oakland County, Michigan	**9**	$1,725	55	$18,723	1	0	0	0	0	96	2	0	0	15	24	61
Census Tract 1966, Oakland County, Michigan	**9**	$1,992	7	$21,170	0	0	21	0	0	78	0	0	0	6	14	80
Census Tract 1974, Oakland County, Michigan	**9**	$1,365	163	$15,450	1	0	14	0	0	85	0	0	46	16	18	20
Census Tract 5554.01, Wayne County, Michigan	**9**	$1,952	103	$22,069	82	0	1	0	2	15	1	0	22	16	35	28
Census Tract 5574, Wayne County, Michigan	**9**	$2,471	37	$29,055	1	0	0	0	0	95	4	0	1	16	16	67
Census Tract 5590, Wayne County, Michigan	**9**	$2,672	55	$28,747	5	0	0	0	1	93	1	0	1	31	44	24
Census Tract 5632, Wayne County, Michigan	**9**	$1,515	179	$17,069	14	0	1	0	0	78	8	0	0	52	30	18
Census Tract 5659, Wayne County, Michigan	**9**	$1,799	58	$21,108	12	0	3	0	1	84	0	0	18	32	38	11
Census Tract 5664, Wayne County, Michigan	**9**	$1,929	42	$21,921	44	0	0	0	1	55	0	0	4	48	33	15
Census Tract 5673, Wayne County, Michigan	**9**	$1,742	195	$18,598	6	0	1	0	2	90	1	1	12	35	46	7
Census Tract 5688, Wayne County, Michigan	**9**	$1,083	324	$12,715	62	0	10	0	2	24	1	1	31	36	22	12
Census Tract 5697, Wayne County, Michigan	**9**	$1,991	178	$21,505	5	0	0	0	0	91	4	0	18	32	44	7
Census Tract 5765, Wayne County, Michigan	**9**	$2,038	82	$23,518	0	0	1	0	1	84	12	1	5	31	47	17
Census Tract 5779, Wayne County, Michigan	**9**	$1,765	388	$18,841	4	1	0	0	2	87	1	5	23	36	37	5
Census Tract 5801, Wayne County, Michigan	**9**	$1,492	155	$17,163	3	0	1	0	5	88	2	2	13	27	48	12
Census Tract 5805, Wayne County, Michigan	**9**	$1,830	106	$19,432	0	0	0	0	1	98	0	0	7	19	48	26
Census Tract 5840, Wayne County, Michigan	**9**	$2,170	229	$23,465	17	0	0	0	0	82	0	0	4	25	69	3
Census Tract 5880.01, Wayne County, Michigan	**9**	$1,134	196	$12,460	31	0	1	0	0	68	0	0	4	14	44	39
Census Tract 5915.02, Wayne County, Michigan	**9**	$1,599	100	$18,509	5	0	9	0	1	85	0	0	6	41	45	8
Census Tract 2305.01, Macomb County, Michigan	**8**	$1,520	401	$18,500	2	0	1	0	0	89	2	6	14	31	39	16
Census Tract 2318, Macomb County, Michigan	**8**	$2,100	203	$25,239	2	0	4	0	0	94	1	0	24	17	28	31
Census Tract 2320, Macomb County, Michigan	**8**	$2,230	63	$29,479	4	0	2	0	0	94	0	0	15	29	38	18
Census Tract 2330, Macomb County, Michigan	**8**	$2,217	159	$26,506	2	0	0	0	0	98	0	0	9	20	40	31
Census Tract 2405, Macomb County, Michigan	**8**	$2,061	108	$24,251	3	0	0	0	0	95	2	0	3	15	70	13
Census Tract 2410, Macomb County, Michigan	**8**	$1,322	293	$16,724	44	0	2	0	0	54	0	0	9	38	48	4
Census Tract 2414, Macomb County, Michigan	**8**	$1,387	123	$18,222	2	0	0	0	0	98	0	0	12	42	42	5
Census Tract 2503, Macomb County, Michigan	**8**	$1,578	153	$20,720	5	0	0	0	3	91	1	0	6	45	25	24
Census Tract 2522, Macomb County, Michigan	**8**	$1,122	187	$13,252	2	0	1	0	1	96	1	0	5	15	46	35
Census Tract 2545, Macomb County, Michigan	**8**	$1,327	371	$15,785	2	0	0	0	0	97	0	0	19	36	33	12
Census Tract 2552, Macomb County, Michigan	**8**	$1,254	348	$15,392	36	0	1	0	0	57	3	3	5	37	49	9
Census Tract 2585, Macomb County, Michigan	**8**	$1,862	65	$22,469	44	0	0	0	0	50	4	1	23	28	33	17
Census Tract 2603, Macomb County, Michigan	**8**	$1,697	187	$20,786	3	0	5	0	0	91	1	0	9	33	38	20
Census Tract 2607, Macomb County, Michigan	**8**	$1,726	145	$20,715	5	0	12	0	0	79	3	0	6	43	30	22
Census Tract 2609, Macomb County, Michigan	**8**	$1,915	166	$23,985	2	0	37	0	1	59	0	1	4	36	27	34
Census Tract 2610, Macomb County, Michigan	**8**	$1,610	199	$19,772	35	0	8	0	1	56	0	0	15	34	36	16
Census Tract 2614, Macomb County, Michigan	**8**	$1,998	150	$23,657	5	0	7	0	3	83	1	2	12	40	31	18
Census Tract 2616.01, Macomb County, Michigan	**8**	$1,874	39	$24,653	4	0	5	0	2	88	0	0	19	37	29	16
Census Tract 2680, Macomb County, Michigan	**8**	$1,402	419	$18,177	12	0	3	0	1	81	2	0	20	40	33	6
Census Tract 1532, Oakland County, Michigan	**8**	$1,349	15	$16,542	0	0	0	0	0	99	0	0	50	2	4	44
Census Tract 1572, Oakland County, Michigan	**8**	$2,052	248	$26,606	31	0	1	0	0	62	6	0	21	32	28	19
Census Tract 1604, Oakland County, Michigan	**8**	$1,052	408	$12,613	89	0	2	0	0	8	1	0	15	12	49	25

Census Tract 1609, Oakland County, Michigan	**8**	$1,205	159	$15,418	56	0	1	0	0	41	1	0	11	27	26	36
Census Tract 1660, Oakland County, Michigan	**8**	$1,645	95	$20,305	29	0	8	0	0	61	1	0	6	24	27	43
Census Tract 1685, Oakland County, Michigan	**8**	$1,187	193	$14,198	27	0	2	0	1	69	1	0	17	17	24	42
Census Tract 1689.02, Oakland County, Michigan	**8**	$1,232	142	$14,492	29	0	34	0	5	32	0	0	4	4	50	42
Census Tract 1736, Oakland County, Michigan	**8**	$1,734	62	$20,746	7	0	0	0	4	84	5	0	6	20	33	41
Census Tract 1750, Oakland County, Michigan	**8**	$1,534	285	$18,374	9	0	0	0	0	88	3	0	20	33	36	12
Census Tract 1843, Oakland County, Michigan	**8**	$1,735	42	$20,680	5	0	0	0	1	91	2	0	1	33	33	33
Census Tract 1881, Oakland County, Michigan	**8**	$1,814	19	$21,724	2	0	1	0	1	96	0	0	0	6	14	80
Census Tract 5172, Wayne County, Michigan	**8**	$754	67	$9,579	62	10	5	0	1	12	1	10	1	27	43	29
Census Tract 5652, Wayne County, Michigan	**8**	$1,333	226	$17,700	39	0	4	0	2	53	0	1	10	38	43	9
Census Tract 5803, Wayne County, Michigan	**8**	$1,660	228	$20,901	0	0	0	0	1	96	2	0	10	31	50	9
Census Tract 5808, Wayne County, Michigan	**8**	$1,426	82	$17,752	1	0	0	0	3	95	0	0	9	57	31	3
Census Tract 2309.02, Macomb County, Michigan	**7**	$1,273	215	$17,921	12	0	0	0	0	86	3	0	1	34	56	10
Census Tract 2472.02, Macomb County, Michigan	**7**	$2,010	72	$29,716	2	0	0	0	0	89	2	7	10	15	60	15
Census Tract 2565, Macomb County, Michigan	**7**	$1,950	81	$26,670	26	0	0	0	1	71	2	0	6	22	66	6
Census Tract 2626, Macomb County, Michigan	**7**	$1,163	257	$15,626	17	0	10	0	1	71	0	1	17	45	21	16
Census Tract 1686.01, Oakland County, Michigan	**7**	$1,324	9	$18,835	10	0	21	0	0	69	0	0	0	0	1	99
Census Tract 1703, Oakland County, Michigan	**7**	$1,676	33	$22,411	2	0	0	0	1	93	2	1	7	15	42	36
Census Tract 1724, Oakland County, Michigan	**7**	$881	245	$12,367	52	0	2	0	0	45	0	0	16	24	41	20
Census Tract 5157, Wayne County, Michigan	**7**	$726	667	$10,463	87	0	0	0	0	9	2	2	11	25	38	26
Census Tract 5165, Wayne County, Michigan	**7**	$828	145	$12,723	74	0	2	0	1	21	0	2	9	19	55	16
Census Tract 5171, Wayne County, Michigan	**7**	$826	59	$11,102	75	0	1	0	0	22	2	0	13	8	51	28
Census Tract 5207, Wayne County, Michigan	**7**	$759	265	$10,859	49	1	4	0	0	37	2	7	14	27	29	30
Census Tract 5653.02, Wayne County, Michigan	**7**	$948	517	$13,644	34	0	1	0	1	64	0	0	62	8	15	15
Census Tract 5802, Wayne County, Michigan	**7**	$1,332	316	$19,115	0	0	0	0	1	96	2	1	5	66	26	3
Census Tract 2403, Macomb County, Michigan	**6**	$1,530	267	$24,409	2	0	0	0	0	71	27	0	13	37	42	8
Census Tract 2601, Macomb County, Michigan	**6**	$1,298	196	$21,389	16	0	7	0	5	71	0	1	10	41	31	19
Census Tract 1603, Oakland County, Michigan	**6**	$801	582	$12,979	79	0	1	0	0	19	1	0	16	19	42	23
Census Tract 1835, Oakland County, Michigan	**6**	$1,276	229	$22,474	73	0	1	0	0	25	0	0	7	12	68	13
Census Tract 1975, Oakland County, Michigan	**6**	$1,263	83	$20,129	1	0	47	0	1	50	0	0	21	5	14	60
Census Tract 1810.01, Oakland County, Michigan	**5**	$789	505	$15,540	27	0	6	0	0	59	8	0	15	20	30	35
Census Tract 9824, Wayne County, Michigan	**2**	$296	2	$15,546	100	0	0	0	0	0	0	0	0	0	100	0
Census Tract 9820.02, Macomb County, Michigan	**0**	$0	12	$0	0	0	0	0	0	0	0	0	0	0	0	0
Census Tract 9834, Wayne County, Michigan	**0**	$0	8	$55,861	0	0	0	0	0	100	0	0	0	0	100	0
Census Tract 9801, Macomb County, Michigan																
Census Tract 9820.01, Macomb County, Michigan																
Census Tract 9821, Macomb County, Michigan																
Census Tract 9822, Macomb County, Michigan																
Census Tract 9823, Macomb County, Michigan																
Census Tract 9811, Oakland County, Michigan																
Census Tract 9812, Oakland County, Michigan																
Census Tract 9817, Wayne County, Michigan																
Census Tract 9818, Wayne County, Michigan																
Census Tract 9819.01, Wayne County, Michigan																
Census Tract 9819.02, Wayne County, Michigan																
Census Tract 9825, Wayne County, Michigan																
Census Tract 9826, Wayne County, Michigan																
Census Tract 9827, Wayne County, Michigan																
Census Tract 9832, Wayne County, Michigan																
Census Tract 9833.01, Wayne County, Michigan																
Census Tract 9833.02, Wayne County, Michigan																
Census Tract 9836, Wayne County, Michigan																
Census Tract 9837, Wayne County, Michigan																
Census Tract 9838, Wayne County, Michigan																
Census Tract 9839.01, Wayne County, Michigan																
Census Tract 9839.02, Wayne County, Michigan																
Census Tract 9839.03, Wayne County, Michigan																
Census Tract 9841, Wayne County, Michigan																
Census Tract 9842, Wayne County, Michigan																
Census Tract 9850, Wayne County, Michigan																
Census Tract 9852, Wayne County, Michigan																
Census Tract 9855, Wayne County, Michigan																

Census Tract 9856, Wayne County, Michigan																	
Census Tract 9857, Wayne County, Michigan																	
Census Tract 9858, Wayne County, Michigan																	
Census Tract 9859, Wayne County, Michigan																	
Census Tract 9863, Wayne County, Michigan																	
Census Tract 9866, Wayne County, Michigan																	
Census Tract 9870, Wayne County, Michigan																	

163
16
2
181

92



nature COMMUNICATIONS

ARTICLE

https://doi.org/10.1038/s41467-022-30146-5 OPEN

Unveiling hidden energy poverty using the energy equity gap

Shuchen Cong [1], Destenie Nock [1,2✉], Yueming Lucy Qiu [3✉] & Bo Xing[4]

Income-based energy poverty metrics ignore people's behavior patterns, particularly reducing energy consumption to limit financial stress. We investigate energy-limiting behavior in low-income households using a residential electricity consumption dataset. We first determine the outdoor temperature at which households start using cooling systems, the inflection temperature. Our relative energy poverty metric, the *energy equity gap*, is defined as the difference in the inflection temperatures between low and high-income groups. In our study region, we estimate the energy equity gap to be between 4.7–7.5 °F (2.6–4.2 °C). Within a sample of 4577 households, we found 86 energy-poor and 214 energy-insecure households. In contrast, the income-based energy poverty metric, energy burden (10% threshold), identified 141 households as energy-insecure. Only three households overlap between our energy equity gap and the income-based measure. Thus, the energy equity gap reveals a hidden but complementary aspect of energy poverty and insecurity.

[1] Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburg, PA, USA. [2] Department of Civil and Environmental Engineering, Carnegie Mellon University, Pittsburg, PA, USA. [3] School of Public Policy, University of Maryland College Park, College Park, MD, USA. [4] Department of Forecasting, Resource Planning and Development, Salt River Project, Tempe, AZ, USA. ✉email: dnock@andrew.cmu.edu; yqiu16@umd.edu

Energy poverty manifests itself in a high percentage of income spent covering energy bills, increased risk of electricity shutoffs, and a household's inability to maintain comfortable indoor temperatures or use desired services (e.g., air conditioning, heat, computers)[1,2]. An often-overlooked space in energy poverty analysis lies in the cavity between metrics that measure financial stress (energy burden defined as energy expenditure over total income) and complete lack of energy services (utility shutoffs). Within this cavity are the households which limit their energy consumption to reduce financial strain. These households may appear to spend small amounts of their income on their energy bills while limiting enough energy to avoid having the utility cut their power supply. It is estimated that, annually, 1300 people die every year in the U.S. from extreme heat[3]. In 2009 and 2010 alone, over 8250 emergency room visits in the US were caused by heat stroke[4], with low-income, minority, and elderly populations being disproportionally affected[3]. A large portion of these deaths may have been prevented if people could cool their homes properly. We acknowledge that proper cooling ability includes being able to acquire and sufficiently use an AC system[5,6].

As the effects of climate change manifest themselves in heatwaves[7] and deep freezes, communities will need to adapt (i.e., reduce their risk of illness and death[8]) by creating comfortable indoor temperatures within their homes. However, this depends on whether they can rely on their resources for adopting energy-efficient heating and cooling systems, meaning many vulnerable households who limit their energy consumption, potentially putting themselves at risk of heatstroke or hypothermia, may not qualify for energy poverty alleviation under current programs.

For example, in the US, the two main energy assistance programs, the Low Income Home Energy Assistance Program (LIHEAP) and the Weatherization Assistance Program (WAP), use an income threshold to determine eligibility[9,10]. LIHEAP uses reduction in a household's energy burden, service loss prevention, and service restoration, to calculate the effectiveness of its assistance[9]. WAP is geared more towards homeowners with its performance based on the number of households weatherized and post-weatherization surveys for those receiving assistance, with questions including change in energy burden and change in forgoing other necessities like food to pay energy bills[9,11]. This suggests that these programs make an implicit assumption that people meet or try to meet their energy needs first compared to other necessities like food or healthcare. Neither WAP nor LIHEAP takes into explicit account those who forgo energy consumption to pay for other necessities (i.e., energy limiting behavior), nor do they offer a clear definition of energy poverty[9]. The lack of consideration for households who forgo energy for other needs poses a limitation in identifying the multidimensional nature of poverty[12,13] and reduces the options for policy intervention. In LIHEAP and WAP, spending patterns are viewed as adequate ways to measure the effectiveness of these energy assistance programs[9,11].

