



THE UNIVERSITY OF CHICAGO  
**THE LAW SCHOOL**  
Abrams Environmental  
Law Clinic

November 13, 2025

*Via E-Filing*

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

RE: MPSC Case No. U-21870

Dear Ms. Felice:

Please find enclosed the Official Exhibits of Sergio Cira-Reyes on Behalf of Urban Core Collective, UCC-27 to UCC-37 (Part 3 of 6), along with proof of service, for electronic filing in the above-referenced matter.


Please do not hesitate to contact my office with any questions or comments.

Sincerely,

A handwritten signature in black ink, appearing to read 'Mark N. Templeton'.

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-21870

 An official website of the United States government



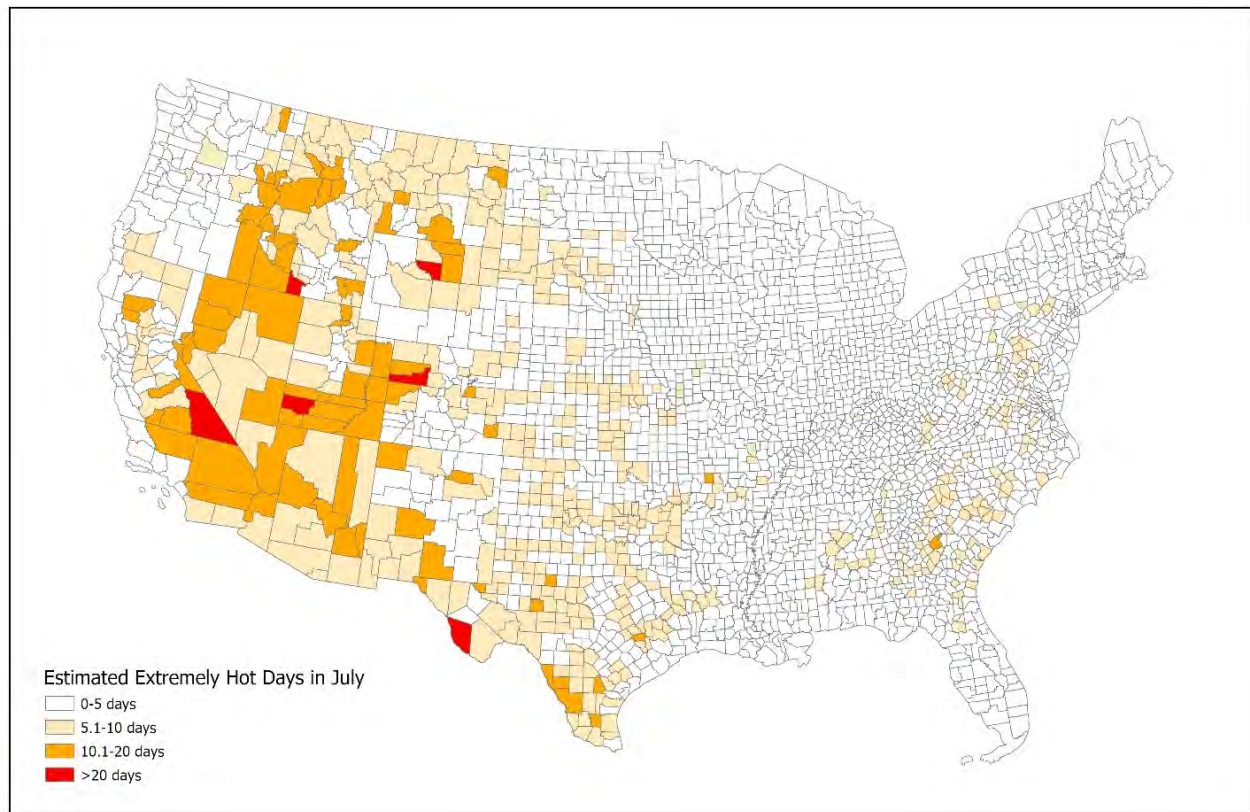
[Home](#) </> [Climate Change & Health Equity, and Environmental Justice at HHS](#) </climat...

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# Extreme Heat

## Where are extremely hot days expected in July?



**Figure:** This map shows the expected number of extremely hot days in July in for each county in the contiguous U.S. The forecast is based on the NOAA Climate Prediction Center’s probabilistic outlook of temperatures being above, below, or near normal in July. A county’s ‘normal’ temperature is based on the 30-year average from 1991–2020. An ‘extremely hot day’ is when the daily maximum temperature is above the 95th percentile value of the historical temperature distribution in that county. For more information on your county, please refer to the Centers for Disease Control and Prevention (CDC) Heat and Health Tracker [↗](https://ephtracking.cdc.gov/applications/heattracker/) <<https://ephtracking.cdc.gov/applications/heattracker/>>.

In July, a total of **594 counties** across Texas (126), Montana (41), Kansas (38), Oklahoma (37), Georgia (32), Idaho (30), California (26), Colorado (26), Utah (23), South Dakota (22), South Carolina (16), Arizona (15), Nebraska (15), New Mexico (15), Nevada (15), Virginia (14), Wyoming (13), Pennsylvania (12), Alabama (11), Arkansas (11), North Carolina (11), Washington (8), Missouri (7), Oregon (7), West Virginia (7), North Dakota (4), Maryland (3), Kentucky (2), Louisiana (2), Florida (1), Iowa (1), Mississippi (1), Tennessee (1), and Vermont (1) are expected to have five or more extremely hot days. In these counties, the total population at risk is **62,859,224**. Extreme summer heat is already increasing in the U.S. and climate projections indicate that extreme heat events will become more frequent

and intense in coming decades. Heat-related deaths have been increasing in the U.S. [↗](https://wonder.cdc.gov/mcd-icd10-provisional.html)  
<<https://wonder.cdc.gov/mcd-icd10-provisional.html>>, with approximately 1,602 occurring in 2021, 1,722 in 2022, and 2,302 in 2023.

## Heat Affects Health in Many Ways

Warmer temperatures increase the risk for a diverse range of health risks. For example:

- An increased risk of **hospitalization for heart disease**.
- **Heat exhaustion**, which can lead to **heat stroke** if not treated, can cause critical illness, brain injury, and even death.
- Worsening **asthma** and **chronic obstructive pulmonary disease (COPD)** as heat increases the production of ground-level ozone.
- Dehydration, which can lead to **kidney injury** and blood pressure problems. Some kidney damage can become irreversible with repeated or untreated injury.
- Mental health and substance use risks, including **loss of sleep** and **slowing of brain cognition**, and heightened risk of **increased acute psychiatric and substance use symptoms** among people with chronic behavioral health conditions.
- Some medications increase the risk of heat-related illness. These include diuretic medicines (sometimes called “water pills”), antihistamine medicines (including many allergy medicines), and many antipsychotic medicines used to treat a variety of psychiatric and neurologic illnesses. Please review this list of common psychiatric medications - PDF [🔗 <https://dbh.dc.gov/sites/default/files/dc/sites/dmh/release\\_content/attachments/8777/heatadvice.pdf>](https://dbh.dc.gov/sites/default/files/dc/sites/dmh/release_content/attachments/8777/heatadvice.pdf) that can impair the body’s normal ability to cool itself, as well as this list of tips for coping with hot weather for people who take medications - PDF [🔗 <https://store.samhsa.gov/sites/default/files/pep23-01-01-001.pdf>](https://store.samhsa.gov/sites/default/files/pep23-01-01-001.pdf).

**Who is at high risk in the counties with the most extreme heat days?**

People at elevated health risk from extreme heat exposure according to NIHHS [↗](https://www.heat.gov/pages/who-is-at-risk-to-extreme-heat) <<https://www.heat.gov/pages/who-is-at-risk-to-extreme-heat>> and CDC [↗](#) include those who:

- Have increased exposure (e.g., are experiencing homelessness, are emergency responders, are athletes, and/or work outdoors, or indoors with insufficient cooling);
- Have increased biologic sensitivity (e.g., are under age 5; are age 65 or over; are pregnant; and/or have chronic health conditions such as a mental health condition, diabetes, or cardiovascular condition); and/or
- Face high socioeconomic burden and/or additional barriers to accessing cooling or healthcare (e.g., are low income, live in a low resource community, and/or have one or more disabilities).

Check out your heat forecast for July along with top risk factors of concern in your county with our portal [↗](https://storymaps.arcgis.com/stories/93ea47545cc944139e3fcefa919cb42b) <<https://storymaps.arcgis.com/stories/93ea47545cc944139e3fcefa919cb42b>> and learn how to protect people at elevated risk [↗](#).

### **Partnering to Distribute Air Conditioning & Improve Health for At-Risk Residents**

In summer 2020, air conditioning (AC) units were distributed in New York City (NYC) to low-income residents over age 60, and those with mobility impairments, to prevent heat-related illness. NYC officials developed the AC unit distribution program, a more expansive effort than traditional cooling assistance programs, in response to the co-occurring issues of extreme heat and COVID-19-related recommendations to stay home and avoid indoor public spaces, including cooling shelters. NYC government agencies, including Emergency Management, the Housing Authority, the Department of Health and Mental Hygiene, and the Department of Housing Preservation and Development Authority, worked together to distribute and install 16,000 AC units in public housing and 56,000 in private households [↗](https://www.niehs.nih.gov/research/supported/translational/peph/newsletter/2023/09) <<https://www.niehs.nih.gov/research/supported/translational/peph/newsletter/2023/09>>. Participating agencies enrolled eligible residents who were already receiving benefits, community organizations that supported housing programs enrolled residents, and eligible residents were able to enroll themselves.

In a recent study partially funded by the National Institute of Environmental Health

Sciences (NIEHS), researchers from Columbia and WE ACT for Environmental Justice evaluated the program's effectiveness in equitable distribution and health outcomes [↗](https://pubmed.ncbi.nlm.nih.gov/36759422/) [<https://pubmed.ncbi.nlm.nih.gov/36759422/>](https://pubmed.ncbi.nlm.nih.gov/36759422/). They used NYC's Heat Vulnerability Index to compare AC distribution to the Index's map of residents most at-risk of adverse outcomes from heat exposure and found that AC distribution aligned closely to vulnerable areas and serving populations most in need. They also surveyed a sample of program participants and a comparable group of non-participants, which showed that installation of an AC unit had a positive effect on health during a summer when there were fewer public, cooled spaces available. Specifically, participants were less likely to report that hot weather made them feel sick in their homes compared to non-participants. As cities grapple with increasing extreme heat due to climate change, the NYC AC distribution program provides a model for supporting those most in need.

### **Agricultural Workers: A Priority Population for Preventing Heat-related Illness**

Extreme heat exposure can cause heat-related illnesses [↗](https://www.osha.gov/heat-exposure/illness-first-aid) [<https://www.osha.gov/heat-exposure/illness-first-aid>](https://www.osha.gov/heat-exposure/illness-first-aid) including heat stroke, heat exhaustion, cramps, fainting, and rashes. Outdoor workers, as well as indoor workers with insufficient ventilation or mechanical cooling, are at elevated risk for heat-related illness. One group of particular concern is agricultural workers [↗](https://www.migrantclinician.org/explore-environmental-justice-and-worker-health/heat-related-illness.html) [<https://www.migrantclinician.org/explore-environmental-justice-and-worker-health/heat-related-illness.html>](https://www.migrantclinician.org/explore-environmental-justice-and-worker-health/heat-related-illness.html), who often have physically demanding work outdoors through the hottest months and even during extreme heat waves. Recent studies have found that the average agricultural worker experiences 21 days (out of the average 153 day summer) of unsafe working days [↗](https://www.ncbi.nlm.nih.gov/pmc/articles/pmc7594196/) [<https://www.ncbi.nlm.nih.gov/pmc/articles/pmc7594196/>](https://www.ncbi.nlm.nih.gov/pmc/articles/pmc7594196/) per year (i.e., days over 83.4°F) and the risk of heat-related death was more than 35 times higher for people working in agriculture [↗](https://www.ncbi.nlm.nih.gov/pmc/articles/pmc4657558/) [<https://www.ncbi.nlm.nih.gov/pmc/articles/pmc4657558/>](https://www.ncbi.nlm.nih.gov/pmc/articles/pmc4657558/) compared to other occupations. The risks associated with unsafe working days are further compounded if nighttime temperatures are elevated or many excess heat days occur in a row.

There are an estimated 2.9 million agricultural workers [↗](https://www.ncfh.org/facts-about-agricultural-workers-fact-sheet.html) <https://www.ncfh.org/facts-about-agricultural-workers-fact-sheet.html> in the U.S., of which a recent survey [↗](https://www.ncfh.org/facts-about-agricultural-workers-fact-sheet.html) <https://www.ncfh.org/facts-about-agricultural-workers-fact-sheet.html> found that 78% self-identify as Hispanic and 70% as born outside of the U.S. Without protective measures, these workers are likely to experience even more heat-related illnesses as heat seasons become longer, hotter, and more intense. Important preventative measures [↗](https://www.cdc.gov/niosh/topics/heatstress/heatapp.html) <https://www.cdc.gov/niosh/topics/heatstress/heatapp.html> for agricultural workers as well as all outdoor workers include providing water, shade, and breaks during the working day. The creation of culturally and linguistically appropriate training and resources related to heat protection and symptom identification can help migrant and seasonal agricultural workers protect themselves from the dangers of extreme heat. The OSHA field sanitation standard [↗](https://www.ecfr.gov/current/title-29/subtitle-b/chapter-xvii/part-1928/subpart-i/section-1928.110) <https://www.ecfr.gov/current/title-29/subtitle-b/chapter-xvii/part-1928/subpart-i/section-1928.110> requires agricultural employers with 11 or more workers to provide drinking water. For more information on how to prevent, recognize, and treat heat-related illness, check out the Farmworker Justice and Migrant Clinicians Network Heat-Related Illness Clinicians guide [↗](https://www.migrantclinician.org/resource/heat-related-illness-clinicians-guide-june-2021.html) <https://www.migrantclinician.org/resource/heat-related-illness-clinicians-guide-june-2021.html>. Migrant workers can also find helpful resources and more information about their employment-related rights in the U.S. at MigrantWorker.gov [↗](https://www.dol.gov/general/migrantworker) <https://www.dol.gov/general/migrantworker> or TrabajadorMigrante.gov [↗](https://www.dol.gov/general/trabajadormigrante) <https://www.dol.gov/general/trabajadormigrante>.



**Image:** Farmworkers exposed to sun and heat working in a strawberry field in Salinas, CA, wearing protective clothing including hats and long sleeve shirts.  
Source: iStock/rightdx.