In a broader sense, energy poverty is defined as insufficient energy access due to lack of supply, low affordability, limited quantity, poor quality, unreliability, or a combination of these shortcomings. Existing energy poverty metrics fall into the following categories: A) primary or secondary, and B) relative or absolute, as seen in Fig. 1. Here we define each category combination and provide some examples of each. A primary metric is defined as a metric that directly utilizes consumer-level information. A secondary metric would require derivation to reach a conclusion. Secondary metrics include metrics that aggregate utility information or use weighted scoring for poverty indices. A relative metric compares the energy poverty status of two or more entities (i.e., country-to-country or household-to-household) or one with oneself (i.e., progress over time for one country). Finally, an absolute metric will provide a strict threshold for energy poverty.

Relative-secondary metrics for energy poverty use summary statistics from the regional or local level (not individuals) and compare the progress of different regions to some benchmark. These are often used to describe progress in energy poverty reduction in developing countries. One example is an access-consumption matrix at a national level[14]. Access-consumption matrices portray shifts in a country's energy profile, mainly the change in fuel utilization and how many people use each fuel. If more people are gaining access to energy services in an underdeveloped country, and more people are shifting from dirtier to cleaner fuels in developing regions, energy poverty is reported as decreasing[14,15]. Due to the fact that energy poverty in developing regions often means a lack of access to modern energy services, these national energy access metrics are best used for countries beginning their clean energy transition and expanding access to modern energy services[14,15].

Relative-primary metrics come directly from households or individuals, and benchmark feelings of energy poverty in comparison to others in the population. These can be scores from a survey asking questions on self-perception of energy poverty. For example, a survey done in Greece used indicators such as "inability to keep home adequately warm," "leakages, damp walls, mold," and "restriction of other essential needs" to solicit the subjective feeling of energy poverty[16,17]. Compared with the 10% energy burden threshold, the study found that when a household is objectively categorized as energy-poor, they were more likely to respond "yes" for the subjective indicators. Another study explores the relationship between social relations and energy access, where a positive feedback loop exists between good social relations and higher quality energy access[2,18]. However, drawbacks of survey-based metrics are long completion times and difficulty comparing the level of energy poverty experienced

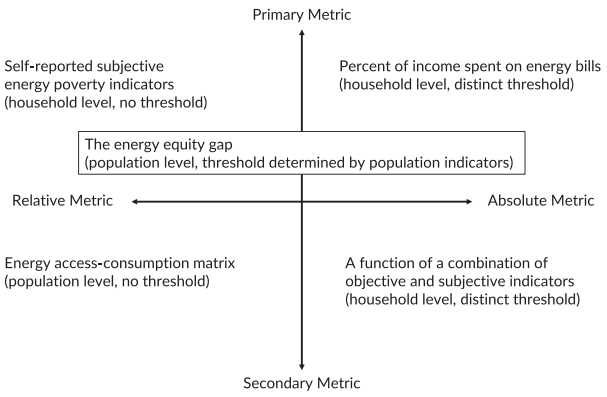


Fig. 1 Categories of energy poverty metrics. The *X*-axis represents relative or absolute metrics, or whether the metric has a distinct threshold for energy poverty. The *Y*-axis represents primary or secondary metrics, or whether a metric requires more than basic consumer-level data to calculate. A primary-absolute metric can be energy burden, or percent of income spent on energy bills; a primary-relative metric can be self-reported energy poverty indicators; a secondary-absolute metric can be a combination of the previous two, where an arbitrary score is calculated based on energy burden and survey results; and a secondary-relative metric can be an energy access-consumption matrix, often used to portray the progress of energy access in developing countries. The energy equity gap is a primary metric that can be both relative and absolute, where it can tell us the relative energy equity progress of a region, as well as household-level energy poverty.

between households. Although there are many survey studies on housing characteristics and perceived energy poverty[16,19,20], we find a lack of metrics which can quantify the amount of energy a household forgoes to alleviate financial burden (i.e., energy limiting behavior). Thus, there is a need to use surveys in combination with data driven approaches to elicit perceptions of energy limited behavior, while also determining the degree to which people actually limit energy consumption.

Absolute-secondary metrics compare information related to energy usage against some predetermined threshold. These metrics often combine income-based metrics with socio-demographic factors and housing conditions to calculate a weighted score to measure energy poverty[2,18]. However, because these measures (income-based, survey, and combined) single out those currently experiencing energy poverty, they can miss distributional changes over time and the severity of the energy poverty experience relative to the rest of the population. Additionally, a limitation is that these metrics often focus on equality (i.e., all households reaching a certain status) but miss equity because they cannot identify how the energy-poor compare to the non-energy-poor. Achieving energy equality entails giving everyone the same tools to achieve a desired level of energy consumption. For example, providing households with a voucher to spend less than 10% of their income on their current energy bills. Achieving energy equity entails giving groups different types of tools such that they can equally take advantage of opportunities or reach a desired goal. For example, an energy equity policy could entail each person receiving enough assistance to cool or heat their homes to their desired comfortable temperature.

Absolute-primary metrics use individual or household information and measure energy usage and other information against some predetermined threshold. These metrics are often used to measure household-level energy burden (i.e., energy expenditure over income). The underlying theory is that the more significant percentage of income spent on energy, the more energy-poor one is, similar to Engel's Coefficient for food expenditure[21]. A common threshold for energy burden to indicate a household is energy poor (proposed in 1991) is 10%[9,18]. Energy burden can depend on a number of factors such as electricity price, prices of other goods, and heating or cooling needs[1]. The advantage of this threshold metric is that it indicates the economic burden of meeting energy needs and does not have a high computational burden. However, limitations of using the energy burden threshold metric include not distinguishing between gross (i.e., pre-tax) and disposable income (i.e., post-tax and other mandatory charges like mortgage and rent), not considering indoor comfort levels, and not considering local and current costs of living[18]. As a result, households may have the same pre-tax income level but have vastly different mortgage or rental costs, meaning that the 10% threshold on gross income may miss people who are spending more than 90% of their income on other basic necessities[22].

Despite the recent development of new metrics to capture consumer behaviors (e.g., under-consumption of energy and choice of thermal comfort)[3,8], household-level energy poverty evaluation for government assistance programs in developed countries has been led by absolute-primary income-based metrics[9,18,23,24]. While these income-based metrics are widely used, they have a few shortcomings. First, they are sensitive to energy prices and mask the degree to which households change their energy consumption behavior following a price shift[18]. Second, and perhaps more importantly, the energy burden metric does not capture vulnerable low-income households who forgo energy usage to reduce financial stress. Lastly, income-based metrics miss essential dimensions of energy poverty, such as the inability to use enough energy to cool or heat homes to comfortable, and/or safe temperatures[25].

Most papers investigating the inability to satisfy a household's desired energy demand focus on electricity supply and reliability constraints in developing countries[26–28] and energy affordability in developed countries[1,29,30]. Within developed countries (i.e., those with close to 100% electricity supply access)[31], energy poverty and insecurity can manifest themselves in 1) electricity shutoffs resulting from nonpayment, 2) forgoing heating services due to financial strain and participating in unsafe practices (e.g., using the stove or oven for heat, unsafe uses of space heating technologies which lead to fires[32]), 3) spending a large percentage of income on energy bills, and 4) difficulty adopting clean energy and efficient technologies[17,33–35]. While multiple papers address the indicators of energy poverty[9,36,37] and insecurity[17,35], we find a void of metrics that can identify energy-limiting households (i.e., those without comfortable indoor temperatures) who may put themselves at risk of heat-related illness, excess indoor moisture, mold growth, and other adverse health effects[35,38,39] (e.g., respiratory illness and asthma).

In countries where the entire population has access to modern energy infrastructure, household-level energy poverty manifests itself as having inadequate energy services within the household, or an inability to consume energy at a desired level[2]. Thus, a more holistic definition of energy poverty would include people who limit their energy consumption (i.e., display energy limiting behavior), and those who spend a large portion of their income on their energy bills (i.e., high energy burden). Our work fills this gap by creating a metric which can identify energy limiting behavior. We define energy limiting behavior as a household's inability or unwillingness to consume enough energy to reach a desired level of comfort. A household displays energy limiting behavior if they reduce their energy consumption significantly below another household within the same region that does not have a budget constraint for energy spending. For example, assume households A and B live in the same region and have similar preferences for their ideal indoor temperature, around 70 °F (21 °C). Household A is a low-income household (i.e., a budget constraint on energy spending), and Household B is a high-income household (i.e., no budget constraint). If Household B starts using their air conditioning unit when it is 70 °F (21 °C) outside, but Household A waits until it is 75 °F (24 °C) outside, then household A is displaying 5 °F (3 °C) of energy limiting behavior compared to Household B.

Here, we introduce a behavior-based energy poverty measure, the energy equity gap, which captures one critical aspect of energy poverty (i.e., energy-limiting behavior), providing a complementary metric to capture inequity within a region. We first determine the outdoor temperature at which households start using cooling systems, the inflection temperature. Then, our relative energy poverty metric, the energy equity gap, is defined as the difference in the inflection temperatures between low and high-income groups. In our study region, we estimate the energy equity gap to be between 4.7 °F (2.6 °C) and 7.5 °F (4.2 °C). In 2015–2016, within our sample of 4577 households, we found 86 energy-poor and 214 energy-insecure households. In contrast, the income-based energy poverty metric, energy burden, identified 141 households as energy insecure when the threshold is set to 10%, with only three households overlapping between our energy equity gap and the income-based measure.

Results

Quantifying residential electricity consumption patterns. To capture those households left behind by income-based energy poverty measures, we propose a different energy poverty metric: the energy equity gap. We illustrate its effectiveness for identifying households at risk for inability to reach comfortable indoor

temperatures, and possibly heat-related illness. Our study region in the US, Arizona, has long, high-heat summers and mild winters (see Supplementary Information Note 6). Arizona has a higher level of heat-related illnesses (2944 heat-related ER visits in 2019[40]) compared to cold-related illnesses (495 cold-related ER visits in 2019[41]), leading us to focus our energy poverty analysis on the electricity sector due to this providing the bulk of cooling energy in the summer (air conditioning (AC) or fan usage). Identifying cooling system use is vital for addressing and planning for energy justice, which hinges on the proper distribution of benefits for a clean energy transition[42–44] and an ability to mitigate the effect of heatwaves. We also introduce a tiered system for identifying and addressing the energy poverty needs of the most vulnerable households and contrast this with the existing income-based metric.

The energy equity gap is a measure that investigates how consumer electricity consumption behavior across income groups shifts with temperature (i.e., consumers' temperature response functions). Previous research has investigated how consumers' temperature response functions (modeling energy usage against temperature or other climate factors) change with climate[45,46], but have not incorporated these functions into energy poverty identification. The energy equity gap metric considers the effect of outdoor temperature on energy consumption and quantifies relative energy limiting behavior, where those with fewer constraints on their budget set the threshold for a desired level of energy consumption to maintain a comfortable indoor temperature in the region (see Methods). Using the energy equity gap, we measure electricity usage patterns between income groups within a metropolitan region, thus eliminating the effect of weather or outdoor temperature on electricity usage for different households, which might occur in large study areas. A benefit of our primary-relative energy poverty metric, energy equity gap, is that policymakers can have more targeted energy justice efforts by first identifying the outdoor temperature that places their region at risk for heat-related illnesses or energy limiting behavior. Once the threshold has been set, policymakers can then use our relative metric to identify energy insecure households that are dangerously close to sinking into energy poverty and create proactive measures for reducing their burden and increasing their ability to consume energy to increase their comfort. In addition to capturing household-level electricity consumption behavior, the energy equity gap allows for a cross-temporal comparison of population-level energy equity within a region.

The basis of the energy equity gap is household-level inflection temperatures. To best incorporate behavior into the metric, we define the inflection temperature as the outdoor temperature at which a household starts using its cooling system as it shifts from spring to summer temperatures, assuming there is no difference in comfort preference or need across income groups. To find the inflection temperature of each household, daily electricity consumption is modeled using average daily temperature, electricity pricing plan, holiday effects, and day-of-the-week and month-of-the-year fixed effects (see Methods). The minimum of the quadratic equation between electricity consumption and temperature after controlling for the covariates mentioned above is defined as the temperature at which people start using their cooling systems, the inflection temperature (Fig. 2). This assumption stems from 1) heating and AC systems being the largest energy consumer within a household[45], and 2) our study region having a warm and dry climate, with short, mild winters and long, high-heat summers. If the study region is in a colder climate or a climate with more distinct seasons, we recommend separating the year into two climate zones (i.e., spring-summer-fall and fall-winter-spring). To adapt the energy equity gap to identify heating system energy use, we would need to include information from the gas and oil sector. We leave the heating sector analysis for future work. We hypothesize that low-income households are more likely to endure higher temperatures before they start cooling their homes in the summer to save money and will thus have higher inflection temperatures.

Redefining energy poverty and energy insecurity. The energy equity gap is defined as the difference between the highest and lowest median household inflection temperatures among all income groups (Fig. 3) of the study region, a metropolitan area in Arizona (see Methods). We chose to use the median instead of the mean to desensitize the measure from outliers. The energy equity gap indicates the disparity in energy use across the income spectrum for a region while eliminating the effect of climate and electricity pricing. Within our metropolitan region, we assume the climate is uniform for households in the sample data, and everyone has access to the same energy services. Therefore, a sign of reduced energy inequity would be a narrowing energy equity gap, indicating that households are converging to a similar inflection temperature, thus reduced energy inequity.

The distribution of household-level inflection temperatures across income groups is shown in Fig. 3. We see that the energy equity gap ranges from 4.7–7.5 °F (2.6–4.2 °C), highlighting that low-income groups are more likely to forgo cooling services until later in the summer than high-income groups (see Supplementary Info Note 5 for another sample analysis). Furthermore, there is a statistically significant difference between the median inflection temperatures between each income group for all years, meaning there is little chance that the inflection temperature differences occurred by chance, verified using the Mood's Median test (see Methods).

Figure 4 illustrates the change in the energy equity gap across income groups for the four years in our analysis. The higher inflection temperatures further show low-income households tend to wait longer to turn on their AC units, pointing to underlying constraints, budget or otherwise, restricting their access to cooling. When cooling is restricted, it has been shown that buildings are at a higher risk for increased rates of mold, allergens, and fungi growth[47,48] and that when the degree of

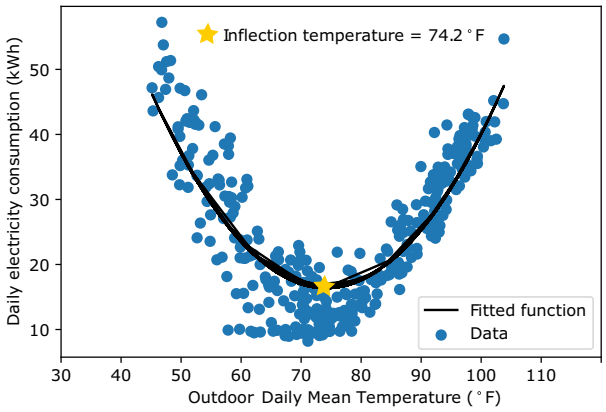


Fig. 2 Identifying the inflection temperature for daily electricity consumption and local daily mean outdoor temperature. This graph represents the daily electricity consumption of one household for one year ($N = 365$). The star marks the inflection temperature for this household for this year. We note that our true temperature response function includes electricity price, weekend, holiday, day of the week, and month of the year effects. The inflection temperature is the minimum of the quadratic temperature response function between the residuals after controlling for these factors and outdoor temperature.