### Heat Season Returning Soon: Impacts of Heat on Mental Health Outcomes & Risks for Those with Preexisting Conditions

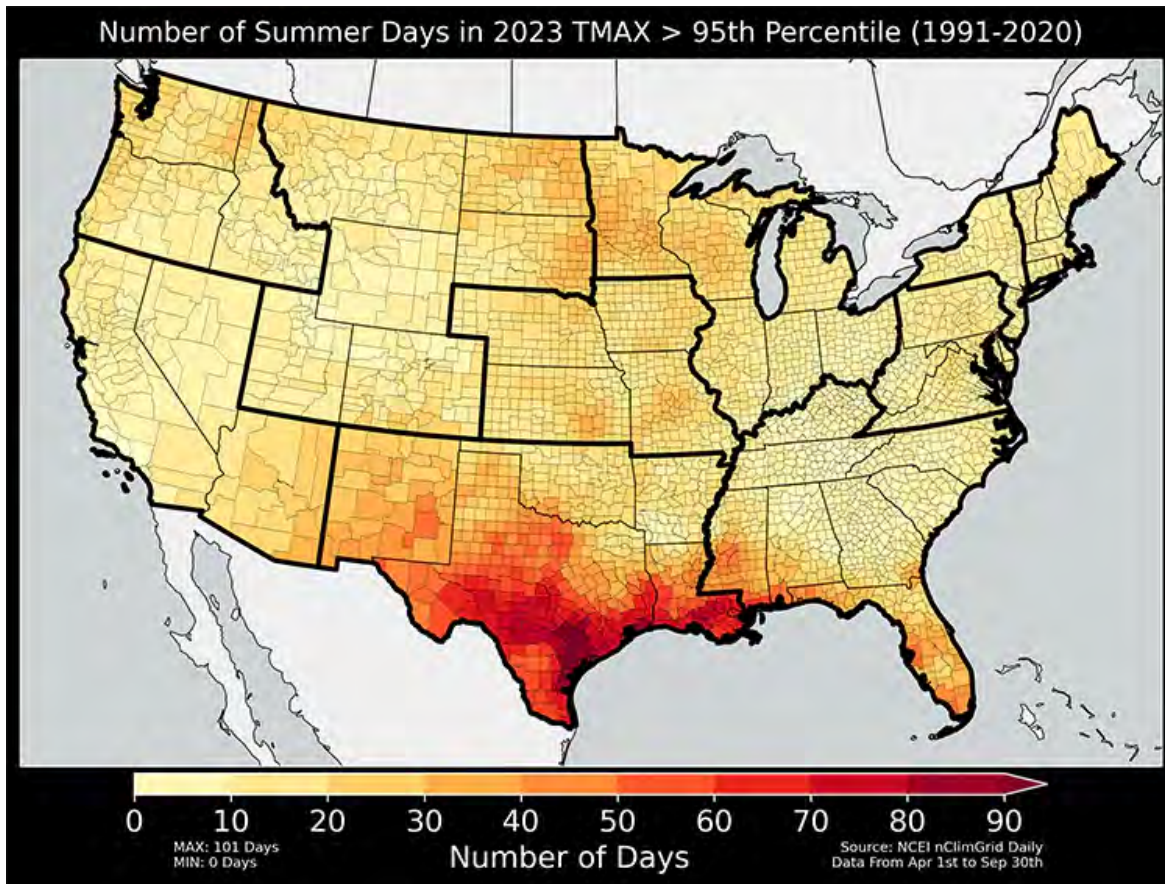
Exposure to extreme heat can lead to increased stress, anxiety, and cognitive impairment - PDF [↗](https://www.cdc.gov/aging/pdf/cognitive_impairment/cogimp_poilicy_final.pdf) [https://www.cdc.gov/aging/pdf/cognitive\\_impairment/cogimp\\_poilicy\\_final.pdf](https://www.cdc.gov/aging/pdf/cognitive_impairment/cogimp_poilicy_final.pdf) ⓘ . Research has shown that extreme heat is associated with several mental health outcomes [↗](#) ⓘ including increased risk of suicide and increased mental health-related hospital admissions and emergency department (ED) visits. A recent study found that associations between heat and mental health-related ED visits were highest in the U.S. Northeast, Midwest, and Northwest [↗](https://pubmed.ncbi.nlm.nih.gov/35195664/) <https://pubmed.ncbi.nlm.nih.gov/35195664/> ⓘ regions. Furthermore, individuals with preexisting behavioral health conditions are at increased risk of heat-related illness

or death from extreme heat [↗](https://www.samhsa.gov/blog/heat-health-awareness-why-its-important-persons-substance-use-disorders-mental-health) [i](https://www.samhsa.gov/blog/heat-health-awareness-why-its-important-persons-substance-use-disorders-mental-health) . Psychotropic medications - PDF [↗](https://store.samhsa.gov/sites/default/files/pep23-01-01-001.pdf) [i](https://store.samhsa.gov/sites/default/files/pep23-01-01-001.pdf) , which are commonly used in mental health treatment, as well as alcohol and other substances can contribute to this increased risk. A recent study on heat-related deaths [↗](https://www.ncbi.nlm.nih.gov/pmc/articles/pmc7302478/) [i](https://www.ncbi.nlm.nih.gov/pmc/articles/pmc7302478/) found that 18% of deaths were due to alcohol poisoning (3%) and drug overdose (15%).

#### Resources:

- The CDC provides a list of common warning signs and symptoms of heat-related illness [↗](https://www.cdc.gov/disasters/extremeheat/warning.html) [i](https://www.cdc.gov/disasters/extremeheat/warning.html) along with tips on what to do when you or someone you know is experiencing symptoms.
- Some medications increase the risk of heat-related illness. These include diuretic medicines (sometimes called “water pills”), antihistamine medicines (including many allergy medicines), and many antipsychotic medicines used to treat a variety of psychiatric and neurologic illnesses. Check out SAMHSA’s Tips for People Who Take Medication: Coping with Hot Weather - PDF [↗](https://store.samhsa.gov/sites/default/files/pep23-01-01-001.pdf) [i](https://store.samhsa.gov/sites/default/files/pep23-01-01-001.pdf) for more information.

## Where was Heat Abnormally High in 2023?



**Figure:** Temperature is calculated from NOAA's nClimGrid-Daily v1-0-0 [↗](https://www.ncei.noaa.gov/products/land-based-station/nclimgrid-daily) <https://www.ncei.noaa.gov/products/land-based-station/nclimgrid-daily> ⓘ , a 5km gridded dataset aggregated into counties for the contiguous U.S. For each day from April 1st to September 30th, a county's temperature in 2023 is compared against its climatological normal from 1991–2020. Temperatures above the 95th percentile are considered abnormally hot for the region. Thick lines on the map indicate HHS regional boundaries:

Region 1: CT, ME, MA, NE, RI, VT

Region 2: NJ, NY, PR, VI

Region 3: DE, DC, MD, PA, VA, WV

Region 4: AL, FL, GA, KY, MS, NC, SC, TN

Region 5: IL, IN, MI, MN, OH, WI

Region 6: AR, LA, NM, OK, TX

Region 7: IA, KS, MO, NE

Region 8: CO, MT, ND, SD, UT, WY

Region 9: AZ, CA, HI, NV, AS, MP, FSM, GU, MH, PW

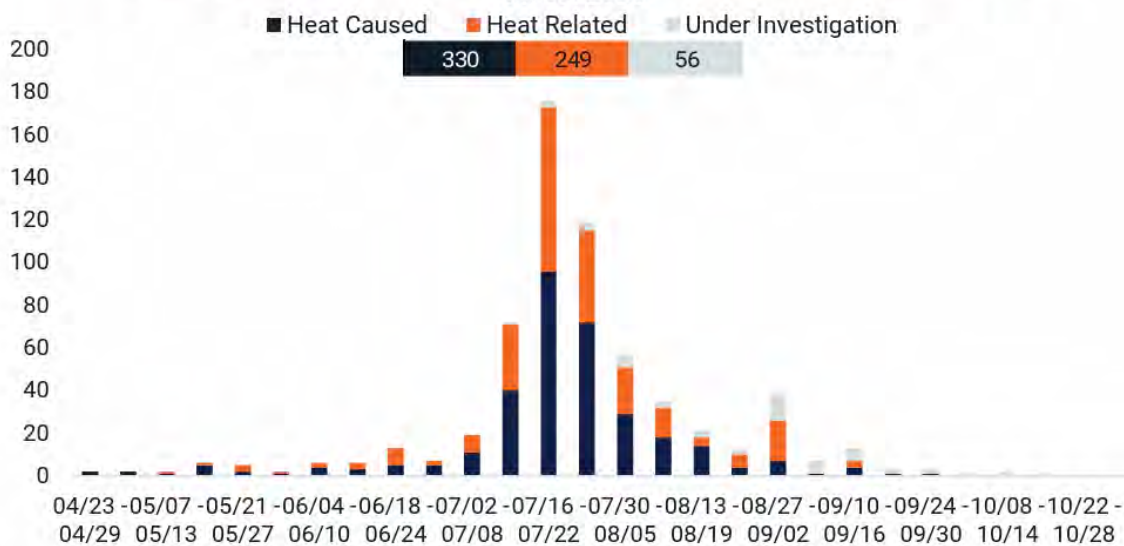
*Region 10: AK, ID, OR, WA*

2023 was the 5th-warmest year [↗ <https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/national/rankings/110/tavg/202312>](https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/national/rankings/110/tavg/202312) on record for the contiguous U.S. (average annual temperature 2.4°F above average). Texas, Louisiana, Mississippi, New Hampshire and Massachusetts each ranked warmest year on record while Maine, Vermont, Connecticut, Maryland, Virginia and Florida each ranked second warmest. The map above depicts the number of summer days in 2023 when a county’s maximum temperature exceeded its 95th percentile, thus indicating an abnormally hot day. Much of HHS Region 6, especially Texas and Louisiana, experienced more than 30 days of abnormally hot temperatures in 2023.

**Heat-Related Illness in 2023: A Case Study of Maricopa County, AZ**

	Confirmed	Under Investigation	First Death
2023 Cumulative Total	579	56	4/11/2023
2022 Cumulative Total	386	51	3/13/2022

**Graph 1. There have been 579 heat-associated deaths in Maricopa County as of 11/07/2023**



**Figure:** Table and plot of heat-associated deaths in Maricopa County in 2023 from

*the Department of Public Health's latest report* [↗](https://www.maricopa.gov/archivecenter/viewfile/item/5734) <https://www.maricopa.gov/archivecenter/viewfile/item/5734>. *Heat-caused deaths include cases where heat is listed as a direct cause of death on the death certificate, heat-related deaths include cases where heat is listed as contributing, and under investigation includes cases where the medical examiner suspects a heat-associated death.*

Maricopa County, AZ is a highly populated county that experiences some of the U.S.'s most extreme heat. In 2023, there were over 100 days when the temperature was above 100° F [↗](#). It also experiences high rates of heat-related illnesses. For example, it ranks in the 99th percentile of U.S. counties for their number of heat-related Emergency Medical Services (EMS) activations according to the National EMS Information System's (NEMIS) Heat-Related EMS Activation Surveillance Dashboard [↗](https://nemsis.org/heat-related-ems-activation-surveillance-dashboard/) <https://nemsis.org/heat-related-ems-activation-surveillance-dashboard/>. In 2022, Maricopa suffered a record 425 confirmed heat-related deaths, after experiencing 339 confirmed in 2021. Through November 7, 2023, they had already confirmed 579 heat-associated deaths [↗](https://www.maricopa.gov/archivecenter/viewfile/item/5734) <https://www.maricopa.gov/archivecenter/viewfile/item/5734>. Additional analysis gives insight into risk factors: 25% of the deaths occurred indoors, with air conditioning present but not functioning for 109 out of 146 of these cases. 45% of the deaths occurred among individuals experiencing homelessness.

This high number of heat-related deaths has prompted Maricopa County to take many actions including:

- Partnering with the Maricopa County Association of Governments, municipalities, universities, and community and faith-based organizations to form the Heat Relief Network [↗](https://azmag.gov/programs/heat-relief-network) <https://azmag.gov/programs/heat-relief-network> to establish cooling centers and hydration stations;
- Providing surveillance via the county's Department of Public Health [↗](https://www.maricopa.gov/1871/extreme-heat) <https://www.maricopa.gov/1871/extreme-heat> to track heat-related illness and death in order to support heat relief planning and provide guidance for residents to protect themselves;
- Expanding access to heat relief by increasing evening and weekend hours and funding 2-1-1 Arizona [↗](https://211arizona.org/get-help/search-by-category/) <https://211arizona.org/get-help/search-by-category/> to assist in finding transportation to the nearest Heat Relief location;

- Increasing funding to the HVAC repair and replacement fund [↗](#); and
- Partnering with the state of Arizona to sign up for heat warning alerts [↗](#).

## EMS HeatTracker

**Figure:** Image of the EMS HeatTracker showing county-level rates of heat-related EMS activations from July 29, 2023 – August 11, 2023. View the EMS HeatTracker: <https://nemsis.org/heat-related-ems-activation-surveillance-dashboard/> [↗](#) <https://nemsis.org/heat-related-ems-activation-surveillance-dashboard/>

OCCHE and the National Highway Traffic Safety Administration (NHTSA) have launched a new resource called the Heat-Related EMS Activation Surveillance Dashboard [↗](https://nemsis.org/heat-related-ems-activation-surveillance-dashboard/), or the “EMS HeatTracker” for short. This first-of-its-kind tool maps EMS responses to heat-related illness across the country to help local decision makers and communities prioritize resources and interventions to prevent heat-related illness and save lives.

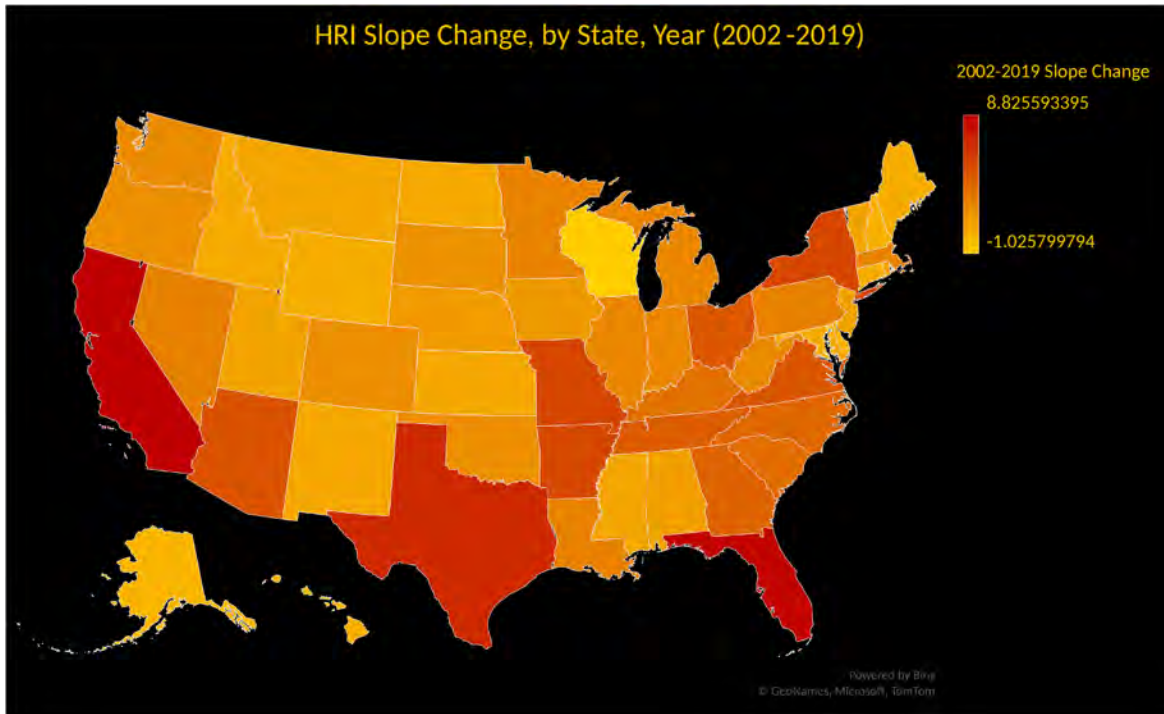
The EMS HeatTracker highlights jurisdictions (including all 50 U.S. States, Puerto Rico, and D.C.) and counties with the highest rates of heat-related EMS activations and allows for county- and jurisdiction-level comparisons to national averages in three categories in the prior rolling 30- and 14-day periods:

- population rate of heat-related EMS activations within a community;
- average EMS time in transit to reach a patient; and
- the percent of patients who are transported to a medical facility for further treatment.

The tool also provides national-level information on the number of heat-related EMS activations and the number of heat-related deaths among patients who were alive when EMS officials arrived on the scene. Demographic information is also available at the national level, including the age, race, gender, and urbanicity (i.e., urban, suburban, rural, and frontier) of patients.

The information displayed on the EMS HeatTracker is updated every Monday morning with a two-week lag behind real time.

## Heat-Related Illness Among Veterans



**Figure:** Heat map of all 50 U.S. states and District of Columbia. States with the largest increase in heat-related illness diagnoses over the assessment period are red, with less dramatic increases represented in shades of orange.

A recent publication [↗](https://www.sciencedirect.com/science/article/pii/S2667278223000561#fig0005) <https://www.sciencedirect.com/science/article/pii/S2667278223000561#fig0005> [i](#) from the U.S. Department of Veterans Affairs, Stanford University, University of Iowa, and CDC found that Veterans have been diagnosed with heat-related illnesses (HRIs), such as heat exhaustion and heat stroke, in all 50 states and that the rate of diagnosis has increased over time. The assessment utilized the Veterans Health Administration [↗](https://www.va.gov/health/) <https://www.va.gov/health/> [i](#)'s national electronic health record database to identify HRIs diagnosed from January 1, 2002, through December 31, 2019, and found that there were **33,114 documented cases of HRIs**, which impacted **28,039 unique patients**. The

Veterans Health Administration is the largest integrated healthcare system in the United States, with 1,298 facilities serving over 9 million enrolled Veterans.