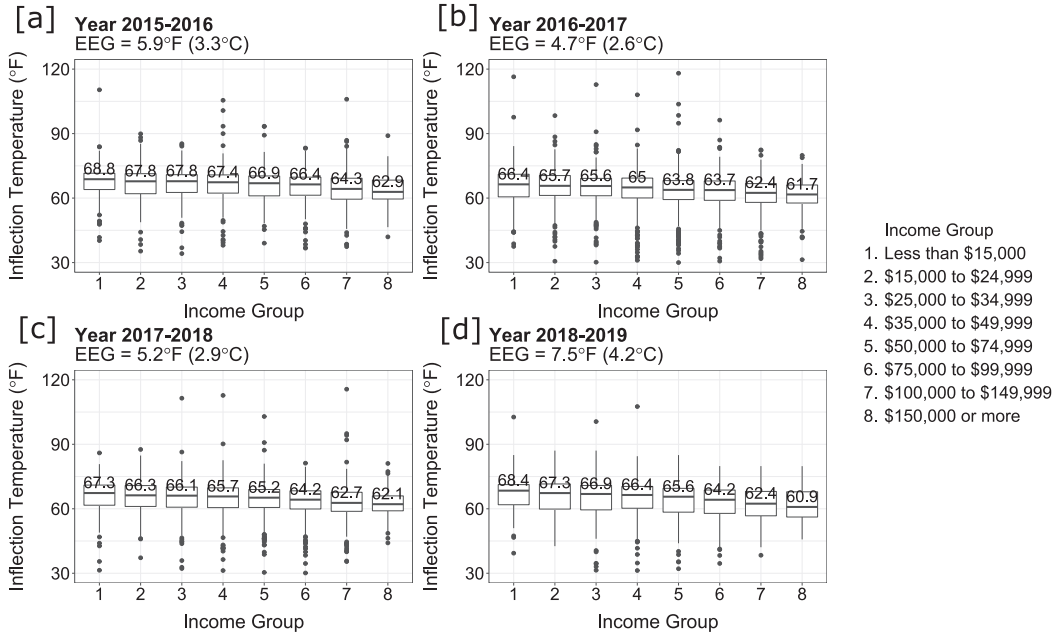


Fig. 3 The distribution of inflection temperature across income groups. The energy equity gap (EEG) for each year is calculated as the difference between the highest and lowest median inflection temperature (indicated by the middle bar and number) among all income groups in all four panels, income group 1 had the highest, and income group 8 had the lowest median inflection temperature. The energy equity gap (EEG) is shown at the top of each panel. (**a**) 2015–2016 $N = 4577$ households, (**b**) 2016–2017 $N = 4522$ households, (**c**) 2017–2018 $N = 3852$ households, (**d**) 2018–2019 $N = 2650$ households. Each box and whiskers plot indicates the minima and maxima of inflection temperatures of one income group for one year (the lower and upper bound of the whiskers), the first and third quantiles (the lower and upper bound of the box), and the median (the middle line). The outliers are shown as dots on either side of the whiskers. Source data can be found in our code repository.

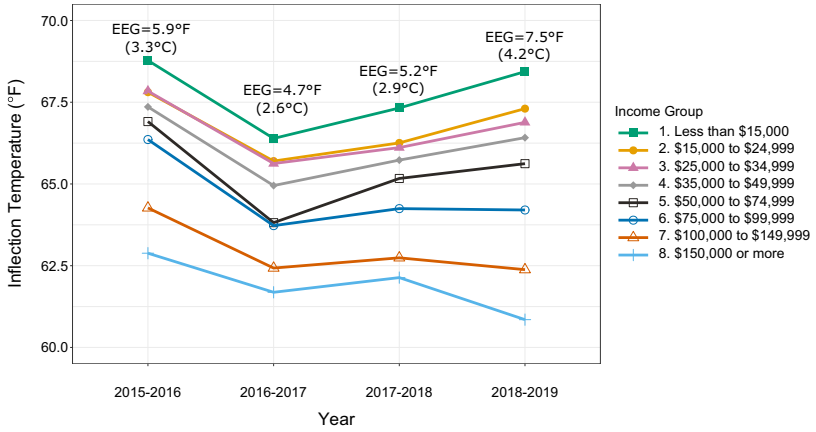


Fig. 4 Energy equity gap (EEG) and median inflection temperature changes across study years. Each line represents one income group. Each data point represents the median inflection temperature of the income group for that year.

discomfort becomes too great (high indoor temperature) populations are at a higher risk for heat stroke[49].

The energy equity gap shrinks and widens, resulting from low-income households first lowering then increasing their inflection temperatures while high-income households have a general trend of lowering their inflection temperatures across the years in our analysis. Thus, highlighting increasing energy inequity in the region.

The energy equity gap narrowed by 20.3% between the first two years of our study, but then widened by 10.6% and 44.2% in the last three years of our study, as seen in Table 1. We find that a change in cooling degree days or residential electricity price correlates to energy equity gap changes in the following year. Between years one and two, there was a 2.4 % increase in residential electricity prices and a 3.6% increase in cooling degree days. This parallels with a 10.6% increase in the energy equity gap in year 3, most likely caused by low-income groups waiting longer to turn on their AC systems. This may signify a delayed price elasticity of demand effects in year-to-year residential electricity price changes and a warming climate. Between years two and three, the residential electricity price rose again by 2.7% and cooling degree days by 2.5%, which corresponds to a 44.2% increase in the year's energy equity gap. Thus, both a higher temperature and a higher electricity price can cause energy equity to deteriorate. Within our study population, low-income

Table 1 Temperature, electricity price, and energy equity gap shifts in Arizona.

Arizona metric	Change from year 1 to 2	Change from year 2 to 3	Change from year 3 to 4
Warmest Month Average Max outdoor temperature	1.0%	−0.2%	−0.2%
Cooling Degree Days (CDD)	3.6%	2.5%	−5.2%
Average residential electricity retail price (cents/kWh)	2.4%	2.7%	−2.7%
Energy equity gap	−20.3%	10.6%	44.2%

Warmest Month Average Max is the average maximum temperature of the hottest month in a year.

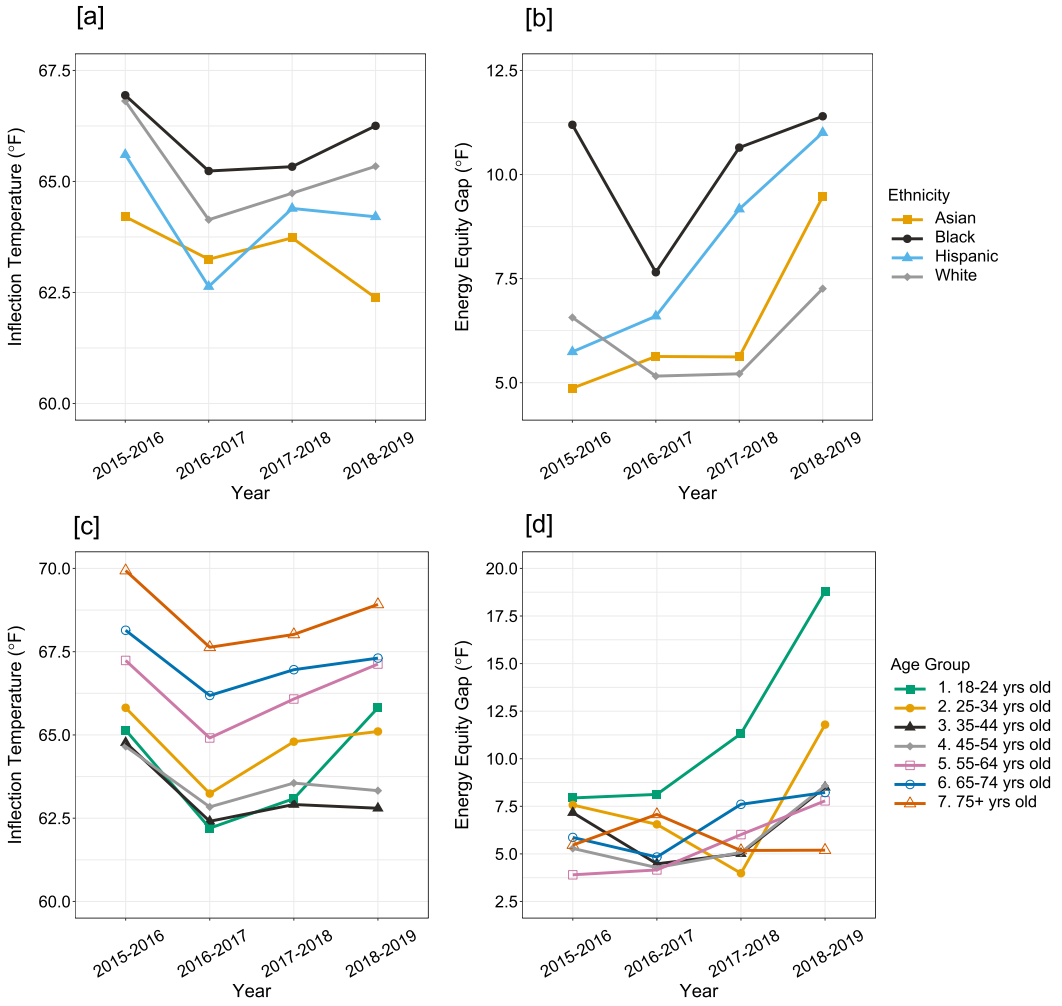


Fig. 5 Inter- and intra-group comparison of the inflection temperature and energy equity gap for ethnicity and age groups. Median inflection temperatures by (**a**) ethnicity and (**c**) age group show disparities across demographics. The energy equity gap highlights energy consumption behavior differences between high and low-income populations within their respective (**b**) ethnicity and (**d**) age groups. See Supplementary Information Notes 3 and 4 for more details.

households are more likely to live in older residences (see Supplementary Information Note 2), which can contribute to more significant energy needs and financial strain required to cool the home.

Price shifts will impact electricity consumption shifts within minority groups and those at the intersection of multiple vulnerable groups (e.g., low-income minority groups or low-income elderly populations) differently. Figure 5a, c show the median inflection temperature for each ethnicity and age group; Fig. 5b, d show the energy equity gap within each ethnicity and age group, respectively. Comparing Fig. 5a, b (assuming similar temperature preference between ethnicities[50,51]), we see that the overall inflection temperature is highest in the Black population. This combined with high energy equity gaps, indicates that the Black population is worse off and experiences high levels of inequity. In the Asian population, the overall median inflection temperatures are low yet there are wide energy equity gaps, indicating high income disparity within the group.

In the Black population, we see increasing disparity followed by the 2.4% electricity price increase from year 1 to 2, resulting in a 39% increase in the energy equity gap from year 2 to 3, earlier than the large price shock that affected the whole population.

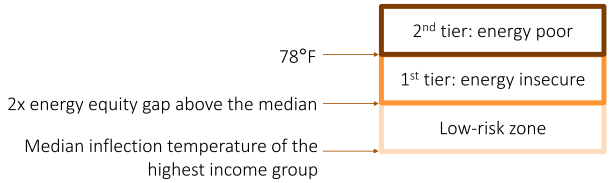


Fig. 6 Tier systems for energy poverty and insecurity identification using the energy equity gap. The darker the shade the more severe the level of energy poverty experienced by a household is.

This indicates that the Black population is disproportionately affected by price shifts compared to the other ethnicities. The white population most closely resembles the overall population trend because white populations account for the majority (>70%) of residents in our sample. In general, we find that even when a minority group's median inflection temperature is low, there can be a high disparity between low and high-income populations (see Supplementary Information Note 3), evident in the Asian population.

We also investigated energy poverty and equity across head of household age groups (Fig. 5c, d). There are statistically significant differences between median inflection temperatures across age groups ($p < 0.05$), as confirmed using the Mood's Median test (see Methods), indicating low probability that these variations occur solely due to chance. For the 18–24 age group, both the median inflection temperature (>7 °F, 3.9 °C) and the energy equity gap increased sharply (>14 °F, 7.8 °C) between 2018 and 2019, while for the older populations, the energy equity gap had little change across the years. From an energy poverty targeting standpoint, this highlights that within the elderly population, all residents should be targeted to reduce inflection temperatures, while for the youngest age groups, the most effective poverty eradication policy would be to target low-income groups.

For all age groups except for 75+, the later increase in the energy equity gap is from low-income households getting worse off and high-income households performing better, most evident in age groups 18–24 and 25–34. The difference in inflection temperatures between age groups may be attributed to each age group's different temperature comfort levels. Elders may prefer warmer indoor temperatures, and cooling air from an AC system may inflame arthritis[52], but caution should be used when differentiating between a comfortably warm temperature and one that puts the resident at risk for a heat-related illness[53]. Because there is a significant relationship between household income and inflection temperature, the high energy equity gap in younger age groups may be attributed to larger income inequality among young people.

We acknowledge that there is a chance that the inflection temperature and energy equity gap can be affected by indoor thermostat preferences. To account for varying preferences across ethnic and age groups, we investigate the inflection temperature disparities for different income groups within demographic distinctions (see Supplementary Information Note 3). For example, if one ethnic group preferred to turn on their AC units at a certain temperature, we expect to find a narrow vertical distribution for the inflection temperatures (i.e., the Hispanic population in Supplementary Information Note 3). On the other hand, if the different inflection temperatures represent inequity, we expect to find a wide vertical distribution (i.e., the Black and Asian population in Supplementary Information Note 3). Thus, the energy equity gap can highlight inequities across and within groups in a region. We present a more detailed discussion of the preference limitation in the Supplementary Information Note 3.

We introduce a tiered system (Fig. 6) to identify the households with the highest risk of heat-related illness and death. First, we assume the median inflection temperature of the highest income group is the ideal inflection temperature for this region. This assumption stems from the belief that the highest income groups are the least likely to constrain their budget and thus would initiate cooling systems earliest in the year. Similar to using a standard deviation, we define people with inflection temperatures between one and two energy equity gaps above the ideal inflection temperature to be in the low-risk zone. Next, households with inflection temperatures between two energy equity gaps and 78 °F (25.6 °C) are in the energy insecure zone. Within government buildings, it is recommended that 78 °F degrees be the indoor set point[54], meaning this temperature setting may limit the risk for mold and allergen build-up, as well as heat-related illness and death. Finally, households with inflection temperatures higher than 78 °F (25.6 °C) are defined as energy poor. We use the indoor 78 °F (25.6 °C) comfort set point as our energy poverty threshold because households would need some degree of cooling above this outdoor temperature.

We acknowledge that there are multiple factors that can influence comfort levels and the health risk of occupants in high heat temperatures. Previous studies have shown that heat-mortality risk occurs when outdoor temperature rises above 90 °F (32.2 °C)[55]. However, our goal is to identify households at risk for both health-related illness and death, which can result from a lower temperature threshold. We derive this lower threshold (78 °F, 25.6 °C) from recommended indoor AC setting for government buildings[54,56], as well as from recommendations of various utility companies[57,58]. A key assumption in this threshold is that when the outdoor temperature is above this level, the indoor temperature would rise enough to warrant turning on the AC.

Using this tiered system, policymakers and utility companies can create more targeted weatherization aid programs. When we apply the tiers system to 2015–2016 data (Table 2), we identify 86 energy poor (1.9% of our sample) and 214 energy insecure households (4.7% of our sample).

Comparing the energy equity gap to income-based measures. While US government assistance programs lack a clear definition for energy poverty, change in energy burden is often used to measure the outcome of these programs[9,11]. Both LIHEAP and WAP use income limit by household size to determine eligibility[59,60], with some flexibility for states to determine what income level to set as the eligibility threshold. When using the 10% energy burden threshold to identify energy-insecure households in our study region, we found that less than 3% of households were defined as energy insecure (Fig. 7), of which over 70% reside in the lowest income group (<$15,000) for all years in our study. Comparing the energy equity gap categorization with the energy burden measure of individual households, we find that few households (≤ 20) were identified as energy insecure or energy poor under both metrics (Table 2, also see Supplementary Information Note 7 for a visual representation). The energy burden metric categorizes more households as energy insecure, but our tiered system identifies more energy-poor households who may be placing themselves at risk by limiting cooling-associated energy use. The energy burden metric misses more than 95% of those with high inflection temperatures and, therefore, a higher risk of extreme heat exposure. Of that 95%, around half of the households are in one of the three low-income groups (<$35,000). There are energy insecure households identified in the non-low-income groups, which hints that while some

Table 2 Comparing the energy equity gap (EEG) and financial-based energy assistance categories.