In addition to a statistically significant increase in the incidence of HRIs over time, the results raised important **health equity concerns**. Of note, Black and American Indian/Alaska Native Veterans were more likely to be diagnosed with HRIs.

Veterans with existing medical conditions, including common comorbidities, also saw a greater increase in HRIs over time. For example, in 2022 ~50% of HRI diagnoses impacted Veterans with hypertension, but this increased to ~70% in 2019. The results demonstrated that there has been an increase in diagnosed HRIs among Veterans for **nearly all U.S. states** with a disproportionate increase of HRIs in California, Florida, and Texas. There were also notable increases in HRI diagnoses in other states such as Missouri, Arkansas, Virginia, Ohio, and New York. However, the rates for the Veteran homeless population were increasing in the first half of the assessment period, but then decreased in the second half of the assessment. This change in the trend occurred alongside the development and expansion of Veteran homeless programs, which suggests specific interventions can decrease the extent of heat related illnesses.

### **California Department of Public Health's Findings from the 2022 Labor Day Heat Wave**

From August 31 through September 9, 2022, a record-breaking heat wave occurred across California. Temperature records were set in approximately 1,500 locales and excessive heat warnings were issued for much of the state. During this 10-day heat wave, an analysis by the California Department of Public Health (CDPH) - PDF [↗](https://www.cdph.ca.gov/programs/ohe/cdph%20document%20library/climate-health-equity/cdph-2022-heat-wave-excess-mortality-report.pdf) found a 5% increase in deaths in the state – **395 more deaths** than would be expected. The **highest increases in deaths were seen among people aged 25-64, people who identify as Hispanic or Latino, and people from the South Coast region, including Los Angeles and neighboring counties**. While we know from previous analyses that older adults and the very young are vulnerable to negative health impacts from extreme heat,

CDPH notes that **it is important for heat interventions to also consider the vulnerability of working-age adults, who may work in hot conditions or have other types of over-exposure to heat.** CDPH believes the finding for the South Coast region may reflect where fewer residences have air conditioning, and where people are less acclimated to heat than inland residents.

This analysis highlights that we can likely expect heat impacts to extend into September in coming years. **California has invested \$404 million towards addressing extreme heat impacts, guided by the state's Extreme Heat Action Plan** - PDF [↗ <https://resources.ca.gov/-/media/cnra-website/files/initiatives/climate-resilience/2022-final-extreme-heat-action-plan.pdf>](https://resources.ca.gov/-/media/cnra-website/files/initiatives/climate-resilience/2022-final-extreme-heat-action-plan.pdf). CDPH hopes that these findings will help guide future public health prevention, response, and resilience efforts as this plan is implemented.

### **What is the Wet Bulb Globe Temperature**

The Wet Bulb Globe Temperature (WBGT) is a measure of heat stress on the human body, taking into account the effect of temperature, relative humidity, wind speed, and solar radiation on humans. Sweating can usually cool the body down to a stable internal temperature, but when the humidity is high, the air can become so saturated with moisture that the evaporation of sweat slows, hindering the body's ability to cool itself.

Those who work or exercise in direct sunlight are particularly vulnerable to heat stress when the WBGT is high. Monitor the WBGT using the National Weather Service one-week WBGT forecast [↗](#) and take a break in an air conditioned building if you notice that you are sweating excessively while working or exercising outside.

## Pediatric Heatstroke Prevention

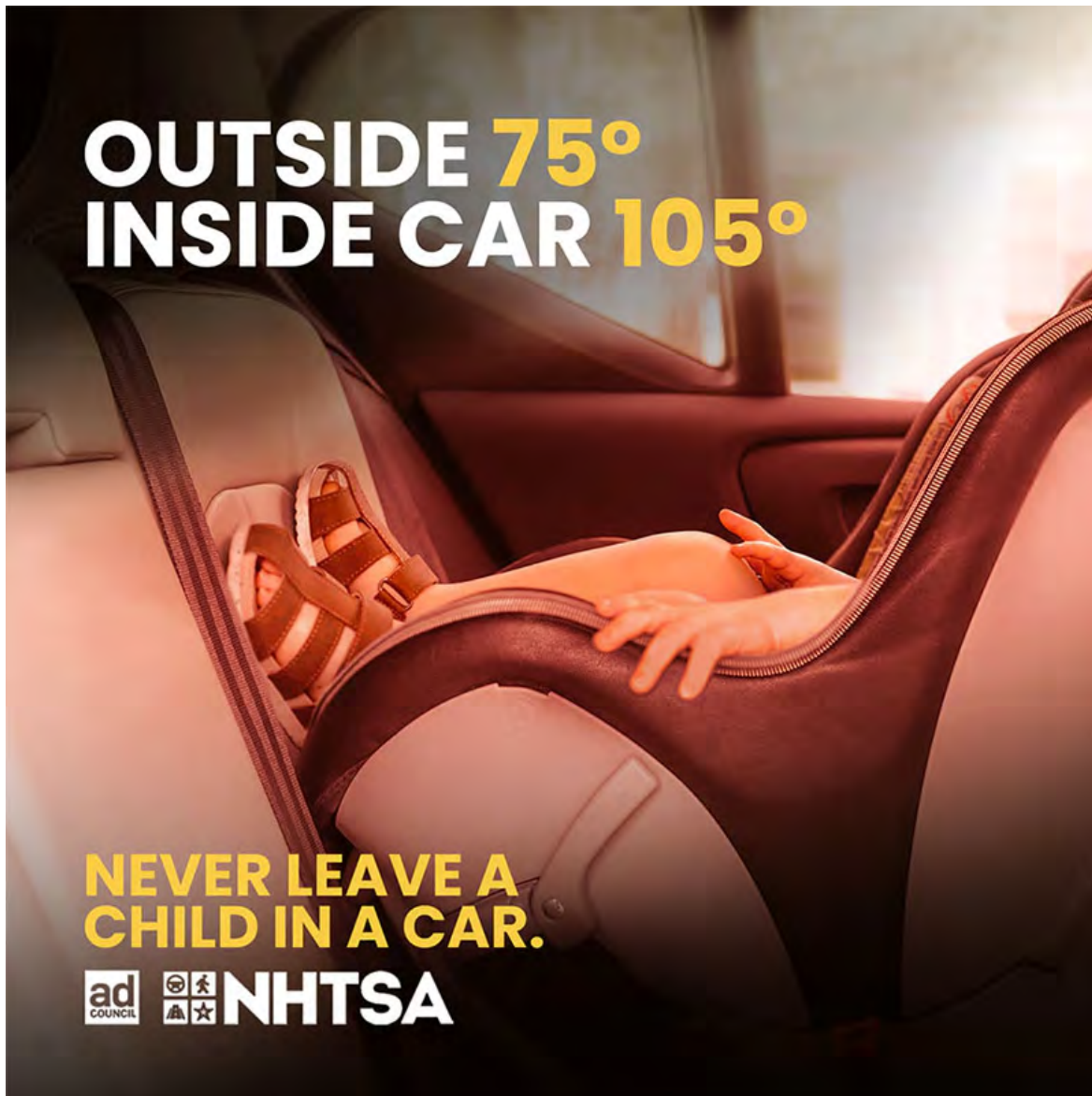


Image source: <https://www.trafficsafetymarketing.gov/get-materials/child-safety/heatstroke-prevention>  <<https://www.trafficsafetymarketing.gov/get-materials/child-safety/heatstroke-prevention>>

Between 1998 and 2022, a total of 937 children died due to heatstroke when left in a vehicle alone, with an average number of 37 deaths each year (see [noheatstroke.org](http://noheatstroke.org) for more information). More than half of the deaths (54%) are children under 2 years of age. All of these fatalities were preventable. In 10 minutes, a car can heat up by as much as 20 degrees Fahrenheit and become life

threatening for a child trapped inside. Rolling down a window does little to keep a vehicle cool. Since the body temperature of a child rises three to five times faster than that of an adult, a hot vehicle can become dangerous within a short period of time.

Among the reported fatalities, 53% of children were forgotten by their caregivers, 25% gained access to the car on their own, and 20% were knowingly left in the car by the caregiver. Three tips to remember to prevent children from dying in a hot car: never leave a child in a car unattended, make it a habit to look in the back seat every time you exit, and always lock the car, and put the keys out of reach.

### **Earth saw its 3rd-warmest May in 174 years**

According to the National Oceanic and Atmospheric Administration [🔗 <https://www.noaa.gov/news/earth-saw-its-3rd-warmest-may-in-174-years>](https://www.noaa.gov/news/earth-saw-its-3rd-warmest-may-in-174-years), May 2023 was the world's third-warmest May on record and North America's warmest May on record. Due in part to North America's record-setting high temperatures, several hundred wildfires broke out across Canada in May, burning over 6 million acres and causing widespread air quality deterioration across much of Canada and the United States. Elsewhere in the world, Antarctic sea ice extent hit a record low in May and tropical cyclone Mocha made a devastating landfall as a Category 4 Cyclone in Myanmar on May 14. Earth's ocean surface temperatures also set a record high for the second month in a row.

### **The Danger of Early Season Heat Waves**

Although early season extreme heat events are less common than those that occur later in the summer, they may be more deadly. As the summer progresses, our bodies get used to the higher temperatures and become more efficient at cooling,

by increasing sweating rates, for example. When temperatures are very high early in the season, before our bodies have a chance to adjust, the risks of heat stress and heat stroke may be higher.

One study [↗](https://www.ncbi.nlm.nih.gov/pmc/articles/pmc3040608/) of heat waves in 43 U.S. cities found that the first heat wave in a community generally had greater impacts on mortality than heat waves that were not the first in the season. Heat-related mortality risk early in the heat season is even greater for those who are more vulnerable to the impacts of heat, such as young children, older adults, pregnant people, or those with chronic medical conditions that make them more susceptible to heat-related illness.

Because of the ways climate change increases temperature and temperature variability, these early season extreme heat events may become more common. Whenever temperatures are high, and particularly during extreme heat events in the early heat season, it is important to take precautions to protect yourself and those around you.

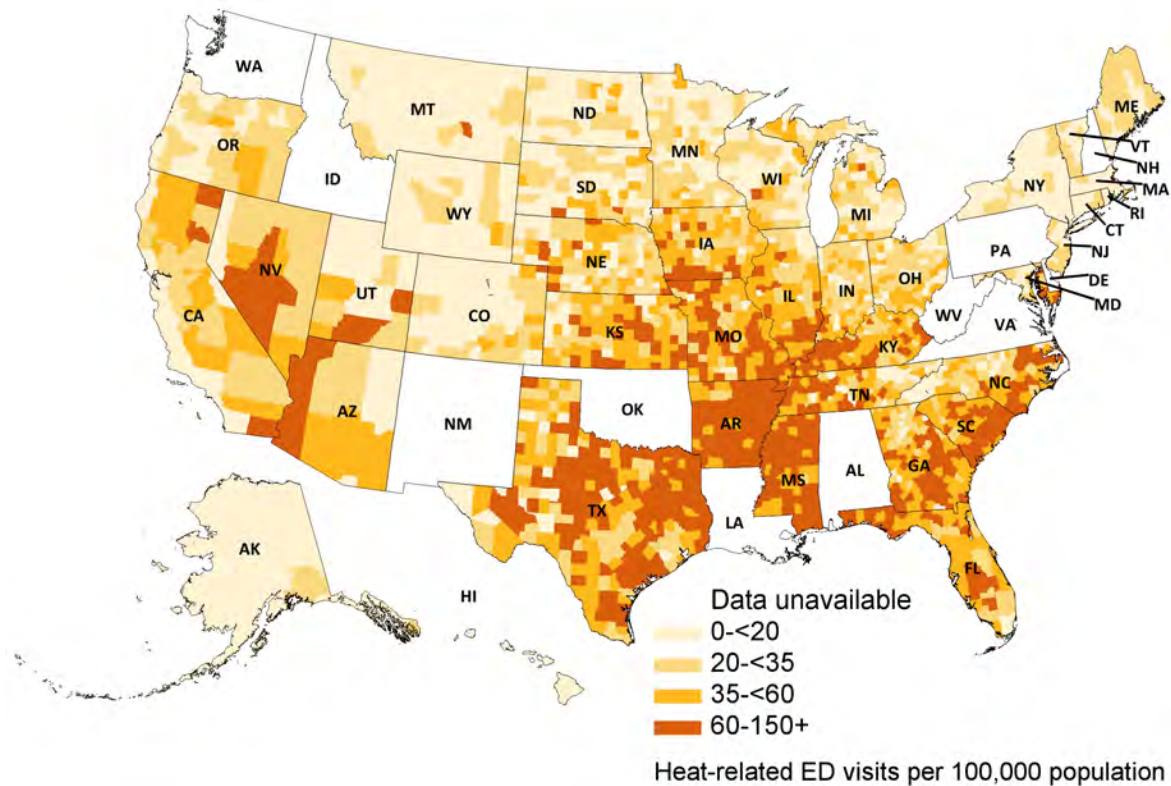
### **Health Impacts During the Heat Dome of 2021**

During June–July 2021, the western U.S. experienced a record-breaking heat wave that lasted for several days. Estimated heat-related deaths and illnesses demonstrate the tragic toll of the heat wave on public health. Comparing the health records from June 26–July 10 between 2021 and 2020, heat-related deaths increased from 2 to 145 in Washington, 0 to 119 in Oregon, and 12 to 25 in California. These estimates were provided by the California Department of Public Health, Oregon Health Authority, and Washington State Department of Health. For context, the CDC estimates an average of 702 heat-related deaths per year for the entire U.S. (based on 2004–2018 data).

An article - PDF [↗](https://files.asprtracie.hhs.gov/documents/extreme-heat-events-lessons-from-seattles-record-breaking-summer.pdf) from the Administration for Strategic Preparedness and Response Technical Resources, Assistance Center, and Information Exchange

features health care stakeholders sharing how lessons learned during the 2021 heat dome event and robust regional and local collaboration and communications during the pandemic facilitated connections during the heat wave in the summer of 2022.

### Spotlight on Health Equity: Health Impacts in Rural Areas



In April 2022, Agency for Healthcare Research and Quality used the Healthcare Cost and Utilization Project (HCUP) 2016–2019 to estimate county-level population rates of emergency department (ED) visits with a diagnosis directly indicating heat exposure. The analysis was limited to records of ED visits, regardless of hospital admission, at community hospitals, excluding rehabilitation and long-term acute care facilities, with any-listed diagnosis directly indicating heat exposure. This analysis includes ED data from 2,550 counties in 39 States and the District of

Columbia, representing 85 percent of the population and 81 percent of all counties in the United States in 2019. **Among the 1,122 rural counties, 152 (13.5%) had heat-related ED visit population rates of 85 or more per 100,000 population (i.e., 90th percentile of population rates). In contrast, among the 344 large metropolitan counties, 8 (2.3%) had heat-related ED visit population rates in the 90th percentile.** The report - PDF [↗](https://hcup-us.ahrq.gov/reports/ataglance/hcupanalysisheatexposureedvsts.pdf) <https://hcup-us.ahrq.gov/reports/ataglance/hcupanalysisheatexposureedvsts.pdf> highlights that a larger proportion of rural than large metropolitan counties experience a high rate of heat-related illness, although there are more heat-related ED visits in large metropolitan areas (n=135,585 ED visits) than in rural areas (n=30,115 ED visits).

## Resources for People at High Risk of Heat-Related Health Problems

Certain populations with limited resources may have restricted access to information on heat illness prevention, cool indoor environments, and government programs that provide critical support. Find more resources on heat illness prevention from Heat.gov [↗](https://www.heat.gov/) <https://www.heat.gov/> and CDC [↗](https://www.cdc.gov/disasters/extremeheat/index.html) <https://www.cdc.gov/disasters/extremeheat/index.html> websites.