(Number of households in each category)	2015–2016	2016–2017	2017–2018	2018–2019
Total households	4577	4522	3852	2650
Energy equity gap (EEG) low risk zone	2719	2143	1889	1619
EEG 1st tier: Energy insecure	214	631	484	42
EEG 2nd tier: Energy poor	86	83	57	59
Households with energy burden ≥10%	141	135	111	88
EEG low-risk zone households with energy burden ≥10%	94	59	64	55
EEG 1st tier households with energy burden ≥10%	6	16	9	1
EEG 2nd tier households with energy burden ≥10%	3	4	1	2
EEG 1st and 2nd tier households with energy burden <10%	274	587	286	93
EEG 2nd tier households not eligible for LIHEAP	72	63	48	48
EEG 2nd tier households not eligible for WAP	53	37	33	29

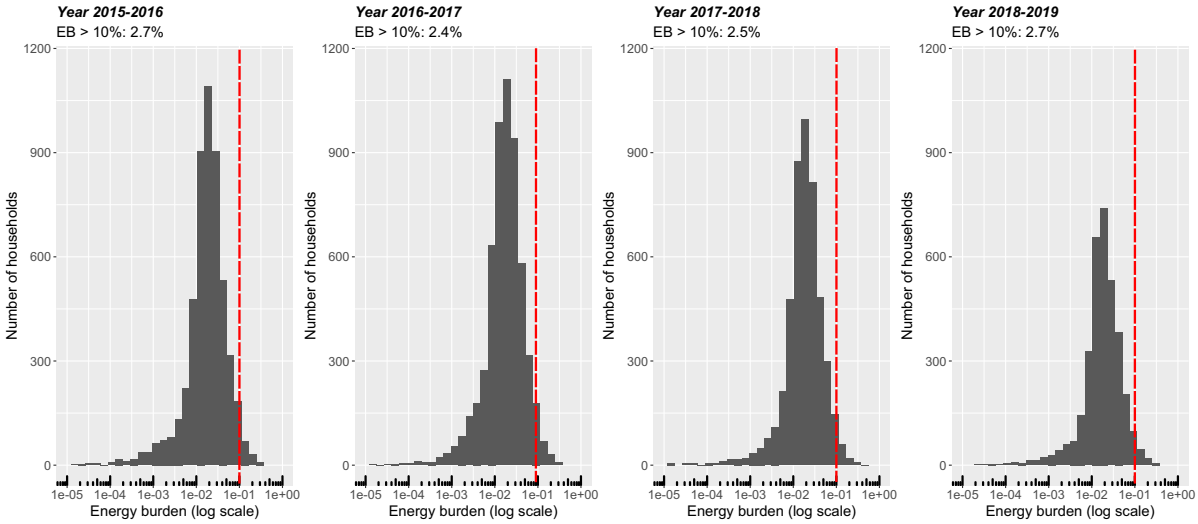


Fig. 7 Energy insecurity measured using the energy burden (EB) metric. The *x*-axis represents the percent of income a household spends on electricity. The red dotted line indicates the 10% income spending threshold, and EB10 details the proportion of households above the energy spending threshold. For example, in 2015–2016, 2.7% of households in our sample spent more than 10% of their income on electricity. The maximum amount of spending in our sample population is 35%.

households are not classified as low-income, they may have low disposable income (e.g., high mortgage or rent costs) and limit their financial burden by reducing their energy consumption. This further highlights the need for multiple energy poverty and insecurity measures to determine financial and behavioral energy consumption trends in energy-insecure households.

We also compared eligibility for LIHEAP and WAP and households in the 2nd tier of the energy equity gap metric. In our dataset of 6002 households, 871 qualified for LIHEAP and 1553 qualified for WAP using their respective income threshold[9]. We found that 48–72 households each year have high inflection temperatures but are not eligible for LIHEAP. Because WAP has a higher income threshold than LIHEAP, all households that qualify for LIHEAP also qualify for WAP, so this range reduces to 29–53 households when comparing the energy equity gap and WAP. Many of these missed households are just on the edge of the low-income threshold but have uncomfortably and sometimes dangerously high inflection temperatures, making them vulnerable without assistance.

Limitations of analysis and opportunities for future work. Energy poverty exists in multiple forms, leading to numerous limitations in any quantification method. Here we present a discussion of the limitations of our methods and opportunities for future improvements. Uncertainties in using the iteration of the energy equity gap outlined in this paper include the lack of heating data from the natural gas provider. From the dataset provided by the electric utility, we gather that 60% of households in this study use electricity for both cooling and heating, while the remaining most likely use natural gas or oil for heating. However, we did not find the type of heating system to be a significant indicator of household inflection temperatures. Thus, the model used to calculate the inflection temperature still stands for this particular electricity-based dataset (see Methods), particularly for a high-heat area like Arizona where heat-related illness and death is significantly higher than cold-related ones[40,41].

Housing characteristics that relate to the energy efficiency of the home[61] (e.g., number of windows, insulation, wall thickness, finishing material, the orientation of the home, etc.) were not included in the dataset but would be valuable additions to future utilities data collection effort. We did find a relationship between residence age and income group, where a large proportion of low-income households lived in older homes (see Supplementary Information Note 2), which could contribute to higher inflection temperatures and less overall household energy efficiency.

One limitation of this study is a lack of indoor thermostat data and an inability to quantify the actual indoor temperature of homes. Thermostat data could provide more information about the willingness of occupants to consume energy for cooling and heating needs. However, thermostat information would not reveal a consumer's true temperature comfort preferences. The inability of thermostat data to identify true household preferences results from household occupants adjusting their thermostat based on multiple factors such as spending limits (i.e., disposable income), comfort, and energy conservation habits. Thus, a person might deliberately keep their thermostats at non-ideal temperatures (i.e., energy limiting behavior), rather than their true comfortable temperature, to save money or energy. Another possibility is that the energy equity gap could be wider than our analyses suggest due to the urban heat islanding effect[62,63], with low-income households being more exposed to high heat due to less shading and vegetation in their urban environments.

In spite of these limitations, we believe this analysis provides a crucial first step in identifying energy limiting behavior in low-income households in a metropolitan region. A fruitful direction for future work would be to investigate actual temperature discrepancies within the home.

Discussion

The energy burden metric targets households who limit other necessities to meet energy needs but misses out on those who limit energy spending to meet other needs. The energy equity gap fills this void by identifying who chooses to endure higher temperatures in the summer and how their behavior may change due to price spikes and weather changes. The two types of metrics should be used in conjunction to identify households experiencing multiple forms of energy poverty: those who experience financial strain while satisfying their energy needs, and those who forgo energy consumption to reduce financial strain and satisfy other necessities. By considering behavior patterns in addition to spending patterns, policy makers will be able to better identify who is in need of energy assistance. As nations continue designing equitable and sustainable energy policies, regions need a straightforward method to evaluate the current level of energy poverty from an economic, consumption, and behavioral perspective.

By grouping households by income and energy equity gap severity, policymakers and utility companies can target the most at-risk households requiring urgent financial help with energy bills and weatherization. The value of the energy equity gap is that it creates the possibility of a sliding-scale energy poverty assistance program, which could set weatherization targets for the population based on their ability to adapt to extreme weather events (e.g., heatwaves) and how they are performing relative to others in the region. For example, if primary policies were designed to target households with an inflection temperature above 78 °F (25.6 °C) and those that spend more than 10% of their income on meeting their energy needs, this could reduce financial strain and risk of heat-related illnesses in the region. Secondary policy targets should focus on households with low income and above-average inflection temperatures. These households are likely to suffer from multiple forms of energy poverty and insecurity but are not at high risk for heat-related death.

On the other hand, high-income households with high inflection temperatures may be best suited for discounted weatherization programs. Despite having higher incomes, weatherization costs may still be too high for these households if they have limited disposal income. When adapting the energy equity gap to other regions, electricity consumption may be sufficient for similarly high-heat regions. However, researchers and energy planners should consider gas, electric, and potentially other fuels used for heating to estimate total energy consumption for colder climates. Calculating the energy equity gap requires the same information for the traditional energy poverty metric, so the cost to compute and utilize the energy equity gap would be marginal.

In the ever-evolving discussion around equity, justice, and policy, we need to study and develop policy that answers the needs of those historically and systemically marginalized. We can start by identifying those falling through the policy cracks of economic-based poverty metrics by casting a finer net which also includes poverty displayed through energy consumption behavior. The energy equity gap contributes to the discussion of existing energy poverty metrics by capturing a region's relative progress while including the households that income-based metrics may have left behind. By targeting the population with higher-than-ideal inflection temperatures with equity-centered policies, regions will more effectively eradicate energy poverty and assist their residents in adapting to climate change.

Methods

Data. The data was provided by Salt River Project, a large utility company in Arizona. The dataset comprises two parts: first, hourly electricity consumption in kWh from May 2015 to April 2019 for 6000 households and the billing plan for each household; second, a comprehensive Residential Equipment and Technology Survey conducted in 2017 for those households. The survey included information on household sociodemographic information, and dwelling characteristics (e.g., residence age, size, and type). For summaries of demographics information please see Supplementary Information Note 1.

Salt River Project provides different billing packages from which customers can choose based on their preferences. Each billing package has its own pricing rules and condition. The billing packages can be categorized into Basic Rate Plan, Time-of-Use Plans, and Prepaid Plans. Pricing rules were integrated into the consumption dataset to account for energy consumption patterns based on electricity pricing, where a uniform weighted average electricity price is calculated across 24 h of the day.

The hourly electricity consumption was aggregated into daily consumption. Daily consumption information was then coupled with daily average temperatures for the study region, compiled from WeatherForYou.com[64].

Inflection temperature. The inflection temperature is defined as the outdoor temperature where a household shifts from using its heating system to its cooling system. We recognize that there may be a temperature range where the household uses neither heating nor cooling, and the base level energy consumption during that period would be temperature-independent[46]. In this context, the inflection temperature is still an indicator of the shift in energy consumption behavior. A household's inflection temperature is calculated using a nonlinear regression model (Eq. (1)), which estimates daily electricity consumption of household i on day t ($E_{i,t}$) based on the following variables: daily average temperature (T_t), electricity price based on the billing plan of the household and season ($P_{i,s}$), dummy variables of whether day t is a holiday (H_t), day-of-the-week fixed effects (δ_t), and month-of-the-year fixed effects (μ_t). When modeling day-of-the-week and month-of-the-year dummy variables, Wednesday and March were dropped, respectively, to prevent collinearity.

$$E_{i,t} = \alpha + \beta_1 \times T_t + \beta_2 \times {T_t}^2 + \beta_3 \times P_{i,s} + H_t + \delta_t + \mu_t \quad (1)$$

The quadratic equation models the relationship between daily electricity consumption and daily average temperature. We chose a quadratic relationship because it best coincides with the shape of the electricity consumption and temperature data, and a median R^2 value of 0.8 for all households (Fig. 2). The convex shape of the curve confirms the notion that electricity consumption is highly correlated with temperature. The inflection temperature is the minimum electricity consumption point (Eq. (2)) and signifies the outdoor temperature a household must experience before initiating their AC units.

$$T_{\mathrm{inf}} = T_t \; when f'(E_{i,t}) = 0 \quad (2)$$

We acknowledge that in building literature there are studies that use a piecewise linear function to identify cooling and heating turn on points (often referred to as balance points)[45,46,65–67]. We use the quadratic function over the piecewise linear function due to higher R^2 values, which is consistent with other studies[68] (see Supplementary Information Note 12 for more discussion).

The outliers of the inflection temperature model are defined as any household with an inflection temperature below 30 °F (−1.1 °C) or above 120 °F (48.9 °C), based on outdoor temperature limit ranges measured within the study region. An inflection temperature outside of this bound may indicate incomplete electricity consumption data. Within our study, we filtered out 0.5% in year one, 1.6% in year two, 1.2% in year three, and 0.2% in year four from our analysis due to their classification as outliers. There are a total of 6002 households across the four years of study, but not all households have complete data for all years, which is why the total number of households in Table 2 decreased. One reason for the incomplete data may be that households started or stopped service midway with this utility company.

Computing the energy equity gap. The energy equity gap quantifies the relative energy consumption behavior differences between low and high-income groups using the inflection temperatures. We hypothesized that lower-income households are more likely to have higher inflection temperatures due to financial limitations and a desire to delay cooling their homes to reduce their energy burden (i.e., percent of income spent on energy services). After calculating the inflection temperature (T_{inf}) for each household for one year, we group households by income. The energy equity gap for year y, G_y, is the maximum median inflection temperature ($\max(T_{\mathrm{inf},median})$) minus the minimum inflection temperature ($\min(T_{\mathrm{inf},median})$) among all income groups.

$$G_y = \max\left(T_{\mathrm{inf},median}\right) - \min\left(T_{\mathrm{inf},median}\right) \quad (3)$$

We hypothesized that lower-income households are more likely to have higher inflection temperatures. To test our hypothesis, we performed tow-tailed Mood's Median tests, a nonparametric alternative to a one-way analysis of variance, for significance. A significant result from a Mood's Median test demonstrates that one sample stochastically dominates another, and the differences between sample medians are statistically different. Tests were also performed on median inflection temperatures of ethnicity and age groups, with P-values shown in Table 3. When we group the households by income, we see significant *P*-value results for all four years, which indicates that the difference in median inflection temperatures of income groups have a close to 0% chance of solely being random (i.e., they are statistically significant). We see similar results when we group the sample population by age, which means age may also be a strong indicator of inflection temperature. Therefore, we cannot rule out that age may play a role in electricity consumption habits (e.g., older people may prefer to turn on their AC at a higher temperature), which would affect the inflection temperatures seen across groups. That being said, when computed within an age or ethnicity group, the energy equity gap can highlight when members are experiencing worsening poverty (i.e., the gap is widening), or when members of the group are adapting to temperature changes in a similar fashion (i.e., the gap is narrowing). While the ethnicity *p*-values are not on the same order of magnitude as income or age groups, we find that there is less than a 1% chance that the variation between ethnic groups is solely due to chance for years one, two, and four, and less than 6% for year three, thus indicating high statistical significance.

We also considered the potential effects of type of residence (i.e., single-family home, multi-family home, condo, mobile home, townhouse), residence age, and residence size that can have on the household's inflection temperature. However, we find including these variables would introduce multicollinearity into the model because they are correlated with income. For more details see Supplementary Information Note 8.

Computing the traditional energy poverty metric. The traditional economic based energy poverty metric, energy burden, is defined as the percent of income a household spends on satisfying their energy (e.g., electricity) demand. We calculate the proportion of energy expenditure of each household for each year using income, residential electricity price, and energy consumption. For each household, the utility company provides the income bracket each household falls into. We use the midpoint of each income group to estimate the percent of income spent on energy consumption. For the lowest income group (<$15,000), $10,000 was taken as the midpoint; for the highest income group (>$150,000), $175,000 was taken as the midpoint.

$$S_{i,y} = \frac{\sum E_{i,t} \times P_i}{I_{i,m}} \quad (4)$$

$S_{i,y}$ is the energy expenditure over income of household i in year y, $E_{i,t}$ is the daily electricity consumption of household $i$on day t. P_i is the average electricity price of the billing plan of household i. $I_{i,m}$is the midpoint estimate of income for household i.

Table 3 *P*-values from two-tailed Mood's Median tests on median inflection temperatures of income, ethnicity, and age groups.

Grouping	2015–2016	2016–2017	2017–2018	2018–2019
Income	5.36E−23***	6.85E−22***	2.50E−16***	2.05E−13***
Ethnicity	5.94E−03*	6.02E−05***	2.85E−01	1.73E−02·
Age	2.30E−29***	1.61E−32***	8.91E−20***	7.36E−17***

Alpha = 0.05.
Signif. codes: "***" [0, 0.001] "*" (0.01, 0.05] "." (0.05, 0.1] " " (0.1, 1].

Reporting summary. Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability

The raw and processed electricity consumption data and the residential energy technology survey data are available under restricted access bound by a non-disclosure agreement, access can be obtained by upon reasonable request to the authors and with permission from the Salt River Project. Records of mean daily outdoor temperatures were retrieved from WeatherForYou.com by way of web scraping and can be accessed here. Source data for Fig. 3, Supplementary Information Figs. S3, S6, and S9 can be accessed here.

Code availability

All data and models are processed in Python 3.8.5. The figures are produced in PowerPoint and R studio (based on R 4.0.3). All custom code[69] is available on GitHub at https://github.com/Pa223/The-Energy-Equity-Gap.