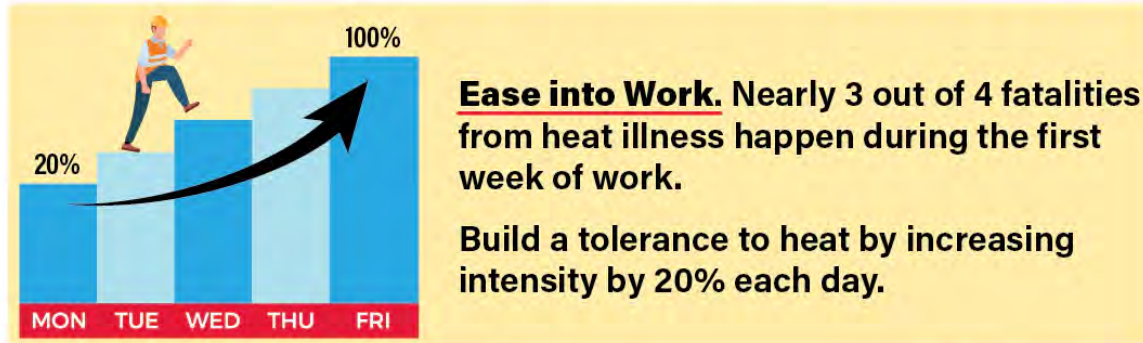
### Worker Health

Occupations that require strenuous work outdoors pose a high risk for heat-related illness. This includes construction workers, farmers, agricultural workers, delivery workers, athletes, landscapers, and others. Learn more about the dangers of working in heat. Employer responsibilities and resources for safety are also available through the Occupational Safety and Health Administration (OSHA) Heat Illness Prevention campaign [↗](https://www.osha.gov/heat) <https://www.osha.gov/heat>.

- The Heat Safety Tool [↗](https://www.cdc.gov/niosh/topics/heatstress/heatapp.html) <https://www.cdc.gov/niosh/topics/heatstress/heatapp.html> provides real-time heat index and hourly forecasts, specific to your location, as well as occupational safety and health recommendations from OSHA and the National Institute for Occupational Safety and Health (NIOSH).
- The National Institute of Environmental Health Sciences (NIEHS) Worker Training Program [↗](https://www.niehs.nih.gov/careers/hazmat/about_wetp/index.cfm) <https://www.niehs.nih.gov/careers/hazmat/about\_wetp/index.cfm> has heat safety and health training for at-risk workers.
- The Health Resource Services Administration (HRSA) funds National Training and Technical Assistance Partners — Farmworker Justice and Migrant Clinicians Network [↗](https://www.migrantclinician.org/webinar/its-hot-and-its-dangerous-webinar-community-health-workers-learn-about-heat-related-illness) <https://www.migrantclinician.org/webinar/its-hot-and-its-dangerous-webinar-community-health-workers-learn-about-heat-related-illness> that helps clinicians prevent and treat heat-related illness among agricultural workers.



# Prevent Heat Illness at Work



**Drink cool water even if you are not thirsty**



**Rest for long enough to recover from the heat**



**Take breaks in a shady or cool area**



**Wear a hat and dress for the heat**



**Watch out for each other**



**Verbally check on workers wearing face coverings**



Image source: <https://www.osha.gov/heat> <<https://www.osha.gov/heat>>

## Federal Heat-Related Funding Opportunities

A new resource from the National Integrated Heat Health Information System and the White House Extreme Heat Interagency Working Group highlights federal funding opportunities that are relevant to heat <<https://www.heat.gov/pages/funding-opportunities>> made available through the Inflation Reduction Act and the Bipartisan

Infrastructure Law. These opportunities are open for applications from state, local, territorial, and Tribal governments; nonprofit organizations; manufacturers; and more. The webpage will be updated weekly as new funding opportunities become available.

## Staying Safe Indoors

- The Low Income Home Energy Assistance Program <<https://www.acf.hhs.gov/ocs/map/liheap-map-state-and-territory-contact-listing>> (LIHEAP) and the Weatherization Assistance Program (WAP) help keep families safe and healthy through initiatives that assist families with energy costs. To inquire about LIHEAP assistance, call the National Energy Assistance Referral (NEAR) hotline at 1-866-674-6327.
- HHS has issued guidance <<https://www.acf.hhs.gov/ocs/policy-guidance/liheap-im-2022-06-heat-stress-flexibilities-and-resources-fy2022>> that for the first time expands how LIHEAP can promote the delivery of efficient air conditioning equipment, community cooling centers, and more.
- The National Institute on Aging resource Hot Weather Safety for Older Adults  <<https://www.nia.nih.gov/health/hot-weather-safety-older-adults>> offers background information on heat stroke, who is at risk, lowering your risk, and best practices.
- Medicare Advantage (MA) plans may provide Special Supplemental Benefits for the Chronically Ill - PDF  <[https://www.cms.gov/medicare/health-plans/healthplansgeninfo/downloads/supplemental\\_benefits\\_chronically\\_ill\\_hpms\\_042419.pdf](https://www.cms.gov/medicare/health-plans/healthplansgeninfo/downloads/supplemental_benefits_chronically_ill_hpms_042419.pdf)> (SSBCI) with equipment and services that improve indoor air temperatures and quality (such as portable air conditioners) to chronically ill patients.

## LIHEAP'S IMPACT BY THE NUMBERS

### In Fiscal Year 2021, LIHEAP:



Reduced energy burden by an average of **~52%**



Prevented the loss of home energy services for over **1.4 million households**



Helped **5.4 million households** pay their energy bills



Served over **58,000 households** with weatherization or minor home energy repairs



Provided cooling and summer crisis assistance to over **939,000 households**



Provided an average cooling assistance benefit of **\$737** and/or summer crisis benefit **\$699**

Image sources: [https://www.acf.hhs.gov/sites/default/files/documents/ocs/COMM\\_LIHEAP\\_Earth%20Day\\_FY2022.pdf](https://www.acf.hhs.gov/sites/default/files/documents/ocs/COMM_LIHEAP_Earth%20Day_FY2022.pdf) - PDF <[https://www.acf.hhs.gov/sites/default/files/documents/ocs/comm\\_liheap\\_earth%20day\\_fy2022.pdf](https://www.acf.hhs.gov/sites/default/files/documents/ocs/comm_liheap_earth%20day_fy2022.pdf)>, <https://liheappm.acf.hhs.gov/datawarehouse> <<https://liheappm.acf.hhs.gov/datawarehouse>>

### Best Practices for Emergency Managers

This CDC report on Heat Response Plans - PDF [↗](https://www.cdc.gov/climateandhealth/docs/heatresponseplans_508.pdf) <[https://www.cdc.gov/climateandhealth/docs/heatresponseplans\\_508.pdf](https://www.cdc.gov/climateandhealth/docs/heatresponseplans_508.pdf)> reviews steps emergency managers and health officials can take to develop and implement measures to protect their communities. Spikes in energy demand should be expected during summer months as air conditioning use increases. The combination of sagging power lines (copper expands as it heats up, thus increasing impedance and reducing throughput) and increased energy demands can cause power failures that make certain populations more vulnerable when the risk is highest. The HHS emPOWER <<https://empowermap.hhs.gov/>> program collects and shares de-identified Medicare data to help response agencies take action to protect the health of Medicare beneficiaries who depend on vulnerable electrical medical equipment.

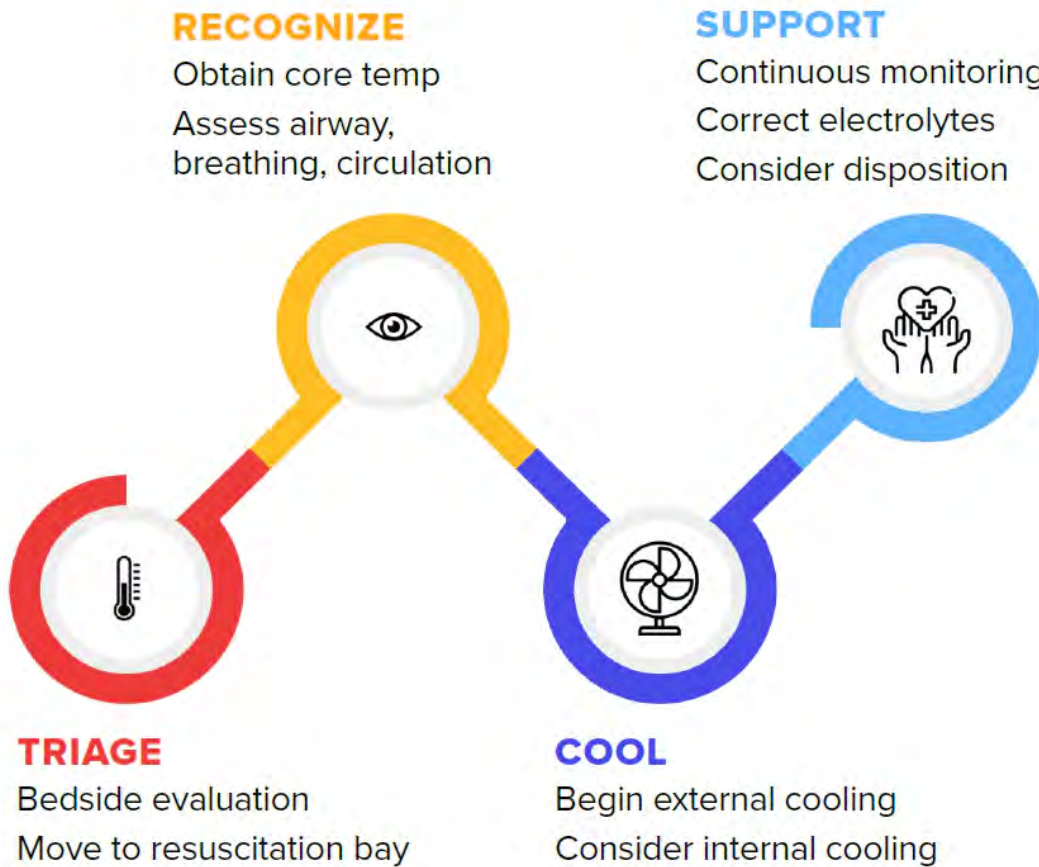
Real-time information on health impacts from extreme heat can also help decision-makers implement strategies to reduce risk. CDC's Heat and Health Tracker [↗](https://ephtracking.cdc.gov/applications/heattracker/) <https://ephtracking.cdc.gov/applications/heattracker/> provides regular updates on the rate of heat-related Emergency Department visits (organized by HHS regions) and observed temperature.


If you are a local organization planning to open a cooling shelter, consider referring to CDC guidance - PDF [↗](https://www.cdc.gov/climateandhealth/docs/useofcoolingcenters.pdf) <https://www.cdc.gov/climateandhealth/docs/useofcoolingcenters.pdf> on how to maintain a safe shelter during a heat wave.

Check out SAMHSA's Tips for People Who Take Medication: Coping with Hot Weather - PDF [↗](https://store.samhsa.gov/sites/default/files/pep23-01-01-001.pdf) <https://store.samhsa.gov/sites/default/files/pep23-01-01-001.pdf> for more information on how higher temperatures may impact your health if you are taking certain medications and steps to build resilience to climate impacts, as well as SAMHSA's Climate Change and Health Equity [↗](https://www.samhsa.gov/climate-change-health-equity) <https://www.samhsa.gov/climate-change-health-equity> site for more information on the behavioral health impacts of climate change, preparing for a disaster, and resources for disaster planning and climate change education.

## Clinical Best Practices

A heat stroke is a medical emergency, and rapid recognition and aggressive early treatment are essential to reduce morbidity and mortality (as illustrated below).



See <https://pubmed.ncbi.nlm.nih.gov/33856299/>  <https://pubmed.ncbi.nlm.nih.gov/33856299/> for the full algorithm.

OCCHE's Referral Guide <https://www.hhs.gov/climate-change-health-equity-environmental-justice/climate-change-health-equity/health-sector-resource-hub/referral-guide/index.html> summarizes resources that can address patients' social determinants of health and mitigate health harms related to climate change. These resources include social services and assistance programs to which patients can be referred, as well as references for anticipatory guidance and counseling to help patients prepare for potential hazards.

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# How High Are Household Energy Burdens?

**An Assessment of National and Metropolitan Energy Burden across the United States**

Ariel Dreihobl, Lauren Ross, and Roxana Ayala



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# Executive Summary



## KEY TAKEAWAYS

- New research based on data from 2017 finds that high energy burdens remain a persistent national challenge. Of all U.S. households, 25% (30.6 million) face a high energy burden (i.e., pay more than 6% of income on energy bills) and 13% (15.9 million) of U.S. households face a severe energy burden (i.e., pay more than 10% of income on energy).<sup>1</sup>
- Nationally, 67% (25.8 million) of low-income households ( $\leq$  200% of the federal poverty level [FPL]) face a high energy burden and 60% (15.4 million) of low-income households with a high energy burden face a severe energy burden.
- The East South Central Region (i.e., Alabama, Kentucky, Mississippi, and Tennessee) has the highest percentage of households with high energy burdens (38%) as compared to other regions.
- Black, Hispanic, Native American, and older adult households, as well as families residing in low-income multifamily housing, manufactured housing, and older buildings experience disproportionately high energy burdens nationally, regionally, and in metro areas.
- Weatherization can reduce low-income household energy burdens by about 25%, making it an effective strategy to reduce high energy burdens for households with high energy use while also benefiting the environment.
- Leading cities and states have begun to incorporate energy burden goals into strategies and plans and to create local policies and programs to achieve more equitable energy outcomes in their communities. They are pursuing these goals through increased investment in energy efficiency, weatherization, and renewable energy.

<sup>1</sup> Researchers estimate that housing costs should be no more than 30% of household income, and household energy costs should be no more than 20% of housing costs. This means that affordable household energy costs should be no more than 6% of total household income. For decades, researchers have used the thresholds of 6% as a high burden and 10% as a severe burden (APPRISE 2005). Note that high and severe energy burdens are not mutually exclusive. All severe energy burdens ( $> 10\%$ ) also fall into the high burden category ( $> 6\%$ ).

This report provides an updated snapshot of U.S. energy burdens (i.e., the percentage of household income spent on home energy bills) nationally, regionally, and in 25 select metro areas in the United States.<sup>1,2</sup> Both high and severe energy burdens are caused by physical, economic, social, and behavioral factors, and they impact physical and mental health, education, nutrition, job performance, and community development. Energy efficiency and weatherization can help address energy insecurity (i.e., the inability to adequately meet basic household heating, cooling, and energy needs over time) by improving building energy efficiency, reducing energy bills, and improving indoor air quality and comfort (Hernández 2016).

We recognize that the economic recession brought on by the global COVID-19 pandemic has greatly increased U.S. energy insecurity and also interrupted weatherization and energy efficiency programs nationally. While this report measures energy burdens using 2017 data from the American Housing Survey (AHS), we anticipate the recession will lead to a further increase in energy insecurity and higher energy burdens in 2020 and beyond.

## Methods

This study calculates energy burdens using the AHS, which includes a national and regional dataset as well as a dataset of 25 metropolitan statistical areas.<sup>4</sup> We calculate energy burdens across all households and in a variety of subgroups to identify those that spend disproportionately more of their income on energy bills than otherwise similar groups, analyzing across income, housing type, tenure status, race, ethnicity, and age of occupant and structure. We also calculate the percentage of households nationally, regionally, and in each select metro area that have high energy burdens (i.e., spend more than 6% of income on home energy bills) and severe energy burdens (i.e., spend more than 10% of income on home energy bills). We do not include households who do not directly pay for their energy bills.

## Energy Burden Findings

### NATIONAL ENERGY BURDENS

U.S. households spend an average of 3.1% of income on home energy bills. Figure ES1 presents our national energy burden findings by subgroup. We acknowledge

that many highly burdened groups are intersectional, meaning that they face compounding, intersecting causes of inequality and injustice, with energy burden representing one facet of inequity. The following are key national findings:

- Low-income households spend three times more of their income on energy costs compared to the median spending of non-low-income households (8.1% versus 2.3%).
- Low-income multifamily households spend 2.3 times more of their income on energy costs compared to the median spending of multifamily households (5.6% versus 2.4%).
- The median energy burden for Black households is 43% higher than for non-Hispanic white households (4.2% versus 2.9%), and the median energy burden for Hispanic households is 20% higher than that for non-Hispanic white households (3.5% versus 2.9%).
- The median renter energy burden is 13% higher than that of the median owner (3.4% versus 3.0%).
- More than 25% (30.6 million) of U.S. households experience a high energy burden, and about 50% (15.9 million) of households with a high energy burden face a severe energy burden.<sup>5</sup>
- Of low-income households ( $\leq$  200% FPL), 67% (25.8 million) experience a high energy burden, and 60% (15.4 million) of those households with a high energy burden face a severe energy burden.
- Low-income households, Black, Hispanic, Native American, renters, and older adult households all have disproportionately higher energy burdens than the national median household.

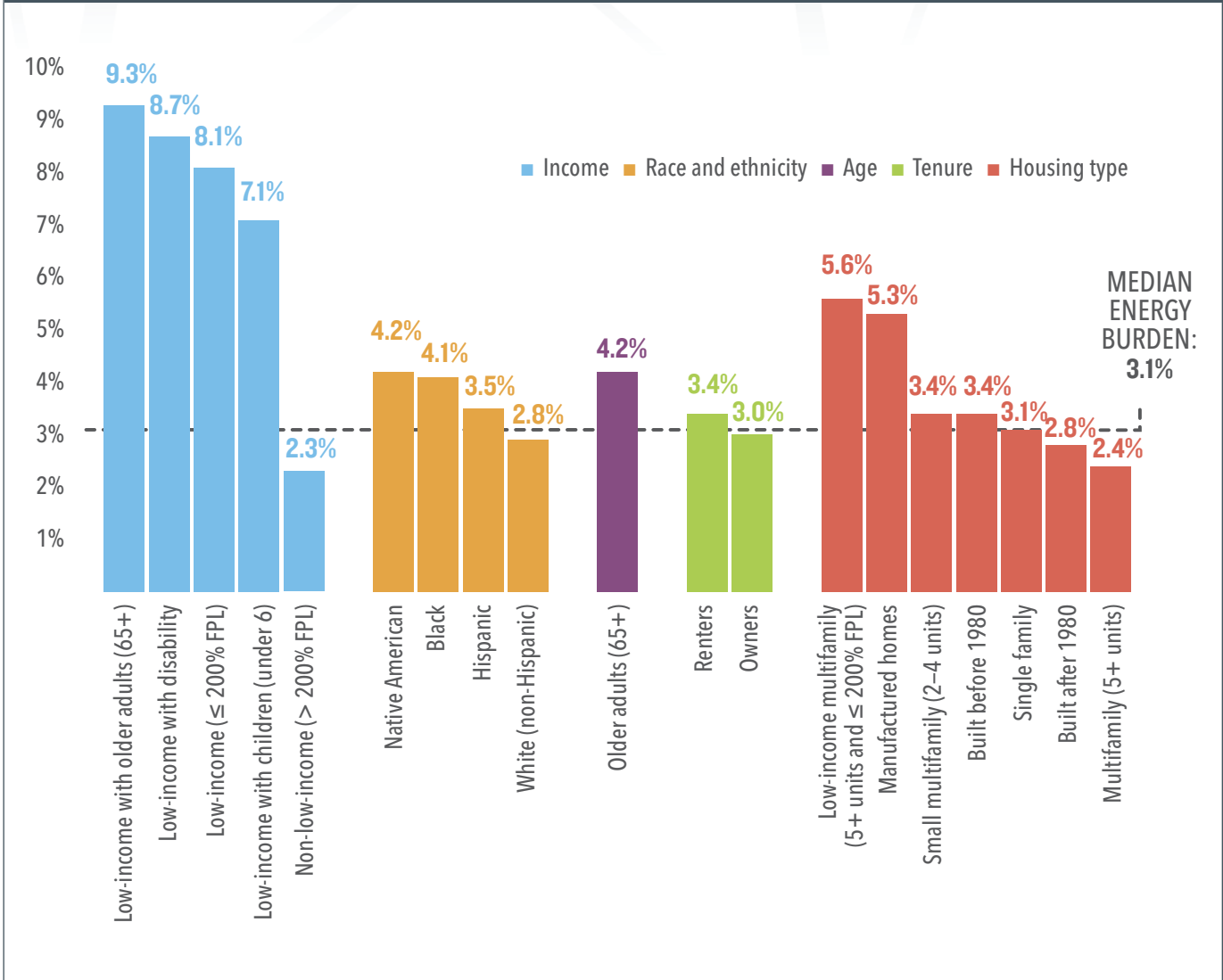
<sup>2</sup> This study focuses on home energy burden and includes electricity and heating fuels. Note that the study does not include transportation, water, or telecommunication cost burdens in its energy burden calculations.

<sup>3</sup> This report provides an update to ACEEE's previous energy burden research. Dreihobl and Ross (2016) analyzed 2011 and 2013 American Housing Survey (AHS) data, and Ross, Dreihobl, and Stickles (2018) analyzed 2015 AHS data. This report analyzes 2017 AHS data, the most recent data available as of publication.

<sup>4</sup> We include the 25 metropolitan statistical areas (MSAs) sampled for the 2017 AHS: Atlanta, Baltimore, Birmingham, Boston, Chicago, Dallas, Detroit, Houston, Las Vegas, Los Angeles, Miami, Minneapolis, New York City, Oklahoma City, Philadelphia, Phoenix, Richmond, Riverside, Rochester, San Antonio, San Francisco, San Jose, Seattle, Tampa, and Washington, DC.

<sup>5</sup> Note that high and severe energy burdens are not mutually exclusive. All severe energy burdens ( $>$  10%) also fall into the high burden category ( $>$  6%).

**FIGURE ES1. National energy burdens across subgroups (i.e., income, race and ethnicity, age, tenure, and housing type) compared to the national median energy burden**



## REGIONAL ENERGY BURDENS

We find that the national trends hold true across the nine census regions. The following are our key regional findings:

- Across all nine regions, low-income household energy burdens are 2.1-3 times higher than the median energy burden.
- The East South Central region (i.e., *Alabama, Kentucky, Mississippi, Tennessee*) has the greatest percentage of households (38%) with high energy burdens, followed by East North Central (i.e., *Illinois, Indiana, Michigan, Ohio, Wisconsin*), New England (*Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont*), and Middle Atlantic regions (i.e., *New Jersey, New York, Pennsylvania*) (all 29%).
- The gap between low-income and median energy burdens is largest in the New England, Pacific (i.e., *Alaska, California, Hawaii, Oregon, Washington*), and Middle Atlantic regions.
- The South Atlantic region (i.e., *Delaware, DC, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia*) had the greatest number of households (6.3 million) with high burdens, followed by the East North Central (5.4 million) and Middle Atlantic (4.6 million) regions.

## METRO AREA ENERGY BURDENS

National and regional patterns are mirrored in cities. The following are our key metropolitan area findings:

- Low-income households experience energy burdens at least two times higher than that of the average household in each metropolitan area included in the study.<sup>6</sup>
- Black and Hispanic households experience higher energy burdens than non-Hispanic white households; renters experience higher energy burdens than owners; and people living in buildings built before 1980 experience higher energy burdens than people living in buildings built after 1980 across all metro areas in the study.
- Six metro areas have a greater percentage of households with a high energy burden than the national average (25%), including Birmingham (34%), Detroit (30%), Riverside (29%), Rochester (29%), Atlanta (28%), and Philadelphia (26%).

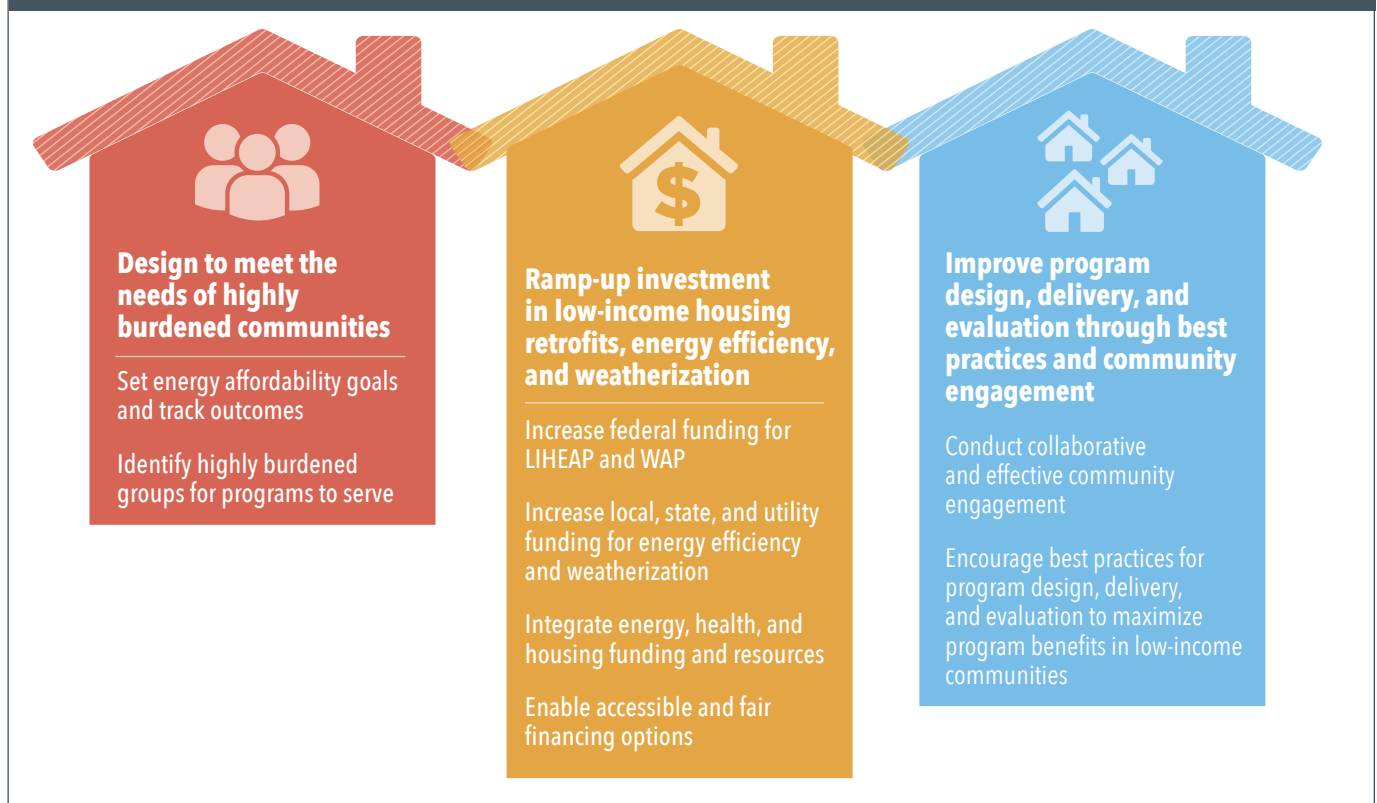
- In five metro areas—Baltimore, Philadelphia, Detroit, Boston, and Birmingham—at least one-quarter of low-income households have energy burdens above 18%, which is three times the high energy burden threshold of 6%.

See the body of the report for additional images, maps, charts, and data on energy burden calculations nationally, regionally, and in metro areas.

## Strategies to Accelerate, Improve, and Better Target Low-Income Housing Retrofits and Weatherization

Clean energy investments—such as energy efficiency, weatherization, and renewable energy—can provide a long-term, high-impact solution to lowering high energy burdens. By investing in energy efficiency and weatherization first or alongside renewable energy technologies, these measures can reduce whole-home energy use to maximize the costs and benefits of

**FIGURE ES2. Strategies to improve and expand low-income energy efficiency and weatherization programs**



<sup>6</sup> We define the “average household” energy burden as the median across all households in the sample (i.e., in each MSA).

**Based on prior evidence of how weatherization reduces average customer bills, we estimate that it can reduce low-income household energy burden by 25%.**

additional renewable energy generation. This report focuses on weatherization and energy efficiency as long-term solutions to reducing high energy burdens; these solutions can be combined with renewable energy investments and/or electrification strategies that reduce energy bills for additional impact. Based on prior evidence of how weatherization reduces average customer bills, we estimate that it can reduce low-income household energy burden by 25%.<sup>7</sup>

To ensure that more low-income and highly energy burdened households receive much-needed energy efficiency and weatherization investments, we recommend that policymakers and program implementers design policies and programs to meet the needs of highly burdened communities and set up processes for evaluation and accountability processes. This involves engaging with community members from the start, increasing funding for low-income weatherization and energy efficiency, and integrating best practices into program design and implementation. Figure ES2 depicts this actionable framework. For more information about these strategies, see the full report.

## Conclusions and Next Steps

Energy affordability remains a national crisis, with low-income households, communities of color, renters, and older adults experiencing disproportionately higher energy burdens than the average household nationally, regionally, and in metro areas. This study finds that each MSA has both similar and unique energy affordability inequities. Further research can help better understand the intersectional drivers of high energy burdens and the policies best suited to improve local energy affordability. Climate change and the global pandemic also underscore the urgency in addressing high household energy burdens. As temperatures continue to rise and heat waves become more common, access to clean, affordable energy is needed more than ever to prevent indoor heat-related illnesses and deaths.

Cities, states, and utilities are well positioned to build on this research and conduct more targeted and detailed energy burden analyses, such as the Pennsylvania Public Utility Commission's study on home energy affordability for low-income customers. Studying energy burden and more broadly analyzing energy insecurity factors are first steps toward setting more targeted energy burden reduction goals and creating policies and programs that lead to more vibrant and prosperous communities.

<sup>7</sup> We assume 25% savings from energy efficiency upgrades based on the U.S. Department of Energy's estimate (DOE 2014) and use the median low-income household values to calculate a 25% reduction. We reduced the median low-income energy bill by 25% from \$1,464 to \$1,098. Using the median low-income household income of \$18,000, this equates to a reduced energy burden of 6.1%. Reducing the median low-income energy burden from 8.1% to 6.1% is a 25% reduction.

# Introduction



**E**nergy insecurity—that is, the inability to adequately meet basic household heating, cooling, and energy needs over time (Hernández 2016)—is increasingly viewed as a major equity issue by policymakers, energy utilities, and clean energy and environmental justice advocates. This multidimensional problem reflects the confluence of three factors: inefficient housing and appliances, lack of access to economic resources, and coping strategies that may lead some residents to dangerously under-heat or under-cool their homes (Hernández, Aratani, and Jiang 2014).

Household energy burden—the percentage of annual household income spent on annual energy bills—is one key element contributing to a household’s energy insecurity. Energy burden as a metric helps us visualize energy affordability (i.e., the ability to afford one’s energy bills); identify which groups shoulder disproportionately higher burdens than others; and recognize which groups most need targeted energy-affordability- and energy-justice-related policies and investments to reduce high energy burdens. Three strategies can reduce both energy insecurity and high energy burdens: increasing household income, increasing bill payment assistance through government or utility resources, and reducing household energy use. This study discusses policy considerations that focus on the third solution of reducing excess energy use to lower high household energy burdens.

This report provides a snapshot of energy burdens nationally and in 25 of the largest U.S. metro areas. We examine median household energy burdens among

groups—varying by income, housing type and age, and tenure status—as well as the percentage of households experiencing high (> 6%) and severe (> 10%) energy burdens nationally, in metro areas, and across groups (APPRISE 2005). Building on ACEEE’s 2016 urban energy burden study and 2018 rural energy burden study (Drehobl and Ross 2016; Ross, Drehobl, and Stickles 2018), this report analyzes national-, regional-, and metro-level data from the U.S. Census Bureau’s most recent American Housing Survey (AHS) conducted in 2017.

Local policymakers, utilities, and advocates can use this report’s data and policy recommendations to better understand both which groups tend to have disproportionately higher energy burdens and how they can measure these burdens in their communities. The subsequent policy recommendations focus on low-income energy efficiency and weatherization as high-impact strategies to alleviate high energy burdens and improve overall energy affordability.