Received: 13 July 2021; Accepted: 13 April 2022;
Published online: 04 May 2022

References

1. Sovacool, B. K. Fuel poverty, affordability, and energy justice in England: Policy insights from the Warm Front Program. *Energy* **93**, 361–371 (2015).
2. Primc, K., Slabe-Erker, R. & Majcen, B. Constructing energy poverty profiles for an effective energy policy. *Energy Policy* **128**, 727–734 (2019).
3. *Climate Change Impacts in the United States: The Third National Climate Assessment*. https://nca2014.globalchange.gov/downloads https://doi.org/10.7930/J0Z31WJ2 (2014).
4. Wu, X., Brady, J. E., Rosenberg, H. & Li, G. Emergency department visits for heat stroke in the United States, 2009 and 2010. *Injury Epidemiol.* **1**, 8 (2014).
5. *Heat wave: a social autopsy of disaster in Chicago, Klinenberg*. https://press.uchicago.edu/ucp/books/book/chicago/H/bo20809880.html (2015).
6. Canouï-Poitrine, F. et al. Excess deaths during the August 2003 heat wave in Paris, France. *Rev. Epidemiol. Sante Publique* **54**, 127–135 (2006).
7. Baldwin, J. W., Dessy, J. B., Vecchi, G. A. & Oppenheimer, M. Temporally compound heat wave events and global warming: an emerging hazard. *Earth Future* **7**, 411–427 (2019).
8. Dong, W., Liu, Z., Liao, H., Tang, Q. & Li, X. New climate and socio-economic scenarios for assessing global human health challenges due to heat risk. *Clim. Change* **130**, 505–518 (2015).
9. Bednar, D. J. & Reames, T. G. Recognition of and response to energy poverty in the United States. *Nat. Energy* **5**, 432–439 (2020).
10. *Low Income Home Energy Assistance Program (LIHEAP) | The Administration for Children and Families*. https://www.acf.hhs.gov/ocs/low-income-home-energy-assistance-program-liheap (2022).
11. Rose, E. M. & Hawkins, B. A. Background Data and Statistics on Low-Income Energy Use and Burden for the Weatherization Assistance Program: Update for Fiscal Year 2020. https://doi.org/10.2172/1761662 (2020).
12. Okushima, S. Gauging energy poverty: a multidimensional approach. *Energy* **137**, 1159–1166 (2017).
13. Duclos, J.-Y., Sahn, D. E. & Younger, S. D. Robust multidimensional poverty comparisons*. *Economic J.* **116**, 943–968 (2006).
14. Pachauri, S. & Spreng, D. Measuring and monitoring energy poverty. *Energy Policy* **39**, 7497–7504 (2011).
15. Culver, L. C. Energy poverty: what you measure matters. *The Stanford Natural Gas Initiative* (2017).
16. Middlemiss, L. et al. Energy poverty and social relations: a capabilities approach. *Energy Res. Soc. Sci.* **55**, 227–235 (2019).
17. Memmott, T., Carley, S., Graff, M. & Konisky, D. M. Sociodemographic disparities in energy insecurity among low-income households before and during the COVID-19 pandemic. *Nat. Energy* **6**, 186–193 (2021).

18. Romero, J. C., Linares, P. & López, X. The policy implications of energy poverty indicators. *Energy Policy* **115**, 98–108 (2018).
19. Spiliotis, E., Arsenopoulos, A., Kanellou, E., Psarras, J. & Kontogiorgos, P. A multi-sourced data based framework for assisting utilities identify energy poor households: a case-study in Greece. https://doi.org/10.1080/15567249.2020.1739783 **15**, 49–71 (2020).
20. Memmott, T., Carley, S., Graff, M. & Konisky, D. M. Sociodemographic disparities in energy insecurity among low-income households before and during the COVID-19 pandemic. *Nat. Energy 2021 6:2* **6**, 186–193 (2021).
21. USDA ERS. *Percent of income spent on food falls as income rises*. https://www.ers.usda.gov/amber-waves/2016/september/percent-of-income-spent-on-food-falls-as-income-rises/ (2016).
22. Papada, L. & Kaliampakos, D. Measuring energy poverty in Greece. *Energy Policy* **94**, 157–165 (2016).
23. Liddell, C., Morris, C., McKenzie, S. J. P. & Rae, G. Measuring and monitoring fuel poverty in the UK: National and regional perspectives. *Energy Policy* **49**, 27–32 (2012).
24. Moore, R. Definitions of fuel poverty: Implications for policy. *Energy Policy* **49**, 19–26 (2012).
25. Herrero, S. T. Energy poverty indicators: a critical review of methods. *Indoor Built Environ.* **26**, 1018–1031 (2017).
26. Dagnachew, A. G., Lucas, P. L., Hof, A. F. & van Vuuren, D. P. Trade-offs and synergies between universal electricity access and climate change mitigation in Sub-Saharan Africa. *Energy Policy* **114**, 355–366 (2018).
27. Batinge, B., Kaviti Musango, J. & Brent, A. C. Perpetuating energy poverty: Assessing roadmaps for universal energy access in unmet African electricity markets. *Energy Res. Soc. Sci.* **55**, 1–13 (2019).
28. Karplus, V. J. & von Hirschhausen, C. Electricity access: an introduction. *Econ. Energy Environ. Policy* **8**, 1–18 (2019).
29. Higgins, L. & Lutzenhiser, L. Ceremonial equity: low-income energy assistance and the failure of socio-environmental policy. *Soc. Probl.* **42**, 468–492 (1995).
30. MURRAY, A. G. & MILLS, B. F. The impact of low-income home energy assistance program participation on household energy insecurity. *Contemp. Economic Policy* **32**, 811–825 (2014).
31. *Access to electricity (% of population), Data*. https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS (2020).
32. Held, J. S. *Common causes of electric space heater fire examined*. https://jsheld.com/insights/articles/common-causes-of-electric-space-heater-fires-methods-of-prevention (2022).
33. Reames, T. G. Targeting energy justice: exploring spatial, racial/ethnic and socioeconomic disparities in urban residential heating energy efficiency. *Energy Policy* **97**, 549–558 (2016).
34. Reames, T. G. A community-based approach to low-income residential energy efficiency participation barriers. *Local Environ.* **21**, 1449–1466 (2016).
35. Hernández, D. & Siegel, E. Energy insecurity and its ill health effects: a community perspective on the energy-health nexus in New York City. *Energy Res. Soc. Sci.* **47**, 78–83 (2019).
36. Union of Concerned Scientists. *The energy burden: how bad is it and how to make it less bad*. https://blog.ucsusa.org/joseph-daniel/how-to-make-energy-burden-less-bad (2019).
37. Middlemiss, L. & Gillard, R. Fuel poverty from the bottom-up: characterising household energy vulnerability through the lived experience of the fuel poor. *Energy Res. Soc. Sci.* **6**, 146–154 (2015).
38. *Damp Indoor Spaces and Health*. *Damp Indoor Spaces and Health*, https://doi.org/10.17226/11011 (National Academies Press, 2004).
39. Evans, J., Hyndman, S., Stewart-Brown, S., Smith, D. & Petersen, S. An epidemiological study of the relative importance of damp housing in relation to adult health on JSTOR. *J. Epidemiol. Community Health* **54**, 677–686 (2000).
40. *Heat-related illness by year emergency department visit inpatient admission (hospitalization)*. https://www.azdhs.gov/documents/preparedness/epidemiology-disease-control/extreme-weather/pubs/heat-related-illness-emergency-department-and-inpatient-admissions-in-arizona-by-year.pdf (2021).
41. *Cold-related illness by year*. https://www.azdhs.gov/preparedness/epidemiology-disease-control/extreme-weather/index.php#cold-home (2021).
42. Jenkins, K., McCauley, D., Heffron, R., Stephan, H. & Rehner, R. Energy justice: a conceptual review. *Energy Res. Soc. Sci.* **11**, 174–182 (2016).
43. Sovacool, B. K., Burke, M., Baker, L., Kotikalapudi, C. K. & Wlokas, H. New frontiers and conceptual frameworks for energy justice. *Energy Policy* **105**, 677–691 (2017).
44. Sovacool, B. K. & Dworkin, M. H. Energy justice: conceptual insights and practical applications. *Appl. Energy* **142**, 435–444 (2015).
45. Chong, H. Building vintage and electricity use: old homes use less electricity in hot weather. *Eur. Economic Rev.* **56**, 906–930 (2012).
46. Fazeli, R., Ruth, M. & Davidsdottir, B. Temperature response functions for residential energy demand - a review of models. *Urban Clim.* **15**, 45–59 (2016).
47. Tang, W., Kuehn, T. H. & Simcik, M. F. Effects of temperature, humidity and air flow on fungal growth rate on loaded ventilation filters. *J. Occup. Environ. Hyg.* **12**, 525–537 (2015).
48. Hirsch, D. J., Hirsch, S. R. & Kalbfleisch, J. H. Effect of central air conditioning and meteorologic factors on indoor spore counts. *J. Allergy Clin. Immunol.* **62**, 22–26 (1978).
49. Kilbourne, E. M., Choi, K., Jones, T. S. & Thacker, S. B. Risk factors for heatstroke: a case-control study. *JAMA: J. Am. Med. Assoc.* **247**, 3332–3336 (1982).
50. Lawes, M., Havenith, G. & Hodder, S. Ethnic differences: the influence of relative humidity on thermal perception. *CIEHF Publications* (2021).
51. Wang, L., Chen, M. & Yang, J. Interindividual differences of male college students in thermal preference in winter. *Build. Environ.* **173**, 106744 (2020).
52. Aikman, H. The association between arthritis and the weather. *Int. J. Biometeorol.* **40**, 192–199 (1997).
53. Oudin Åström, D., Bertil, F. & Joacim, R. Heat wave impact on morbidity and mortality in the elderly population: a review of recent studies. *Maturitas* **69**, 99–105 (2011).
54. DDOE. *Energy tips for institutional and government buildings*. https://doee.dc.gov/service/energy-tips-institutional-and-government-buildings (2021).
55. Díaz, J. et al. Heat waves in Madrid 1986-1997: effects on the health of the elderly. *Int. Arch. Occup. Environ. Health* **75**, 163–170 (2002).
56. Department of Energy. *Thermostats*. https://www.energy.gov/energysaver/thermostats (2021).
57. *Thermostat settings: the ideal settings for summer & winter*. https://valleyservice.net/blogs/thermostat-settings (2020).
58. *Recommended thermostat settings for winter and summer*. https://www.centralhtg.com/blog/recommended-thermostat-settings (2018).
59. Benefits.gov. *Low Income Home Energy Assistance Program (LIHEAP)*.https://www.benefits.gov/benefit/623 (2020).
60. Department of Energy. *How to apply for weatherization assistance*. https://www.energy.gov/eere/wap/how-apply-weatherization-assistance (2022).
61. Thomson, H., Simcock, N., Bouzarovski, S. & Petrova, S. Energy poverty and indoor cooling: an overlooked issue in Europe. *Energy Build.* **196**, 21–29 (2019).
62. Hsu, A., Sheriff, G., Chakraborty, T. & Manya, D. Disproportionate exposure to urban heat island intensity across major US cities. *Nat. Commun.* **12**, 1–11 (2021).
63. Harlan, S. L. et al. In the shade of affluence: the inequitable distribution of the urban heat island. *Res. Soc. Probl. Public Policy* **15**, 173–202 (2007).
64. Phoenix Arizona Local Weather Forecasts and Conditions - WeatherForYou.com. https://www.weatherforyou.com/reports/index.php?config=&pass=&dpp=&forecast=zandh&config=&place=phoenix&state=az&pands=phoenix,az&country=us (2019).
65. Brown, M. A., Cox, M., Staver, B. & Baer, P. Modeling climate-driven changes in U.S. buildings energy demand. *Climatic Change* **134**, 29–44 (2015).
66. Hiruta, Y., Gao, L. & Ashina, S. A novel method for acquiring rigorous temperature response functions for electricity demand at a regional scale. *Sci. Total Environ.* **819**, 152893 (2022).
67. ASHRAE Guideline 14-2002 Measurement of energy and demand savings. ISSN 1049-894X (2002).
68. Kim, Y. J., Lee, S. J., Jin, H. S., Suh, I. A. & Song, S. Y. Comparison of linear and nonlinear statistical models for analyzing determinants of residential energy consumption. *Energy Build.* **223**, 110226 (2020).
69. Pa223. *Pa223/The-Energy-Equity-Gap*, https://doi.org/10.5281/zenodo.6369436 (2022).

Acknowledgements

This work is funded by the National Science Foundation [grant number 2029511 (Y.Q., D.N.); 2017789 (D.N.); 1757329 (Y.Q.)]. We thank graduate research assistant Ali Iftikhar for his support in initial regression analysis, and Jiehong Lou for her support of using the high-performance computing cluster. We thank Alex Davis, Baruch Fischhoff, Granger Morgan, and our other colleagues in the Department of Engineering and Public Policy at Carnegie Mellon University for providing valuable insight and feedback. Nock also acknowledges support from the Google Award for Inclusion Research and the Scott Institute for Energy Innovation, where she is an energy fellow.

Author contributions

D.N. conceived the research idea and designed and oversaw the research process. S.C. designed and performed the analysis. S.C. wrote and revised the initial draft of the paper. D.N. and Y.Q. reviewed and revised the paper. B.X. collected and cleaned the data. Correspondence and requests for materials should be addressed to D.N. or Y.Q.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary information The online version contains supplementary material available at https://doi.org/10.1038/s41467-022-30146-5.

Correspondence and requests for materials should be addressed to Destenie Nock or Yueming Lucy Qiu.

Peer review information *Nature Communications* thanks Rob Bailis and the other, anonymous, reviewer(s) for their contribution to the peer review of this work. Peer reviewer reports are available.

Reprints and permission information is available at http://www.nature.com/reprints

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Home Energy Affordability Gap

Fisher Sheehan & Colton
Public Finance & General Economics

Introduction

The objective was to quantify the gap between "affordable" home energy bills and "actual" home energy bills. We were successful.

In 2003, Fisher, Sheehan & Colton (FSC) introduced a model that calculated the dollar amount by which "actual" home energy bills exceeded "affordable" home energy bills on a county-by-county basis for the entire country. This is the "home energy affordability gap." Updated every year since then, the model has become an invaluable tool for research, legislative analysis, program-planning and advocacy. The analyses are used by individuals and organizations across the country. The 2012 Home Energy Affordability Gap, published in May 2013, introduces the 2nd Series of FSC's annual Affordability Gap analysis. While remaining fundamentally the same, several improvements have been introduced in both data and methodology in the Affordability Gap (2nd Series). Explore our site to learn more.

For Example
Connecticut's 5th Congressional District

The aggregate 2012 Home Energy Affordability Gap for all households **at or below**

For Example
Marion County Oregon

The 2013 Home Energy Affordability Gap for each household **at or below 50%** of the Federal Poverty Level was $1,206. That was a home energy burden (bill as a

For Example
The Commonwealth of Pennsylvania

The aggregate 2012 Home Energy Affordability Gap for all households **at or below 200%** of the Federal Poverty Level in

200% of the Federal Poverty Level in Connecticut's 5th Congressional District was $131,743,402. The gross 2012 LIHEAP allocation for the entire state was $79,532,000.

percentage of income) of 22.9%. Housing analysts consider an energy burden of more than six percent (6%) to be unaffordable.

Pennsylvania was $1,840,924,328. The 2012 "Gap" for each household was $1,252 or $104/month.

Fisher, Sheehan & Colton
Public Finance and General Economics
34 Warwick Rd Belmont, MA 02478-2841 (617) 484-0597

February 15, 2024

Ms. Lisa Felice
Executive Secretary
Michigan Public Service Commission
7109 w. Saginaw Hwy
Lansing, MI 48917

Re: MPSC Case No. U-18120 – Rule 460.151

Dear Ms. Felice:

Attached are DTE Gas's and Electric's revised quarterly report for 1*st*, 2*nd,* and 3*rd* quarters of 2023. The revisions are to item A. total customer contacts. Revisions are shown in bold and italics. These revised reports supersede the reports filed previously. DTE is filing these revised report as directed by Michigan Public Service Commission Staff (MPSC Staff). In addition, DTE has unloaded this revised information to the MPSC's Quarterly report Salesforce. These reports are pursuant to the Consumer Standards and Billing Practices for Electric and Natural Gas Service Rule 460.151.