# Background



## Systemic Patterns and Causes of Inequities

Household access to energy is central to maintaining health and well-being, yet one in three U.S. households reported difficulty paying their energy bills in 2015 (EIA 2018). Black, Indigenous, and People of Color (BIPOC) communities often experience the highest energy burdens when compared to more affluent or white households (Kontokosta, Reina, and Bonczak 2019; Drehobl and Ross 2016; Hernández et al. 2016).<sup>8</sup> These communities often experience racial segregation, high unemployment, high poverty rates, poor housing conditions, high rates of certain health conditions, lower educational opportunity, and barriers to accessing financing and investment (Jargowsky 2015; Cashin 2005). Many of these characteristics are due in part to systemic racial discrimination, which has led to long-standing patterns of disenfranchisement from income and wealth-building opportunities for BIPOC communities as compared to white communities (Rothstein 2017).

<sup>8</sup> We use the term BIPOC in this report to describe communities that experience especially acute systemic inequities, barriers, and limited access to energy programs. By specifically naming Black and Indigenous (Native American) communities, the term BIPOC recognizes that Black and Indigenous people have historically experienced targeted policies of systemic economic exclusion, classism, and racism in the United States. It is important to recognize this history and how it has led to disproportionately high energy burdens and unique barriers to accessing clean energy technologies and investments.

Policies and practices that have led to economic and/or social exclusion in BIPOC communities include neighborhood segregation and redlining, lack of access to mortgages and other loans, mass incarceration, employment discrimination, and the legacy of segregated and underfunded schools (Jargowsky 2015; McCarty, Perl, and Jones 2019).<sup>9</sup> These types of systemic exclusions, underinvestments, discriminative lending practices, and limited housing choices have also limited BIPOC communities' access to efficient and healthy housing (Lewis, Hernández, and Geronimus 2019). In addition, Black communities are 68% more likely to live within 30 miles of a coal-fired power plant, and properties in close proximity to toxic facilities average 15% lower property values than those in other areas (National Research Council 2010). Black children are three times as likely to be admitted to the hospital for asthma attacks than white children (Patterson et al. 2014). According to a study by the American Association of Blacks in Energy, while Black households spent \$41 billion on energy in 2009, they held only 1.1% of energy jobs and gained only 0.01% of the revenue from energy-sector profits (Patterson et al. 2014).

## Limited Access to Energy Programs

A growing body of research shows that BIPOC and low-income communities experience disparate access to residential energy-saving appliances and other energy efficiency upgrades. While low-income and communities of color on average consume less energy than wealthier households, they are more likely to live in less-efficient housing (Bednar, Reames, and Keoleian 2017). Researchers found that, when holding income constant, BIPOC households experience higher energy burdens than non-Hispanic white households (Kontokosta, Reina, and Bonczak 2019). BIPOC and low-income communities also may experience higher costs when investing in energy-efficient upgrades. For example, a study based in Detroit found that energy-efficient lightbulbs were less available in high-poverty areas and smaller stores, and when they were available, they were more expensive than in other areas (Reames, Reiner, and Stacey 2018).

Others have found that untargeted utility-administered energy efficiency programs do not effectively reach BIPOC and low-income communities—particularly those living in multifamily buildings (Frank and Nowak 2016; Samarripas and York 2019). Low-income communities face economic, social, health and safety, and information barriers that impact their ability to access programs, and many programs fail to address these barriers through specific targeting practices. Limited access to energy

**Systemic exclusions, under-investments, discriminative lending practices, and limited housing choices have limited Black, Indigenous, and People of Color communities' access to efficient and healthy housing.**

efficiency resources and investments coupled with lower incomes increase the proportion of income that low-income and BIPOC households spend on energy bills (Jessel, Sawyer, and Hernández 2019; Berry, Hronis, and Woodward 2018).

Where utilities do administer programs targeted at low-income customers, participant needs far exceed available resources. Reames, Stacy, and Zimmerman (2019) found that 11 large investor-owned utilities across six states have distributional disparities in low-income investments; that is, they do not spend energy efficiency dollars proportionally on programs designed to reach low-income populations. A 2018 report found that only 6% of all U.S. energy efficiency spending in 2015 was dedicated to low-income programs (EDF APPRISE 2018). Most states require that utility energy efficiency program portfolios be cost effective, often using tests that focus mostly on direct economic costs to the utility (Woolf et al. 2017; Hayes, Kubes, and Gerbode 2020). This requirement places an additional burden on utilities, states, and local governments that invest in programs that serve low-income communities because it does not account for nonenergy and additional health, economic, and community benefits in program planning and evaluations.

## Definition and Drivers of High Energy Burdens

*High energy burdens* are often defined as greater than 6% of income, while *severe energy burdens* are those greater than 10% of income (APPRISE 2005).<sup>10</sup> Past research found that low-income, Black, and Hispanic communities, as well as older adults, renters, and those residing in low-income multifamily buildings experienced disproportionately higher energy burdens than other households (Drehobl and Ross 2016; Ross, Drehobl, and Stickles 2018).

<sup>9</sup> *Redlining* is the discriminatory practice of fencing off areas in which banks would avoid investments based on community demographics. Redlining was included in local, state, and federal housing policies for much of the 20th century. For more information on historical forms of economic and social exclusion, see *The Color of Law: A Forgotten History of How Our Government Segregated America* by Richard Rothstein.

<sup>10</sup> Researchers estimate that housing costs should be no more than 30% of household income, and household energy costs should be no more than 20% of housing costs. This means that affordable household energy costs should be no more than 6% of total household income.

**TABLE 1. Key drivers of high household energy burdens**

<b>Drivers</b>	<b>Examples of factors that affect energy burden</b>
<b>Physical</b>	Housing age (i.e., older homes are often less energy efficient)
	Housing type (e.g., manufactured homes, single family, and multifamily)
	Heating and cooling system (e.g., system type, fuel type, and fuel cost)
	Building envelope (e.g., poor insulation, leaky roofs, inefficient and/or poorly maintained poorly maintained heating and cooling systems (HVAC), and/or inadequate air sealing)
	Appliances and lighting efficiency (e.g., large-scale appliances such as refrigerators, washing machines, and dishwashers)
	Topography and location (e.g., climate, urban heat islands)
	Climate change and weather extremes that raise the need for heating and cooling
<b>Socioeconomic</b>	Chronic economic hardship due to persistent low income
	Sudden economic hardship (e.g., severe illness, unemployment, or disaster event)
	Inability to afford (or difficulty affording) up-front costs of energy efficiency investments
	Difficulty qualifying for credit or financing options to make efficiency investments due to financial and other systemic barriers
	Systemic inequalities relating to race and/or ethnicity, income, disability, and other factors
<b>Behavioral</b>	Information barriers relating to available bill assistance and energy efficiency programs and relating to knowledge of energy conservation measures
	Lack of trust and/or uncertainty about investments and/or savings
	Lack of cultural competence in outreach and education programs
	Increased energy use due to occupant age, number of people in the household, health-related needs, or disability
<b>Policy-related</b>	Insufficient or inaccessible policies and programs for bill assistance, energy efficiency, and weatherization for low-income households
	Utility rate design practices, such as high customer fixed charges, that limit customers' ability to respond to high bills through energy efficiency or conservation

Source: Updated from Ross, Drehobl, and Stickles 2018

Drivers of high household energy burdens are often the result of the systemic factors, barriers, and challenges that these households face. Previous research identified drivers that can raise energy burdens, including the dwelling's physical structure, the resident's socioeconomic status and behavioral patterns, and the availability of policy-related resources (Drehobl and Ross 2016; Ross, Drehobl, and Stickles 2018). Table 1 shows an updated list of key drivers of high energy burdens.

### **ENERGY INEFFICIENCY AS A DRIVER OF HIGH ENERGY BURDENS**

While low incomes are a substantial factor driving higher energy burdens, inefficient housing is also a

contributor. According to the 2017 AHS data, 9% of total U.S. households completed an energy-efficient improvement in the past two years, but only 17% were low-income households (Census Bureau 2019). Low-income households ( $\leq 200\%$  of the federal poverty level [FPL]) make up about 30% of the population, which means that they are underrepresented in households completing energy efficiency upgrades and thus are not proportionally accessing and benefiting from these investments.

Additional research examining energy benchmarking data in a few major cities has found that households from both the lowest- and highest-income brackets had the highest *energy use intensity* (EUI)—that is, they had

the highest energy consumption per square foot. While consumption behaviors are regarded as the driver for high EUI among higher-income households, the researchers point to inefficient heating and lighting infrastructure to help explain the high EUI among low-income households (Kontokosta, Reina, and Bonczak 2019). High-income households use large amounts of energy to power larger homes—as well as more electronics and devices that use large amounts of energy—while low-income households tend to use fewer, less-efficient devices that require relatively large amounts of energy due to the inefficiency of the dwelling or the appliance itself. Therefore, household inefficiencies rather than inefficient behaviors tend to lead to higher energy use and expenditures for low-income households. Generally, energy efficiency investments can allow households to engage in the same activity while using less energy, thus reducing high energy burdens and improving comfort, health, and safety.

## Adverse Effects of High Energy Burdens

Our comprehensive evaluation of energy burden research reveals both that low-income households spend, on average, a higher portion of their income on energy bills than other groups, and that energy burdens are also higher for communities of color, rural communities, families with children, and older adults (Brown et al. 2020; Lewis, Hernández, and Geronimus 2019; Reames 2016; Hernández et al. 2016; Drehobl and Ross 2016; Ross, Drehobl, and Stickles 2018). Energy burden is one indicator to measure energy insecurity, and high energy burdens are associated with inadequate housing conditions and have been found to affect physical and mental health, nutrition, and local economic development.

### EXCESSIVE ENERGY COST CAN IMPACT RESIDENTS' HEALTH AND COMFORT.

Researchers have found that many households with high energy burdens also live in older, inefficient, and unhealthy housing. Inefficient housing is associated with other health impacts, such as carbon monoxide poisoning, lead exposure, thermal discomfort, and respiratory problems such as asthma and chronic obstructive pulmonary disease (COPD); it is also associated with the potential for hypothermia and/or heat stress resulting from leaky and/or unrepaired heating and cooling equipment (Brown et al. 2020; Norton, Brown, and Malomo-Paris 2017).

Households experiencing energy insecurity may forego needed energy use to reduce energy bills, forcing them to live in uncomfortable and unsafe homes. Hernández, Phillips, and Siegel (2016) found that half of the study's participants who experienced high monthly utility bills engaged in coping strategies such as using secondary heating equipment (i.e., stoves, ovens, or space heaters) to compensate for inefficient or inadequate heating systems. Employing this coping measure can compromise resident safety and comfort, and it may increase exposure to toxic gases. Teller-Elsberg et al. (2015) found that excess winter deaths potentially caused by fuel poverty kill more Vermonters each year than car crashes. In addition, according to the Residential Energy Consumption Survey, one in five U.S. households reported reducing or forgoing necessities such as food or medicine to pay an energy bill (EIA 2018). These tradeoffs can impact long-term health and well-being.

Climate change, rising temperatures, and subsequent cooling demands will continue to exacerbate household energy burdens—and prove deadly for some. In Maricopa County, Arizona—one of the hottest regions in the southwest—more than 90% of residents have access to a cooling system, yet up to 40% of heat-related deaths occur indoors (Maricopa County Department of Public Health 2020). A recent survey of homebound individuals found that one-third faced limitations on home cooling system use, with the overwhelming majority (81%) citing the “cost of bills” as a contributing factor (Maricopa County Department of Public Health 2016). As residents are increasingly forced to weigh the cost of properly cooling their homes, high energy burdens will likely become an even greater public health priority in the years to come.

### HIGH ENERGY BURDENS IMPACT MENTAL HEALTH OF RESIDENTS.

High energy burdens can have mental health impacts—such as chronic stress, anxiety, and depression—associated with fear and uncertainty around access to energy, the complexities of navigating energy assistance programs, and the inability to control energy costs (Hernández, Phillip, and Siegel 2016). In addition, Hernández (2016) found that low-income residents who were experiencing energy insecurity worried about losing their parental rights as they struggled to maintain essential energy services, such as lighting, in their homes.

## **HIGH ENERGY BURDENS CAN LIMIT INDIVIDUALS' ABILITY TO BENEFIT FROM ECONOMIC DEVELOPMENT IN THEIR COMMUNITIES.**

Households with high energy burdens are more likely to stay caught in cycles of poverty. After controlling for common predictors of poverty status such as income loss, illness, health, marital status, education, health insurance, and head of households—Bohr and McCreery (2019) found that, on average, energy-burdened households have a 175–200% chance of remaining in poverty for a longer period of time compared to nonenergy-burdened households.<sup>11</sup> BIPOC communities, older adults, and low-income households often experience this pernicious cycle, which includes persistent income inequality along with limited funding to invest in education or job training, and high energy burdens can perpetuate this cycle (Bohr and McCreery 2019; Lewis, Hernández, and Geronimus 2019).

### **Impact of COVID-19 on Energy Insecurity**

As the world enters a global recession in the wake of the coronavirus pandemic, more households—especially in BIPOC communities—may have difficulty paying their energy bills due to massive job losses; reduced income; a warming climate; and higher energy bills resulting from more time at home due to stay-at-home orders and to students and adults learning and working from home, respectively. For example, in March and April 2020, the California Public Utility Commission stated that residential electricity usage increased by 15–20% compared to the previous year (CPUC 2020). Because such factors lead to higher home energy bills, energy burdens will increase for households across the United States.

**Households with high energy burdens are more likely to stay caught in cycles of poverty.**

COVID-19 disproportionately impacts BIPOC communities due to many of the policies that have led to systemic economic and social exclusion. These policies have led to BIPOC communities experiencing higher rates of underlying health conditions, a lack of health insurance or access to testing, and a higher likelihood of working in the service industry or in other essential worker roles that do not allow for teleworking (SAMHSA 2020; CDC 2020). COVID-19 has also impacted the ability of energy efficiency and weatherization programs to operate, and limited the mix of measures that can be installed; many energy efficiency and weatherization programs have slowed down or are on hold (Ferris 2020). Policies and programs that address energy insecurity are even more important now in the face of rising energy bills and burdens.

Given these factors, energy burdens in 2020 are likely to be much higher than the burdens we calculate in this report, which uses 2017 data. The economic situation has clearly shifted drastically since 2017. While we expect post-2020 burden trends to be similar, yet more acute, we cannot visualize the full extent of current and future energy burdens until the release of post-2020 data in the 2023 AHS, which will include data from 2021.

<sup>11</sup> This study does not examine the relationship between energy burden and rent burden (i.e., the percentage of income spent on housing costs). Studies have found that rent burdens are also increasing, especially for communities of color, older adults, and families (Currier et al. 2018).

# Methods



This analysis builds on the methods used in ACEEE’s previous two energy burden studies, *Lifting the High Energy Burden in American’s Largest Cities* (Drehobl and Ross 2016) and *The High Cost of Energy in Rural America* (Ross, Drehobl, and Stickles 2018). This new study analyzes 2017 data from AHS, which is issued by the U.S. Department of Housing and Urban Development (HUD). The AHS is a biennial household-level survey by the Census Bureau that collects wide-range housing and demographic data from a nationally and regionally representative cross section of households across the United States and in a subset of metropolitan statistical areas (MSAs). The AHS includes household-level income data and energy cost data that we use as the basis of our energy burden calculations. The AHS models its energy cost data based on household characteristics ascertained through its survey and also uses data collected through the Residential Energy Consumption Survey (RECS) for a different national set of households.<sup>12</sup>

As we noted earlier, we define households with high energy burdens as those spending more than 6% of their income on electricity and heating fuel costs, and households with severe energy burdens as those

spending more than 10% of their income on energy costs.<sup>13</sup> These two categories are not mutually exclusive; *severe burden* is a worse-off subset of high burden households.

<sup>12</sup> Beginning with the 2015 edition, the AHS stopped including questions on energy costs. Previously, the majority of these data was self-reported. As part of the 2015 AHS redesign, researchers began estimating energy costs through regression-model-based imputation. They created the utility estimation system (UES) to estimate annual energy costs using regression models developed from the RECS, which collects administrative data from suppliers on actual billing amounts. This estimate was divided by 12 to calculate average monthly energy costs. The RECS also collects some housing characteristics similar to those the AHS collects, which allows the construction of models that can then be applied to the AHS. For more on the energy cost estimation model development and decisions for the 2015 AHS, see [www.huduser.gov/portal/sites/default/files/pdf/American-Housing-Survey.pdf](http://www.huduser.gov/portal/sites/default/files/pdf/American-Housing-Survey.pdf).

<sup>13</sup> HUD determines affordable housing costs to be 30% of total household income. Researchers have determined that, typically, 20% of total housing expenses are energy costs. This equates to 6% of total income spent on energy bills as an affordable level (Fisher Sheehan & Colton 2020). We consider energy burdens above 6% to be high burdens, with burdens above 10% to be severe. This method is in line with other research (APPRISE 2005).

The following are our study's inclusion and exclusion criteria:

- *Electricity and heating fuels.* The study does not include water, transportation, telecommunications, or Internet costs. Although such costs can create additional monetary burdens for households, we include only electricity and heating fuel costs in our energy burden calculations.
- *Households must report household income and the amount they pay for their electricity and their main heating fuel.*<sup>14</sup> If households did not include all three factors, we did not include them in our analysis.

We examine energy burdens for a variety of household subsets at the national, regional, and metropolitan levels, including the following:

- *Income level.* All households that fall into low-income ( $\leq 200\%$  FPL) and non-low-income ( $> 200\%$  FPL) categories.<sup>15</sup>
- *Low-income households with vulnerable persons at home.* Low-income households with a household member over the age of 65, under the age of 6, or who has a disability.
- *Housing type and age.* Single-family, small multifamily (two to four units), large multifamily (five or more units), low-income multifamily (five or more units and  $\leq 200\%$  FPL), manufactured housing, buildings built before 1980, and buildings built after 1980.<sup>16</sup>
- *Tenure:* Renters and owners.
- *Race and ethnicity.* Black, Hispanic, and non-Hispanic white households. We also include Native American households in the national analysis.
- *Age.* Households with one or more adults over the age of 65.

## Limitations

We included 48 MSAs in our last urban energy burden report, which used both 2011 and 2013 AHS data. This report uses only 2017 data, which limits our sample to 25 MSAs (AHS 2019). AHS includes modeled energy costs, which are determined by matching characteristics of households in the AHS to characteristics of households in the RECS. We also exclude households that do not report income, do not have a heating source, or do not pay for their heating costs. Thus, our report findings do not include data on renters who pay for their heating and/or electricity in their rent, or households with no annual income reported.

Our study does not explore causality, so we cannot determine *why* energy burdens differ across metro areas and demographic and other groups. Additional research is needed to determine the causes of disproportionate energy burdens, which can include building efficiency, income and poverty rates, and other timely economic factors. We are unable to compare trends across our energy burden reports, as this study does not explore *why* and *how* energy burdens may have changed over time.

Finally, our study includes only the 25 metro areas sampled by the AHS, which are not necessarily the best or worst performing metro areas regarding energy burdens. Ranking metro areas is thus limited since this is only a partial sample of cities. ACEEE plans to update this research with additional metro areas as more AHS data are available in the fall of 2020.

The following are the 25 MSAs with representative samples in the 2017 AHS dataset:

1. Atlanta	6. Dallas	11. Miami	16. Phoenix	21. San Francisco
2. Baltimore	7. Detroit	12. Minneapolis	17. Richmond	22. San Jose
3. Birmingham	8. Houston	13. New York City	18. Riverside	23. Seattle
4. Boston	9. Las Vegas	14. Oklahoma City	19. Rochester	24. Tampa
5. Chicago	10. Los Angeles	15. Philadelphia	20. San Antonio	25. Washington, DC

<sup>14</sup> AHS calculates household income as total money before taxes and other payments, including Social Security income, cash public assistance, or welfare payments from the state or local welfare office, retirement, survivor or disability benefits, and other sources of income such as veterans' payments, unemployment and/or worker's compensation, child support, and alimony. For more information, see: [www2.census.gov/programs-surveys/ahs/2017/2017%20AHS%20Definitions.pdf](http://www2.census.gov/programs-surveys/ahs/2017/2017%20AHS%20Definitions.pdf).

<sup>15</sup> In ACEEE's 2016 urban energy burden report, we defined low-income as 80% of the area median income (AMI), while this report defines low-income as 200% FPL. We made this change due to data availability. The 200% FPL definition also lines up with the Weatherization Assistance Program and is the most common qualification criterion for utility-led low-income programs. Because of this, low-income data in the 2016 and 2020 reports do not use the same definitions and are therefore not directly comparable.

<sup>16</sup> We chose 1980 as our cutoff point as states and cities began adopting the first building energy codes in the late 1970s and early 1980s. At this time, builders around the country began to consider energy and minimal energy efficiency measures due to increasing awareness of efficiency measures and concerns about energy as a result of the energy-related economic shocks of the 1970s.

# Energy Burden Findings



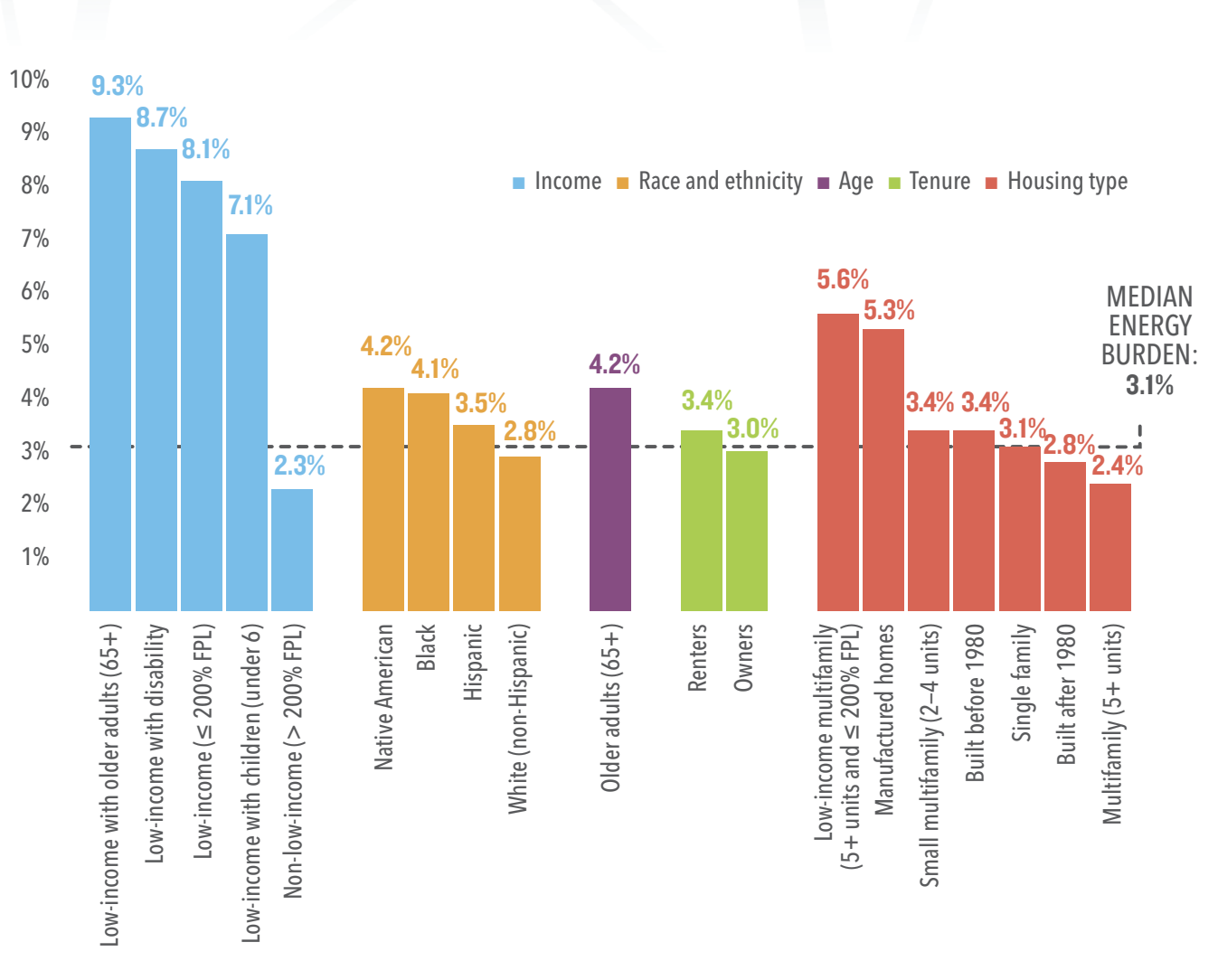
The results of this energy burden analysis reflect previous ACEEE studies in finding that nationally, regionally, and across all 25 metro areas, particular groups experience disproportionately high energy burdens. See **Appendices A** and **B** for tables including national, regional, and metro energy burden data.

## National Energy Burdens

Across the nationally representative sample, we find that low-income, Black, Hispanic, renter, and older adult households have disproportionately higher energy burdens than the average household. Figure 1 shows the median energy burden for different groups nationally,

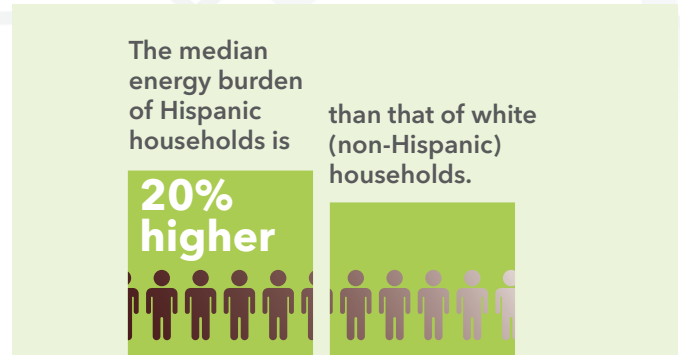
across categories of income, race and ethnicity, age, tenure status, and housing type. We find that the median national energy burden is 3.1%, and that the median low-income ( $\leq 200\%$  FPL) household energy burden is 3.5 times higher than the non-low-income household energy burden (8.1% versus 2.3%).

**FIGURE 1. National energy burdens across subgroups (i.e., income, race and ethnicity, age, tenure, and housing type) compared to the national median energy burden**





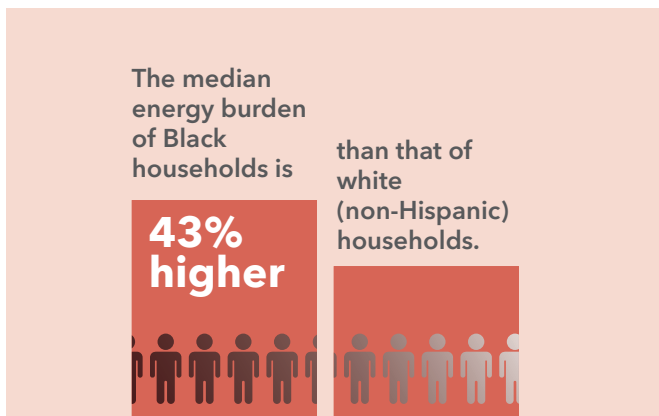
Many groups experience disproportionately high energy burdens, with low-income households having the highest energy burdens. These households have limited discretionary income and often have older, less-efficient housing stock and appliances that lead to higher energy bills. Even for cases in which monthly energy costs are similar between low-income and non-low-income households, the former devote a greater proportion of their income to these costs. Given this, reducing excess energy use in low-income households is critical for addressing energy insecurity.



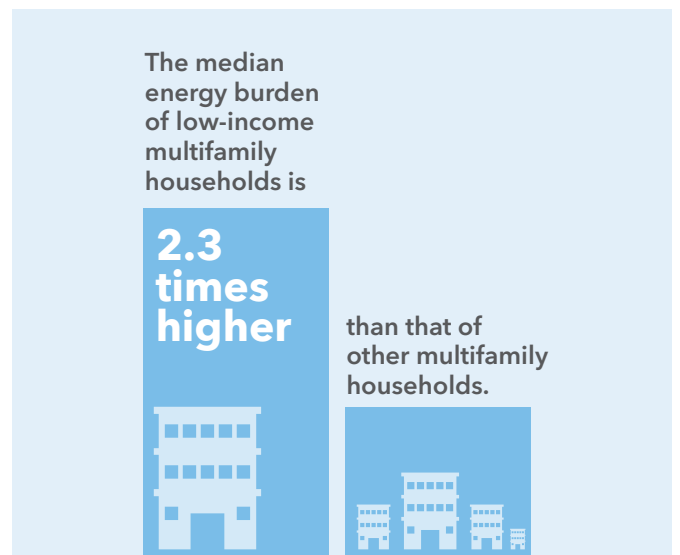
**NATIONAL DATA: HIGH AND SEVERE ENERGY BURDENS**

Median energy burdens allow us to compare burdens between groups, yet they do not illustrate how many people experience the impacts of energy insecurity, or the degrees to which they experience it. We therefore also calculate the percentage of households that experience high and severe energy burdens for different demographic groups. Figure 2 shows the percentage of households across subgroups that experience a high energy burden (above 6%), along with the total number of households experiencing a high energy burden. Figure 2 also indicates the percentage of those households that experience a severe energy burden (above 10%).

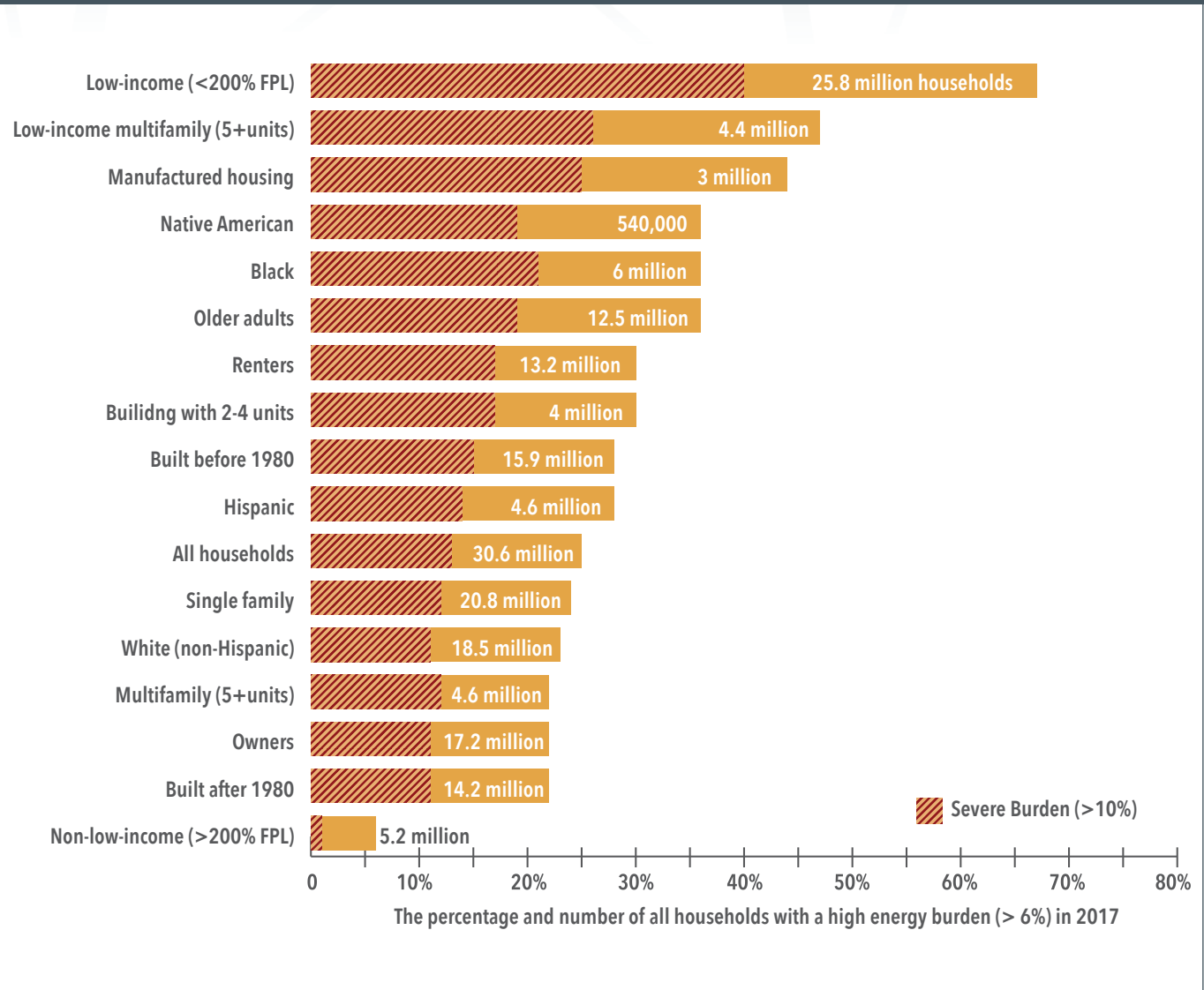
Nationally, more than 25% (30.6 million) of all households experience a high energy burden, and about 50% (15.9 million) of all households that experience a high energy burden have a severe energy burden. These burdens are even more acute for low-income households, of which 67% (25.8 million) experience a high energy burden and 60% (15.4 million) of those experience a severe energy burden. **Appendix B** includes high and severe energy burden percentages and total households that experience a high and severe



We also recognize that many highly burdened groups are intersectional—that is, they face compounding, intersecting causes of inequality and injustice. For example, nearly half of the older adult population in general is economically vulnerable, as are the majority of older Black and Hispanic households (Cooper and Gould 2013). Policies and programs that focus on addressing low-income household energy burdens will likely intersect with other highly burdened groups. Further research can help identify how high energy burdens are impacted by differences in race, ethnicity, income, education, housing type, occupant age, and other factors.