Sincerely,

Denise Diz
Digitally signed by Denise Diz
Date: 2024.02.15 13:02:27
-05'00'

Denise Diz
Sr. Executive Consumer Affairs Consultant

Enclosure

1st Quarter Report
Complaints/Hearings
January - March 2023

MPSC
Michigan Public Service Commission

	January-23	February-23	March-23	Total	Comments
Customer Service					
A. Total customer contacts (Res and Non-Res)	***3,774,033***	***3,864,260***	***4,328,229***	***11,966,522***	January and March have five weeks. Storms in February and March
B. Total customer complaints	1,730	2,143	2,670	6,543	
a. Billing	846	1,126	1,345	3,317	
b. Service	436	617	819	1,872	
c. Credit and Collection	182	131	158	471	
d. Other	266	269	348	883	January - HPP 52, Administrative 119, Claims 33, Property Restoration 55, Energy Waste Reduction/Renewables 7, Totals 266 February – HPP 27, Administrative 106, Claims 34, Property Restoration 82, Energy Waste Reduction/Renewables 20 Totals 269 March – HPP 40, Administrative 126, Claims 54, Property Restoration 120, Energy Waste Reduction/Renewables 8, Totals, 348
Freeform area, If complaint is not listed above, provide general description					
Customer Payment Performance					
C. Number of customers paid by the due date	2,502,344	2,496,067	2,493,023		Customers that are on an active payment arrangement that are current on their monthly payment amount are considered paid by the due date.
D. Number of customers delinquent 31-60 days or more	53,907	58,755	61,027		Data reported is for customers with oldest arrears in the 31-60 days past the due date bucket as of month end.
E. Number of customers delinquent 61-90 days or more	39,004	36,839	36,048		Data reported is for customers with oldest arrears in the 61-90 days past the due date bucket as of month end.
F. Number of customers delinquent 91 days or more	300,476	295,766	290,213		Data reported is for customers with oldest arrears in the >90 days past the due date bucket which includes customers with final arrears as of month end. Final arrears are written off 150 days after the final bill due date.
Payment Plans and Settlements					
G. Number of written settlement agreements	1	0	1	2	
H. Number of payment plan arrangements issued	3,952	3,949	5,689	13,590	
Winter Protection Plan (WPP)					
I. Total enrolled in program at the end of the month	1,256	1,305	961		The month end count is higher than the combined senior and low-income customers because DTE has additional customers enrolled in the program.
a. Number of low-income customers enrolled at end of month	997	1,033	731		
b. Number of seniors enrolled at end of month	232	233	196		
J. Number of defaults at end of month	229	423	420	1,072	
Alternative Shutoff Protection Plan					
K. Total enrolled in program at end of month	35,451	33,076	30,756		Non low-income and non-seniors are included in the month end count for Total enrolled in the program
a. Number of low-income customers enrolled at end of month	11,298	11,271	11,218		
b. Number of seniors enrolled at end of month	16,175	14,648	13,488		
L. Number of defaults at end of month	6,534	6,129	6,105	18,768	
Informal Hearings					
M. Number of hearings requested	2	2	1	5	
N. Number of hearings scheduled		1		1	
O. Total number of hearing determinations issued	0	1	0	1	
a. Hearings resolved in favor of customer				0	
b. Hearings resolved in favor of company		1		1	
c. Hearings resolved in compromise				0	
P. Reasons for the hearings		Billing		0	
Shutoff Information					
Q. Total discontinuation notices issued at end of month	231,338	242,323	219,324	692,985	
a. Electric	231,338	242,323	219,324	692,985	All customer types, and all products, electric, gas or combination
b. Natural Gas				0	
R. Total of customers physically discontinued due to non-payment	18,981	9,048	16,363	44,392	
a. Electric	18,129	8,083	15,618	41,830	
b. Natural Gas	852	965	745	2,562	
S. Total of customers physically discontinued due to unauthorized use	868	777	1300	2,945	
a. Electric	627	473	1,015	2,115	
b. Natural Gas	241	304	285	830	
T. Total of customers physically discontinued due to safety	0	0	0	0	
a. Electric				0	
b. Natural Gas				0	
U. Total of customers physically discontinued due to access	132	49	102	283	
a. Electric				0	
b. Natural Gas	132	49	102	283	
V. Total of customers physically discontinued due to “other” (*ADD new line for each reason)	0	0	0	0	
a. Electric				0	
b. Natural Gas				0	
W. Discontinuations prevented or restored due to “medical emergency”	42	36	54	132	
X. Discontinuations prevented or restored due to “critical care”	17	8	27	52	
Y. Total number of seniors identified	837,368	839,582	841,689		
Restoration Information					
Z. Total number of customers restored	14,642	6,691	12,334	33,667	
a. Electric	14,441	6,340	12,034	32,815	
b. Natural Gas	201	351	300	852	
AA. Total restored due to receiving assistance	443	282	719	1,444	
a. Electric	433	259	689	1,381	
b. Natural Gas	10	23	30	63	

2nd Quarter Report
Complaints/Hearings
April - June 2023

MPSC
Michigan Public Service Commission

	April-23	May-23	June-23	Total	Comments
Customer Service					
A. Total customer contacts (Res and Non-Res)	***2,975,688***	***2,946,978***	***3,885,764***	***9,808,430***	
B. Total customer complaints	1,800	1,991	2,381	6,172	
a. Billing	892	978	1,082	2,952	
b. Service	331	258	605	1,194	
c. Credit and Collection	128	107	131	366	
d. Other	449	648	563	1,660	April - HPP 142, Administrative 82, Claims 58, Property Restoration 265, Energy Waste Reduction/Renewables 2, Totals 449 May – HPP 51, Administrative 94, Claims 97, Property Restoration 402, Energy Waste Reduction/Renewables 4, Totals 648 June – HPP 31 , Administrative 153, Claims 108, Property Restoration 266, Energy Waste Reduction/Renewables 5, Totals 563
Freeform area, If complaint is not listed above, provide general description					
Customer Payment Performance					
C. Number of customers paid by the due date	2,495,343	2,485,640	2,486,490		Customers that are on an active payment arrangement that are current on their monthly payment amount are considered paid by the due date.
D. Number of customers delinquent 31-60 days or more	59,457	51,392	74,467		Data reported is for customers with oldest arrears in the 31-60 days past the due date bucket as of month end.
E. Number of customers delinquent 61-90 days or more	37,747	38,998	31,499		Data reported is for customers with oldest arrears in the 61-90 days past the due date bucket as of month end.
F. Number of customers delinquent 91 days or more	286,192	288,696	292,992		Data reported is for customers with oldest arrears in the >90 days past the due date bucket which includes customers with final arrears as of month end. Final arrears are written off 150 days after the final bill due date.
Payment Plans and Settlements					
G. Number of written settlement agreements	1	1	1	3	
H. Number of payment plan arrangements issued	4,465	5,251	4,925	14,641	
Winter Protection Plan (WPP)					
I. Total enrolled in program at the end of the month	690	525	425		The month end count is higher than the combined senior and low-income customers because DTE has additional customers enrolled in the program.
a. Number of low-income customers enrolled at end of month	497	355	269		
b. Number of seniors enrolled at end of month	143	121	107		
J. Number of defaults at end of month	156	91	89	336	
Alternative Shutoff Protection Plan					
K. Total enrolled in program at end of month	31,488	32,666	33,122		Non low-income and non-seniors are included in the month end count for Total enrolled in the program
a. Number of low-income customers enrolled at end of month	12,133	12,543	13,786		
b. Number of seniors enrolled at end of month	14,074	15,666	15,692		
L. Number of defaults at end of month	5,892	5,453	7,678	19,023	
Informal Hearings					
M. Number of hearings requested	1	0	1	2	
N. Number of hearings scheduled	0	0	0	0	
O. Total number of hearing determinations issued	0	0	0	0	
a. Hearings resolved in favor of customer				0	
b. Hearings resolved in favor of company				0	
c. Hearings resolved in compromise				0	
P. Reasons for the hearings				0	
Shutoff Information					
Q. Total discontinuation notices issued at end of month	251,193	238,306	201,394	690,893	All customer types, and all products, electric, gas or combination
a. Electric	251,193	238,306	201,394	690,893	
b. Natural Gas				0	
R. Total of customers physically discontinued due to non-payment	19,280	14,921	22,808	57,009	
a. Electric	17,725	13,247	21,450	52,422	
b. Natural Gas	1,555	1,674	1,358	4,587	
S. Total of customers physically discontinued due to unauthorized use	1,147	858	788	2,793	
a. Electric	1,031	659	553	2,243	
b. Natural Gas	116	199	235	550	
T. Total of customers physically discontinued due to safety	0	0	0	0	
a. Electric				0	
b. Natural Gas				0	
U. Total of customers physically discontinued due to access	183	117	105	405	
a. Electric				0	
b. Natural Gas	183	117	105	405	
V. Total of customers physically discontinued due to "other" (*ADD new line for each reason)	0	0	0	0	
a. Electric				0	
b. Natural Gas				0	
W. Discontinuations prevented or restored due to "medical emergency"	63	86	100	249	
X. Discontinuations prevented or restored due to "critical care"	19	25	23	67	
Y. Total number of seniors identified	843,260	844,505	845,664		
Restoration Information					
Z. Total number of customers restored	14,304	10,020	16,602	40,926	
a. Electric	13,897	9,693	16,377	39,967	
b. Natural Gas	407	327	225	959	
AA. Total restored due to receiving assistance	591	393	512	1,496	
a. Electric	545	365	499	1,409	
b. Natural Gas	46	28	13	87	

3rd Quarter Report
Complaints/Hearings
July - September 2023

MPSC
Michigan Public Service Commission

	July-23	August-23	September-23	Total	Comments
Customer Service					
A. Total customer contacts (Res and Non-Res)	***3,614,311***	***3,501,489***	***3,764,588***	***10,880,388***	
B. Total customer complaints	2,429	3,100	2,671	8,200	
a. Billing	1,119	1,699	1,848	4,666	
b. Service	755	827	405	1,987	
c. Credit and Collection	104	154	91	349	
d. Other	451	420	327	1,198	July – HPP 13, Administrative 138, Claims 73, Property Restoration 220, Energy Waste Reduction/Renewables 7, Totals 451 August – HPP 15, Administrative 135, Claims 48, Property Restoration 210, Energy Waste Reduction/Renewables 12, Totals 420 September – HPP 21, Administrative 98, Claims 49, Property Restoration 150, Energy Waste Reduction/Renewables 9, Totals 327
Freeform area, If complaint is not listed above, provide general description					
Customer Payment Performance					
C. Number of customers paid by the due date	2,519,259	2,488,444	2,516,176		Customers that are on an active payment arrangement that are current on their monthly payment amount are considered paid by the due date.
D. Number of customers delinquent 31-60 days or more	65,500	60,363	67,872		Data reported is for customers with oldest arrears in the 31-60 days past the due date bucket as of month end.
E. Number of customers delinquent 61-90 days or more	45,481	37,126	37,566		Data reported is for customers with oldest arrears in the 61-90 days past the due date bucket as of month end.
F. Number of customers delinquent 91 days or more	293,537	306,814	301,103		Data reported is for customers with oldest arrears in the >90 days past the due date bucket which includes customers with final arrears as of month end. Final arrears are written off 150 days after the final bill due date.
Payment Plans and Settlements					
G. Number of written settlement agreements	0	0	1	1	
H. Number of payment plan arrangements issued	4,958	5,786	6,229	16,973	
Winter Protection Plan (WPP)					
I. Total enrolled in program at the end of the month	332	275	237		The month end count is higher than the combined senior and low-income customers because DTE has additional customers enrolled in the program.
a. Number of low-income customers enrolled at end of month	188	144	103		
b. Number of seniors enrolled at end of month	83	75	55		
J. Number of defaults at end of month	46	22	28	96	
Alternative Shutoff Protection Plan					
K. Total enrolled in program at end of month	32,400	33,136	34,093		Non low-income and non-seniors are included in the month end count for Total enrolled in the program
a. Number of low-income customers enrolled at end of month	14,546	16,349	17,594		
b. Number of seniors enrolled at end of month	15,011	14,517	14,302		
L. Number of defaults at end of month	6,579	6,780	9,558	22,917	
Informal Hearings					
M. Number of hearings requested	0	0	2	2	
N. Number of hearings scheduled			1	1	
O. Total number of hearing determinations issued	0	0	0	0	
a. Hearings resolved in favor of customer				0	
b. Hearings resolved in favor of company				0	
c. Hearings resolved in compromise				0	
P. Reasons for the hearings			Billing	0	
Shutoff Information					
Q. Total discontinuation notices issued at end of month	226,566	248,578	236,436	711,580	All customer types, and all products, electric, gas or combination
a. Electric	226,566	248,578	236,436	711,580	
b. Natural Gas				0	
R. Total of customers physically discontinued due to non-payment	19,669	20,390	20,668	60,727	
a. Electric	18,841	19,887	19,451	58,179	
b. Natural Gas	828	503	1,217	2,548	
S. Total of customers physically discontinued due to unauthorized use	766	1,112	850	2,728	
a. Electric	645	957	757	2,359	
b. Natural Gas	121	155	93	369	
T. Total of customers physically discontinued due to safety	0	0	0	0	
a. Electric				0	
b. Natural Gas				0	
U. Total of customers physically discontinued due to access	42	57	68	167	
a. Electric				0	
b. Natural Gas	42	57	68	167	
V. Total of customers physically discontinued due to “other” (*ADD new line for each reason)	0	0	0	0	
a. Electric				0	
b. Natural Gas				0	
W. Discontinuations prevented or restored due to “medical emergency”	107	120	74	301	
X. Discontinuations prevented or restored due to “critical care”	35	27	22	84	
Y. Total number of seniors identified	846,958	848,910	850,711		
Restoration Information					
Z. Total number of customers restored	15,898	16,144	15,971	48,013	
a. Electric	15,798	16,082	15,870	47,750	
b. Natural Gas	100	62	101	263	
AA. Total restored due to receiving assistance	452	408	325	1,185	
a. Electric	444	402	316	1,162	
b. Natural Gas	8	6	9	23	
Electric Only - Customer Service					
BB. Average customer call answer time (seconds)	46	60	57		All customer types, and all products, electric, gas or combination
CC. Percentage of the call blockage factor	0%	0%	0%	0	All customer types, and all products, electric, gas or combination
DD. Percentage of the complaint response factor	100%	100%	100%	1	

MPSC Case No: U-21291

Requester: FLO

Question No.: FLODG-1.3

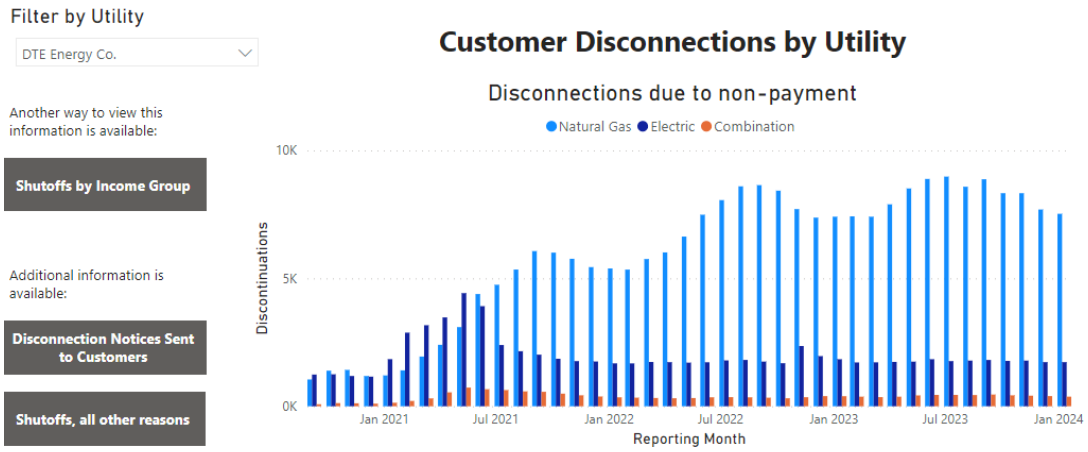
Respondent: J. E. Sparks

Page: 1 of 3

Question: 3. The MPSC aggregates disconnection and shutoff notice information on its "Utility Customer Data" webpage, using data provided by DTE and other utilities. Utility Customer Data, MICH. PUB. SERV. COMM'N, https://www.michigan.gov/mpsc/regulatory/ reports/other/utility-customer-data. According to the data (reproduced below in Figure 1), it appears that gas-only disconnections have increased each year since September 2020. At the same time, according to the data (reproduced below in Figure 2), it appears that gas-only shutoff notices have remained relatively consistent each year since September 2020, following a seasonal pattern that does not appear to exceed 25,000 disconnection notices in a given month.

Please explain why shutoff notices have remained relatively consistent during this period while actual shutoffs have increased each year. In this description, please list factors the Company believes relevant to account for the higher rate in actual shutoffs relative to shutoff notices received.

Figure 1: Customer Disconnections by Utility (DTE)



https://www.michigan.gov/mpsc/regulatory/reports/other/utility-customer-data

MPSC Case No: U-21291

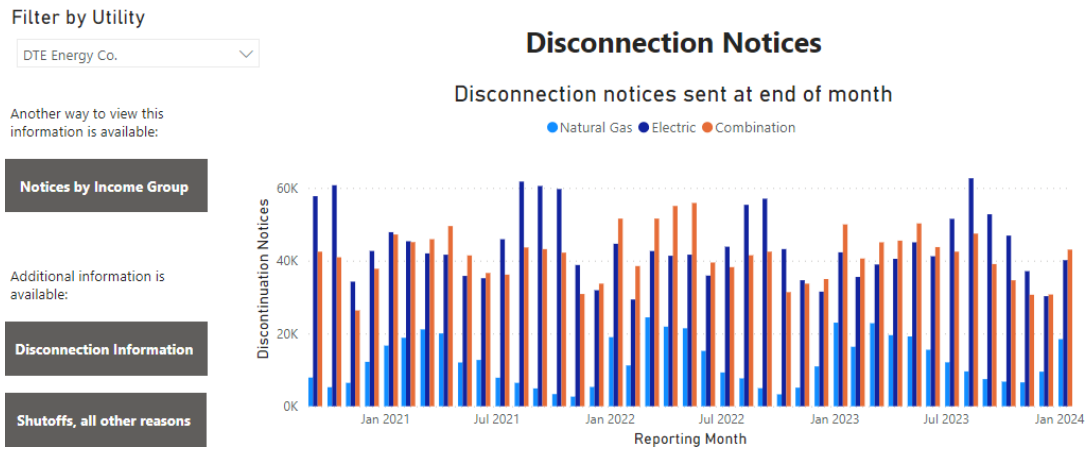
Requester: FLO

Question No.: FLODG-1.3

Respondent: J. E. Sparks

Page: 2 of 3

Figure 2: Customer Disconnection Notices (DTE)



https://www.michigan.gov/mpsc/regulatory/reports/other/utility-customer-data

Answer: The Utility Customer Data website displays information as provided in the Company's monthly U-20757. The gas disconnects information referenced is a total number of residential premises that were disconnected from 11/1/2019 to the last day of the reporting month that have not been restored. It is not the number of residential disconnects for any given month. The displayed screenshot from the website will align with the January 2024 report submitted by the Company. See attachment for the U-20757 report submitted for January 2024 and explanations of the data.

MPSC Case No: U-21291

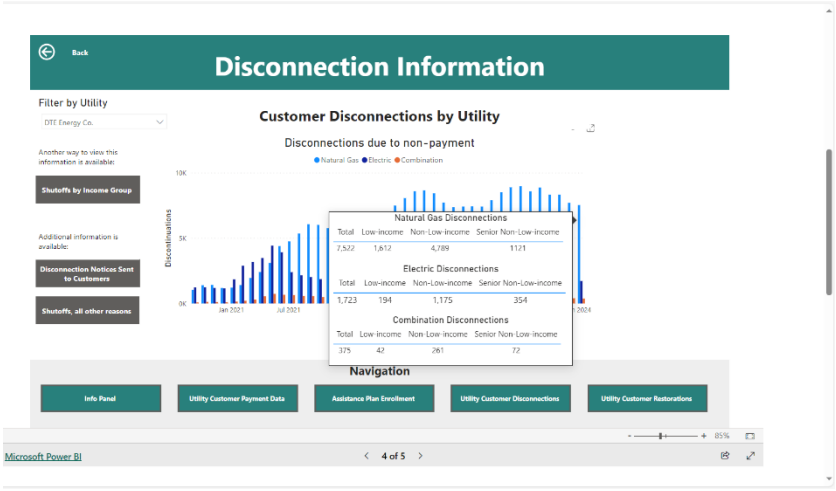
Requester: FLO

Question No.: FLODG-1.3

Respondent: J. E. Sparks

Page: 3 of 3

Figure 1 MPSC Customer Disconnections by Utility (DTE)



Attachment: U-21291 FLODG-1.3-01 U-20757 January 2024 2-12-24 Report

REPUBLISH

Co-published with Outlier Media

This article was produced for ProPublica's Local Reporting Network in partnership with Outlier Media. Sign up for Dispatches to get stories like this one as soon as they are published.

During the early stages of the pandemic, Michigan's largest power company leaned in to a chance to show its charitable side, helping buy laptops for Detroit's public school children and publicizing that it would not disconnect the gas and electric service of people who could not pay their bills. DTE Energy said it was on "high alert to help those customers whose lives are being disrupted."

But the relief from the threat of a shut-off ended quickly for DTE's customers, who pay some of the highest electricity rates in the country. DTE's moratorium on disconnections lasted just over three months.

An analysis by ProPublica and Outlier Media shows the extent to which one of the nation's poorest cities and other communities across Southeast Michigan have been impacted by electric service disconnections since the COVID-19 pandemic began. DTE disconnected customers 80,600 times in 2020 and more than doubled that number in 2021. Its 178,200 disconnections for nonpayment last year were its highest annual total since 2016.

The shut-offs reflect an unrelenting reality in Detroit and surrounding areas, where low-income residents have long struggled to keep their lights on while avoiding crushing debt tied to a basic service. It's a problem rarely discussed except among activists and advocates, as regulators and legislators have focused on other issues, like reliability of service.

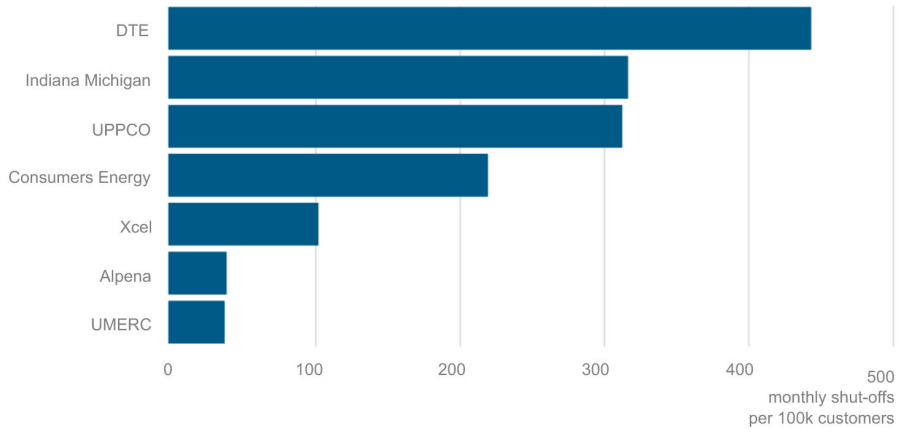
DTE has more than 2 million customers, but size alone does not explain its shut-off numbers, nor does the level of poverty within the company's service area. The analysis by ProPublica and Outlier is the first to examine DTE's disconnections and compare them to shut-offs by other Michigan utilities.

During the pandemic, DTE's rate of electricity shut-offs — disconnections as a proportion of customers — outpaced the six other utilities in Michigan that are owned by private investors and have their prices regulated by the state. DTE's rate was twice as high as the state's second largest utility, Consumers Energy, which serves areas with a similar share of low-income residents, according to an analysis of U.S. Census Bureau data.

Prior to the COVID-19 emergency, from 2013 — the earliest year for which data was available — through 2019, DTE disconnected electric accounts 1.2 million times. That represented 47% more shut-offs than Consumers during those years, adjusted for the number of customers each utility had. (Both utilities also provide gas service and combine those costs into one bill for many customers, but electricity is the more expensive of the two.)

DTE's Rate of Shut-offs Outpaced Others During Pandemic

From April 2020 to December 2021, DTE's average monthly shut-offs for nonpayment per 100,000 customers far outpaced Michigan's other investor-owned electricity providers.



Agnel Philip/ProPublica. Source: Michigan Public Service Commission.

DTE responded to the findings of Outlier and ProPublica in interviews and through email. The utility said that in most cases, customers have service restored within 48 hours. DTE spokesman Christopher Lamphear stressed that the utility works with customers to help arrange affordable payment plans or get financial assistance and contributes millions of dollars annually to a range of programs for low-income communities and customers. He said DTE forgave $2.6 million in debt for struggling customers in 2020.

But DTE, which told state regulators it has half a million customers living in poverty, has acknowledged the struggles faced by customers who can't afford electricity. In recent testimony before state regulators, DTE described how some people build up significant debt on their monthly bills and then see the problem exacerbated by late fees, shutoffs and security deposits required for reconnection.

Many of the customers who experience shut-offs "are stuck in a repeated cycle of disconnects and reconnects" and must "make tough choices about which monthly bills get paid, and which ones don't," a company representative testified.

or ProPublica

Outlier Media helps Detroit residents access useful and verified information via an automated text messaging system monitored by reporters who will follow up with them. This winter, Outlier heard from hundreds of DTE customers who were looking for resources to help pay their bills.

Of those, 136 said they had had their power shut off or owed money to DTE. Another 343 said they needed help to pay their current DTE bill. Among their comments:

“I was diagnosed with covid and stuck in bed so I missed my notice.”

“Insurmountable debt owed to DTE. I live in an apartment which has very little insulation, thereby causing my heating charges to be extreme.”

“My service was shut off due to nonpayment just last month. I had to come up with $135 to get my service restored.”

One Detroit man who responded to Outlier was shut off earlier this year and reconnected the same day. His bill shows he currently owes more than $2,500 to DTE. In an interview, the recent widower described the stress of not knowing if he could keep the electricity on for his children so they could use the internet for school.

“I open the door and I’m just hoping that my service is not off,” said the man, who didn’t want to be named in the story to protect his family’s privacy. “When the power is off, that stops the kids from being able to go to school.” DTE confirmed that his account had been shut off.

Even though many customers routinely scramble to pay their bills, the state’s utility regulators are not empowered by state law to directly consider affordability when setting prices. Echoing a dynamic seen across the country, Michigan’s regulators focus primarily on keeping utilities profitable enough to satisfy investors and on ensuring customers receive power without unexpected blackouts.

“There’s not sort of a clear place in Michigan law where it gets to ‘And also can customers afford to pay for it?’” said Dan Scripps, chair of the entity charged with overseeing utilities, the Michigan Public Service Commission.

Rebecca Mock for ProPublica

Over the last decade, the MPSC has granted DTE a regular series of price hikes worth billions of dollars in revenue to the company.

The state has rules prohibiting shut-offs during extreme weather and requiring notices before disconnection, but it’s often up to utilities to decide how much leniency to show customers.

DTE’s Lamphear said in an email that it has “an obligation to all customers” to manage unpaid bills in a cost-effective way, so that lost revenue doesn’t result in higher costs for all.

“Given these challenges we continue to advocate for additional financial support from federal and state sources to provide a safety net for the most vulnerable people we serve,” Lamphear wrote.

Federal data shows that DTE’s price, as measured in cost per kilowatt-hour, is the second highest among investor-owned utilities in Michigan, behind the Upper Peninsula Power Company, a utility with only about 50,000 customers in Northern Michigan. Consumers’ rate, meanwhile, is about 10% lower than DTE’s.

DTE’s price per kilowatt-hour is also higher than the price charged by the largest utility in each of the other Great Lakes states of Illinois, Indiana, Minnesota, Ohio and Wisconsin.

Despite the rate it charges, DTE said, its average monthly bill is on par with the national average, in large part because Michigan residential customers use less electricity than the average American customer.

Outlier and ProPublica employed the same methodology used by DTE to compare its average bills to those of the largest utilities in those five Great Lakes states. DTE’s average bill turned out to be the second most expensive among that group in 2020, the most recent year with full data.

Researchers have developed another way to measure affordability called “energy burden,” which accounts for price and income by calculating the share of customers’ monthly earnings that goes toward utility costs. A recent study of 25 large metropolitan regions determined that the burden for low-income Detroit residents was particularly severe.

or ProPublica

Michigan regulators don’t require utilities to disclose where shut-offs happen or which communities are most affected, and DTE declined to provide that information to an Outlier reporter. But advocates in Detroit’s low-income neighborhoods and researchers say Black communities are significantly impacted. The percentage of Black residents in DTE’s service area is nearly three times as high as Consumers’, according to a ProPublica and Outlier analysis of census data.

Jeremy Lark of Greenpath Financial Wellness, a nonprofit that helps customers to access payment plans for DTE debt, said more than 60% of people working with Greenpath to manage their DTE debt are Black.

“The customers that come to us,” he said, “it’s pretty common that past due bills are in the thousands of dollars.”

High Prices and Oversight That Favors Utilities

Thomas Edison grew up in Port Huron, Michigan, before going on to help develop electric power generation. One of his first licensees for generating electricity was the Detroit Edison Company; it was reorganized into DTE Energy in 1996.

In the early part of the 20th century, as industry and ordinary households demanded more electricity, governments across the country didn’t have the funds, expertise or will to build a brand new electric grid. Instead, they struck deals with large power companies to supply and distribute power; the utilities would be subject to government oversight but also would be insulated from future competition.

These “investor-owned utilities” — some, like DTE, with publicly traded stock — provide utility service for the majority of Americans and often need government approval to set prices.

The Michigan Public Service Commission, which negotiates these rates through an administrative proceeding, is not empowered to reject rates on the grounds they’re too expensive for low-income customers. Instead, it “has an obligation under Michigan law to set rates based on whether the investments proposed are reasonable and prudent and then allowing for the opportunity to earn a profit on those that are,” saidScripps, chair of the commission.

He added: “Affordability is always a front-of-mind issue, but it’s not tied to how we evaluate utility investments.”

Similar dynamics are at play across the country. Two recent exceptions can be found in Oregon and Massachusetts, where recent legislation gave regulators power to take customers’ ability to pay into consideration when setting gas or electric rates.

Since 2011, the MSPC has approved six rate increases for DTE, each for amounts that were about half of what the company had requested. Over that same time period, according to the commission, DTE’s revenues have increased by several billion dollars, due in part to those rate increases. DTE is currently asking for a seventh rate increase, worth an additional $388 million in annual revenue.

Nationally, the rate DTE charges residents ranks in the top 5 percent of all investor-owned, public and cooperative electric suppliers, according to government data analyzed by Outlier and ProPublica.

In DTE’s service area, the increases in residential rates stand in contrast to what’s happened with businesses and industry. The commercial rates businesses pay have been relatively stable in recent years, while industrial users saw their rates decline between 2010 and 2019, according to federal data analyzed by the Citizens Utility Board of Michigan, a state-funded consumer advocate.

Amy Bandyk, executive director for CUB of MI, said her organization — and by extension residential ratepayers — is outspent by the utility companies, which can afford more lawyers and experts to argue their side in rate cases.

“DTE and Consumers have lots of lobbyists and lawyers and analysts all focused on getting a better return for their shareholders,” she said. “I like to think our arguments are good, but the utilities are just very well-funded.”

She’d like to see the state move toward a billing structure that caps bills at a percentage of income for those who might otherwise struggle to pay, a reform that is popular with advocates nationally.

The MPSC has urged DTE and Consumers Energy to take some steps in this direction, and both companies have taken steps to test this approach. DTE’s pilot program, which began in January, caps bills at 10% of income for some households who use DTE for both gas and electric service, with the company absorbing the rest of the cost. The program will last two years for no more than 2,000 customers living at or below 200% of poverty.

Even as Bandyk observes what’s happening with the MPSC, she would like to see more urgency.

“There are so many people that need help right now,” she said. “High utility rates affect everyone, and, obviously, there are specific groups of customers hit especially hard.”

Donald Lutas is one of those customers. A retiree on a fixed income, he has tried to make his 105-year-old Detroit home more energy-efficient by adding insulation in its attic and replacing windows. But his house is still large and drafty, and he has problems keeping up with his gas and electric bills, especially in winter when he’s seen monthly charges of more than $500.

the entry hallway of his home in Detroit Nick Hagen for ProPublica

"Right now I have to make a choice between paying my part of Medicare or paying for utilities," said Lutas, who used to run a residential care facility for people with mental health challenges. "I couldn't afford both. I had multiple shut-off notices last winter, and I couldn't allow myself to get disconnected."

Lutas said he chose to forgo his primary care visits and only keep his hospitalization insurance in order to afford to pay DTE. As he struggles to make payments, Lutas can't help but think about how DTE continues to thrive financially.

"It is a problem which is more glaring considering that DTE is constantly posting a profit, a major profit," he said.

Even as the pandemic upended lives in the Detroit area, DTE saw strong earnings in 2020 and 2021. Cash dividends paid out to investors in the electric company, bolstered by rate hikes, rose 76% from 2010 to 2020, to $539 million. DTE's financial success is important to everyone in the region, the utility argues, because it allows DTE to attract additional investors and borrow money at a lower financing cost.

Beyond its investor dividends, the health of the company's finances is reflected in the pay of its top executive. CEO Jerry Norcia received a salary of $1.2 million as part of total compensation of $9.7 million in 2020, his first full year on the job. In every other year since 2017, the company's compensation package for its CEO has topped $10 million.

DTE Shut-offs Outpace Other Utilities'

When the pandemic began in 2020, causing a wave of medical and financial hardship, 34 states directed utilities to stop shutting off customers' service, according to the National Association of Regulatory Utility Commissioners. But Michigan was not one of those, relying instead on voluntary pauses by the state's utilities.

DTE's shut-off moratorium was shorter than those put in place by the largest utilities in Illinois, Indiana, Minnesota, Ohio and Wisconsin.

MPSC chair Scripps defended the utility's decision to limit its self-imposed moratorium to only three months in a commentary published in the Detroit Free Press in December 2020. Citing experience from Michigan's recession in the early 2000s, Scripps said people who stop paying their bills during a longer moratorium might be unlikely to ever catch up. He argued that focusing instead on aggressively distributing assistance dollars would have more long-term benefit.

Consumers Energy, meanwhile, voluntarily extended its shut-off moratorium to eight months for most residential customers, through October 2020. The longer moratorium did not lead to more shut-offs once it ended, according to data filed by the company with the MPSC. Consumers' shut-offs in 2021 were the third fewest for any year since 2013. Only 2016 and 2020 had fewer.

Rebecca Mock for ProPublica

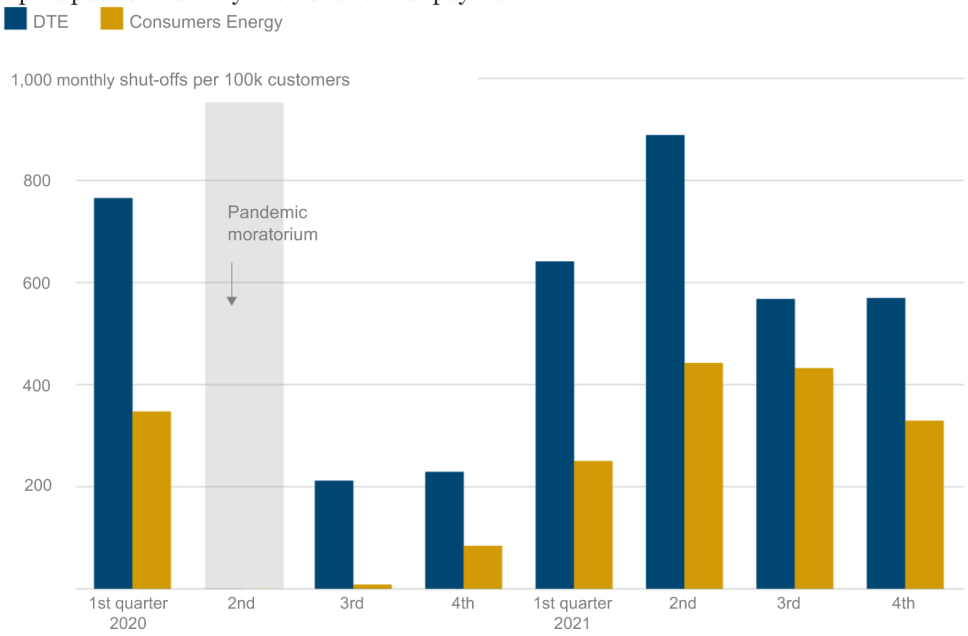
Looking back on its moratorium, Consumers said it did the right thing for its customers. "We believe our approach was the right one," the utility said in an email, "as we did not want to add additional stress onto our customers during an already stressful time."

The MPSC has required utilities to file frequent reports on shut-off numbers during COVID-19, every two weeks for the first few months of the pandemic and then every month since. But

those reports only tally the number of people who remain shut off from electric, gas or both services at the end of each month-long period. Because these reports don't account for shut-offs where service was later reconnected, they underrepresent the true problem.
But Michigan utilities also file quarterly reports with the MPSC tallying every disconnection for nonpayment. Through examining these, a more complete picture of the breadth of shut-offs during the pandemic emerges.
The analysis by ProPublica and Outlier found that from April 2020 through December 2021, the last month for which data is available, DTE disconnected accounts 208,000 times for nonpayment. These reports contain numbers for both residential and commercial disconnections, but the preponderance are residential.

DTE Ramped Up Shut-offs Quickly After Moratorium End

Compared to the next biggest utility in the state, Consumers Energy, DTE quickly picked up its pace of monthly shut-offs for nonpayment.



Agnel Philip/ProPublica. Source: Michigan Public Service Commission.

Because of the way the MPSC collects its data, the analysis could calculate the total number of shut-offs, not the number of customers affected. A single customer might be disconnected more than once during a period of time. DTE, for instance, said that its 80,600 shut-offs in 2020 “represented approximately 66,000 unique customers.”
ProPublica and Outlier asked both DTE and Consumers for their company policies on what triggers a shut-off notice. Again, there was a clear difference.
DTE said it can begin the shut-off notification process after customers miss just one payment and fall more than $100 behind on a bill. State law requires a shut-off notice be sent at least 10 days before an account is disconnected. In order to avoid shut-off, customers can pay their entire past due balance, agree to a payment plan or apply for assistance, which includes a shut-off hold during the application process.
“We offer them a range of options based on their circumstances: affordable payment plans, senior protections, medical holds and low-income assistance,” DTE said in an email. It added: “DTE acts leniently wherever possible within the MPSC’s rules.”
Consumers Energy said it also can start its notification process after customers miss just one bill, but only if they have fallen at least $200 behind. If a late customer gets their balance owed below $75, Consumers said, it won’t go through with the disconnection.
Both companies require customers who get disconnected for nonpayment to provide a deposit before getting reconnected. The deposit can be significant. Under Michigan regulations, the deposit can equal up to twice a customer's average monthly bill; the fee is waived for anyone receiving utility assistance from the state to help them reconnect.
In 2020, aided by an influx of federal COVID-related assistance, the state helped more than 341,000 people across Michigan with energy costs ranging from bills to furnace repairs.
However, more than 40% of individuals who applied that year were rejected, usually because of income requirements, when they applied for that help. Some of the state’s relief programs also require a shut-off notice to qualify.

Detroit’s Heavy Burden

Cassia Haywood, who lives on Detroit’s West Side with her 11-year-old daughter, is quite familiar by now with what DTE shutoff notices look like: a letter marked by several thick red lines and plenty of bold red type.
For years, those letters have forced her to scramble to avoid losing electricity and gas-powered heat. In that very basic sense, her efforts were a success in 2021.
Thanks to payment plans with DTE and intermittent help from social service agencies, Haywood has managed to keep her electricity on. Payment plans can give people more time to pay off money owed to the company in affordable chunks, but some plans still allow the total debt to grow.
Her debt to DTE, built up over several years of gas and electric charges, now totals $8,000, part of which will be added to her bill each month until she has paid it all down. It’s a debt she fears she may never pay off.
Haywood has an auto-assembly job but is only getting sporadic hours. “I’m just not getting ahead with it,” she said.

The financial pressures bearing down on Haywood and others reflect the energy burden faced by many Detroit residents: a household's energy costs, both electric and gas, divided by its income. Researchers and policy makers largely agree that an energy burden over 6% is unaffordable.
Haywood said she uses about $200 of energy each month, making her burden about 10%. Because she also needs to pay hundreds of dollars toward her debt with DTE each month, the actual burden of her DTE bill is about 34% of her income. Sometimes a DTE bill for electricity and gas can rival housing costs.
"We pay so much, even on the payment plan," said Germaine Iwu, who lives with her husband and four children on the East Side of Detroit. Their typical monthly bill this year has been $326 through their plan. "Our mortgage is only like $400," she said.
A recent study by the American Council for an Energy Efficient Economy, a national nonprofit, put the median energy burden in the Detroit metro area at 10% for low-income families. That's higher than the national average and the third-highest among the metropolitan areas it studied, behind Baltimore and Birmingham.
This research found that 43% of Black and 38% of Latinx households in the Detroit metro area have an unaffordable energy burden. Researchers cite a combination of factors for these percentages, including higher energy usage because of older housing stock that is not energy-efficient.
A separate survey of more than 350 Detroit families — conducted over the winter of 2020 by Detroit nonprofit We Want Green Too and Kate Hutchens, a University of Michigan researcher— found their average energy burden was close to 16%, higher than that of the overall metro area.

ıer home in Detroit. Lowe runs We Want Green Too, a nonprofit that studied the energy burden in Detroit. Nick Hagen for ProPubl
Addressing the problem in Detroit won't be easy.
The National Consumer Law Center, which has extensively studied utility prices and regulation, advocates that states develop payment plans that are based on a percentage of income, eliminate deposits for reconnection and prohibit shut-offs for low-income households that include infants or people who are elderly or disabled. To get a clearer view of who is being impacted, the center also wants utility companies to provide more data about who is affected by shut-offs.
In Michigan, the MPSC has pushed utilities to experiment with percentage-of-income plans for some, but there seems to be little momentum for bigger changes. State Sen. Jeff Irwin, a Democrat from Ann Arbor, said regulators and legislators have been overly responsive to the utilities' desires for reliable investor payouts. For instance, Democrats have pushed legislation limiting shut-offs of water but not electricity.
Irwin said the legislature is too responsive to industry and "blind to the needs of residential affordability.
"The very specific conversation about helping people who can't pay their bills does not get a lot of play," he said.
DTE is currently pushing a different idea: a prepaid option it said would help low-income customers. Its reference in state filings to the struggles of customers who face shut-offs came as it urged the MPSC to endorse that proposal.
Under DTE's plan, people would prepay into an energy account, and if that account runs dry, the company would then use a "remote disconnect feature." Customers would need to make a minimum payment of $40 to get their power restored, and the process would begin again.
"That is the thing that brings me closest to feeling like I'm living in a post-apocalyptic world," said Margrethe Kearney, a lawyer with the Environmental Law & Policy Center, which opposes the plan and has intervened in the still-undecided MPSC case.
"DTE has lots of reasons for wanting to do this. And they say, 'Well, you know, it'll help people manage their energy use. It'll keep people from racking up these $3,000 bills.' But at the same time, it's like, what happens when it's the middle of a heatwave? And

or ProPublica

you don't have any money to put in your account?"

Some activists want to fundamentally challenge the way low-income communities must rely on DTE. Advocacy from Soulardarity, an environmental justice group, has led to a pilot program, endorsed by MPSC, that will give hundreds of low-income residents in Highland Park, Detroit and River Rouge access to solar power and credits on their bills.

Shimekia Nichols, the group's executive director, considers that a small step, if an insufficient one, toward a larger goal of independence from DTE's monopoly.

"That is what energy democracy is about," she said. "It's what we have to do, because otherwise people are just going to keep needing help."

About the Data: How We Analyzed Shut-off Rates and Service Area Demographics

Outlier Media and ProPublica collected quarterly reports from the Michigan Public Service Commission that cataloged total disconnections of electric customers for nonpayment by month since 2013. The shut-off numbers do not separate out residential and non-residential customers. The news organizations then calculated average monthly shut-off rates during the pandemic by averaging the disconnections from April 2020 through the end of 2021, which was the most recent data available, and divided that by the average number of electric customers (residential and non-residential) reported by Michigan's investor-owned utilities to MPSC for 2020. Customer counts for 2021 were not available at the time of publication. We followed a similar method for calculating the average shut-off rate from 2013 through 2019, averaging the monthly customer count figures reported for each year as our base.

For our analysis of the customer demographics for Michigan's largest two utilities, we re-created an MPSC map of the electric service areas for DTE and Consumers Energy at the Census tract level, using 2010 boundaries. We then matched these tracts to Census data and calculated the percent of residents in each service area who are Black and the percent who are low-income, using the 2015-2019 five-year American Community Survey. We defined low-income percentage as the number of people at or below the poverty line divided by the total population, for each service area. We excluded tracts where the utilities appeared to only serve a portion of the total area.

Comparisons of average bills and rates per kilowatt-hour were based on data from the U.S. Energy Information Administration.

Erin Smith, Alyssa Johnson and Alex Mierjeski contributed research.

Update, March 18, 2022: *This story was updated to include the name of Chris Lamphear, a DTE spokesman.*

PROPUBLICA
Ten Years After the Flint Water Crisis, Distrust and Anger Linger

Agnel Philip
Agnel Philip is a data reporter at ProPublica.
agnel.philip@propublica.org @agnel88_philip
Signal: (929) 318-7572

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of **DTE ELECTRIC COMPANY** for authority to increase its rates, amend its rate schedules and rules governing the distribution and supply of electric energy, and for miscellaneous accounting authority	Case No. U-21534 ALJ Sally Wallace

---

PROOF OF SERVICE

I, Mark N. Templeton, certify that an electronic copy of the Accompanying Exhibits DAO-125 to DAO-136 (Part 4 of 5) for the Direct Testimony of Justin Schott on Behalf of Soulardarity and We Want Green, Too was served on the following on July 26, 2024.

Name/Party	E-mail Address
Administrative Law Judge Hon. Sally Wallace	wallaces2@michigan.gov
DTE Electric Company Jon P. Christinidis Paula Johnson-Bacon John A. Janiszewski Andrea E. Hayden Breanne K. Reitzel	jon.christinidis@dteenergy.com paula.bacon@dteenergy.com john.janiszewski@dteenergy.com andrea.hayden@dteenergy.com breanne.reitzel@dteenergy.com mpscfilings@dteenergy.com
Michigan Attorney General Joel King	ag-enra-spec-lit@michigan.gov kingj38@michigan.gov
Michigan Public Service Commission Staff Monica M. Stephens Amit T. Singh Heather M.S. Durian Michael J. Orris Lori Mayabb	stephensm11@michigan.gov singha9@michigan.gov durianh@michigan.gov orrism@michigan.gov mayabbl@michigan.gov
The City of Ann Arbor, Michigan **Municipal Association for Utility Issues** Valerie Jackson Valerie J.M. Brader	valeriejackson@rivenoaklaw.com valerie@rivenoaklaw.com
Electrify America, LLC Jennifer A. Morante Stephen Bright	jmorante@grsm.com steve.bright@electrifyamerica.com

Michigan Environmental Council, Citizens Utility Board of Michigan, Natural Resources Defense Council, Sierra Club Christopher M. Bzdok Tracy Jane Andrews Breanna Thomas	chris@tropospherelegal.com tjandrews@tropospherelegal.com breanna@envlaw.com
Michigan Energy Innovation Business Council, Institute for Energy Innovation, Advanced Energy United, The Foundry Association of Michigan, and Energy Michigan, Inc. Laura A. Chappelle Justin K. Ooms Timothy J. Lundgren	lchappelle@potomaclaw.com jooms@potomaclaw.com tlundgren@potomaclaw.com
The Ecology Center, The Environmental Law & Policy Center, Union of Concerned Scientists, and Vote Solar Nicholas Wallace Daniel Abrams Alondra Estrada Carolyn Boyce	nwallace@elpc.org dabrams@elpc.org aestrada@elpc.org cboyce@elpc.org MPSCdocket@elpc.org
The Kroger Company Kurt J. Boehm Jody Kyler Cohn Justin Bieber Michael L. Kurtz	kboehm@bkllawfirm.com jkylercohn@bkllawfirm.com jbieber@energystrat.com
Local 223, Utility Workers Union of America (UWUA), AFL-CIO Benjamin King	bking@michworkerlaw.com
Association of Businesses Advocating Tariff Equity (ABATE) Stephen A. Campbell	scampbell@clarkhill.com
EVgo Services, LLC Nikhil Vijaykar Michael G. Oliva	nvijaykar@keyesfox.com moliva@fosterswift.com
Great Lakes Renewable Energy Association (GLREA) Don L. Keskey Brian W. Coyer	donkeskey@publiclawresourcecenter.com bwcoyer@publiclawresourcecenter.com
International Transmission Company Courtney F. Kissel Richard J. Aaron Olivia R.C.A. Flower Hannah E. Buzolits	ckissel@dykema.com raaron@dykema.com oflower@dykema.com hbuzolits@dykema.com

Michigan Cable Telecommunications Association Sean P. Gallagher	sgallagher@fraserlawfirm.com
PROTEC (The Michigan Coalition to Protect the Public Rights of Way) Michael J. Watza	mike.watza@kitch.com
Walmart, Inc. Melissa M. Horne	mhorne@hcc-law.com
Soulardarity and We Want Green, Too Amanda Urban Mark Templeton Jacob Schuhardt Sam Heppell Madison S. Wilson	t-9aurba@lawclinic.uchicago.edu templeton@uchicago.edu jschuhardt@uchicago.edu heppell@uchicago.edu madisonswilson@uchicago.edu aelc_mpsc@lawclinic.uchicago.edu

The statements above are true to the best of my knowledge, information, and belief.

UNIVERSITY OF CHICAGO LAW SCHOOL
ABRAMS ENVIRONMENTAL LAW CLINIC
Counsel for Soulardarity and
We Want Green, Too

Date: July 26, 2024

Sincerely,

Mark N. Templeton, *pro hac vice*
6020 S. University Avenue
Chicago, IL 60637
Phone: (773) 702-9611
Email: templeton@uchicago.edu