**FIGURE 2. The percentage and number of households nationally with a high energy burden (> 6%) across different subgroups in 2017**



Note: High and severe energy burdens are not mutually exclusive, meaning that the number of households experiencing a severe burden are also counted in the percentage that experience high burdens. All severe energy burdens (> 10%) also fall into the high burden category (> 6%). The red and orange bars in figure 2 sum to the total high energy burdened households, and the number of households is the total that experience a high energy burden.

burden nationally, regionally, and in each MSA across all households and across low-income, Black, Hispanic, older adult, and renting households.

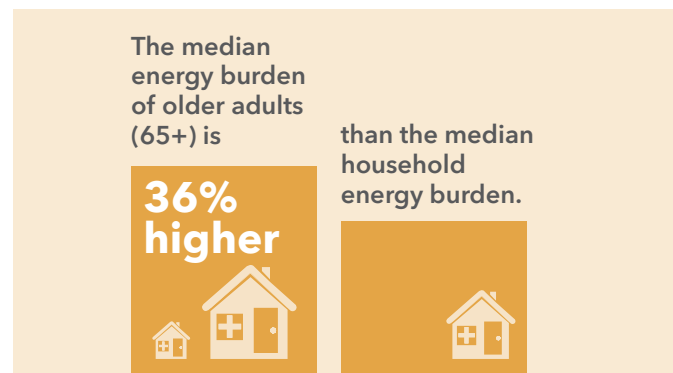
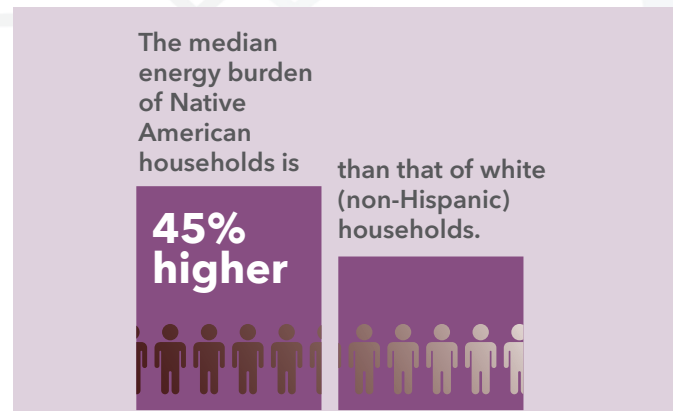
As figure 2 illustrates, U.S. residents experience high and severe energy burdens at different rates depending on factors such as income, occupant age, race, and tenure. Almost 50% of low-income multifamily residents; 36% of Black, Native American, and older adult households; 30% of renters; and 28% of Hispanic households experience a high energy burden.

Many households also have severe energy burdens, spending more than 10% of their income on energy. For example, 21% of Black households experience severe energy burdens as compared to 1% of non-low-income and 9% of non-Hispanic white households. For context, households with severe energy burdens spend at least three times more of their income on home energy bills than the median household.

## Regional Energy Burdens

National patterns play out across all regions, where low-income, Black, and Hispanic households; renters; manufactured housing residents; and older adults all have disproportionately higher energy burdens than each region's average household. Table 2 shows the states in each census region in the study.

Across all nine regions, low-income household energy burdens are 2.1-3 times higher than the median energy burden. The gap between low-income and median energy burdens is largest in the New England, Pacific,

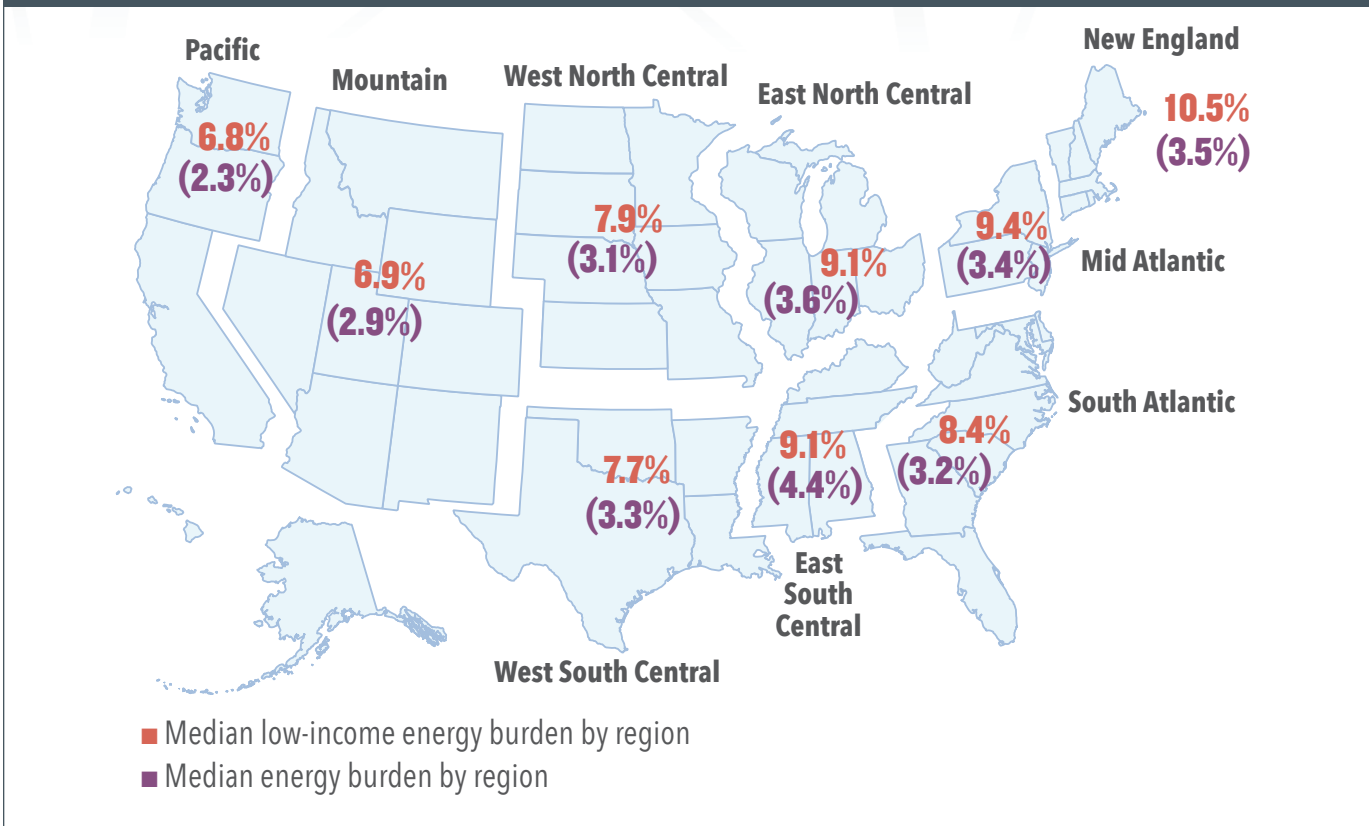


and Mid-Atlantic regions (3.0, 2.9, and 2.8 times higher, respectively). Figure 3 illustrates low-income energy burdens and the median energy burden across the nine census regions.

**TABLE 2. States within each census region**

Region	States
<b>New England</b>	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
<b>Middle Atlantic</b>	New Jersey, New York, Pennsylvania
<b>East North Central</b>	Illinois, Indiana, Michigan, Ohio, Wisconsin
<b>West North Central</b>	Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota
<b>South Atlantic</b>	Delaware, DC, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia
<b>East South Central</b>	Alabama, Kentucky, Mississippi, Tennessee
<b>West South Central</b>	Arkansas, Louisiana, Oklahoma, Texas
<b>Mountain</b>	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming
<b>Pacific</b>	Alaska, California, Hawaii, Oregon, Washington

**FIGURE 3. Median low-income (< 200% FPL) energy burdens by region (red) compared to median energy burdens by region (purple)**



**REGIONAL DATA: HIGH AND SEVERE ENERGY BURDENS**

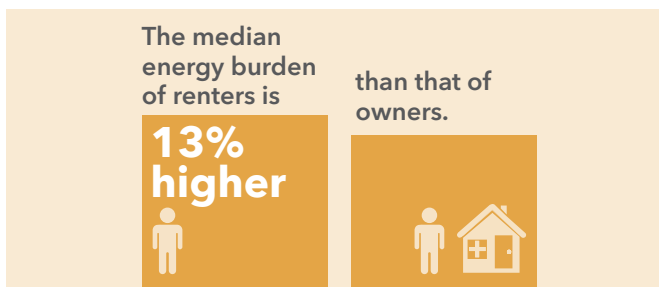
Figure 4 shows the percentage and total number of households that experience high and severe energy burdens in each region.

The percentage and total number of households that experience a high energy burden vary across regions. The East South Central region has the greatest percentage of households with high energy burdens (38%), followed

by East North Central, New England, and Middle Atlantic regions, all with 29%. The South Atlantic region had the greatest number of households (6.27 million) with high burdens, followed by the East North Central (5.40 million) and Middle Atlantic (4.57 million) regions. See **Appendix B** for the total number of highly burdened households across different groups in each region.

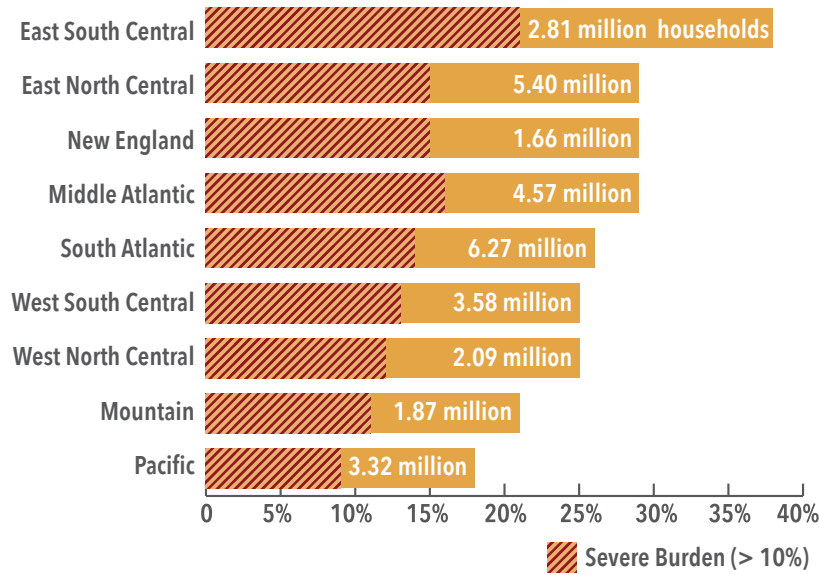
**Metro Area Energy Burdens**

Across the select MSAs—which represent 38% of all households nationally—low-income households, low-income multifamily households, and older adult households are the most energy burdened groups. Groups with the lowest energy burdens are non-low-income, those living in buildings built after 1980, and those living in market-rate multifamily housing. Table 3 includes the median energy burdens for the most highly burdened groups in each metro area; **Appendices A** and **B** offer more details.<sup>17</sup>



<sup>17</sup> **Appendix A** includes national, regional, and metro area sample sizes, median energy burdens, median incomes, median monthly bills, upper-quartile energy burdens, percentage with a high burden, and percentage with a severe burden. **Appendix A** also includes median and upper-quartile energy burdens for subgroups nationally, regionally, and in metro areas, including low-income, low-income with older adults, low-income with a child under 6, low-income with disability, low-income multifamily, non-low-income, Black, Hispanic, non-Hispanic white, older adult, renters, owners, multifamily, built before 1980, and built after 1980. **Appendix B** includes the number of households nationally, regionally, and in metro areas that experience a high or severe energy burden.

**FIGURE 4. The percentage and number of all households with a high energy burden (> 6%) in each region in 2017**



The percentage and number of all households with a high energy burden (> 6%) in 2017

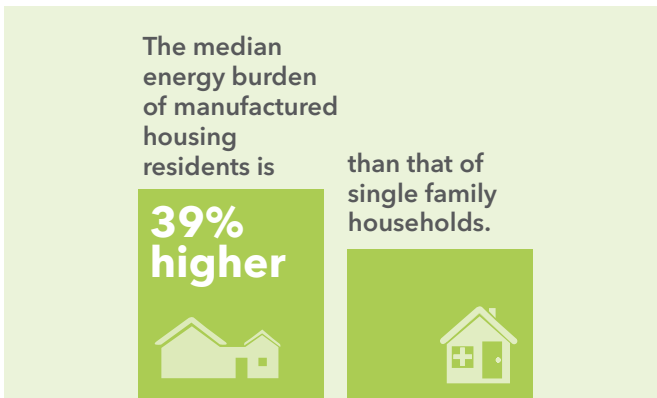
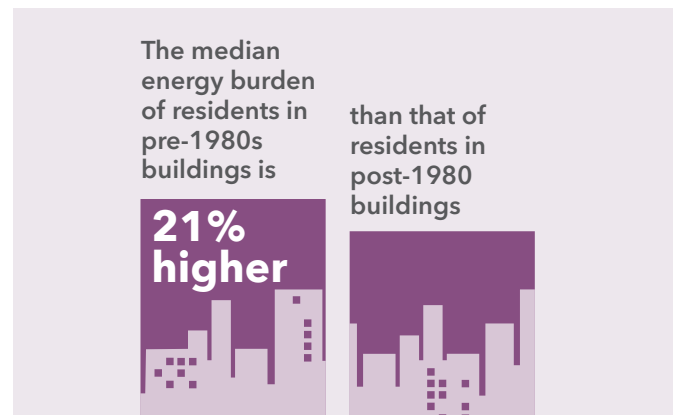


Figure 5 includes the energy burdens at the median and upper quartile, showing that 50% of households in each city experience a burden above the median and 25% experience a burden above the upper quartile. For example, in Baltimore, 25% of low-income households experience an energy burden above 21.7%, which is seven times the national median burden. In five cities—Baltimore, Philadelphia, Detroit, Boston, and Birmingham—a quarter of low-income households have energy burdens above 18%, which is three times the 6% high energy burden threshold.

Across the 25 MSAs, low-income households experience energy burdens at least two times higher than the average household in all cities. In all metro areas, Black and Hispanic households experience higher energy burdens than non-Hispanic white households. Renters and people living in buildings built before 1980 experience higher energy burdens than owners in almost all metro areas in the study.

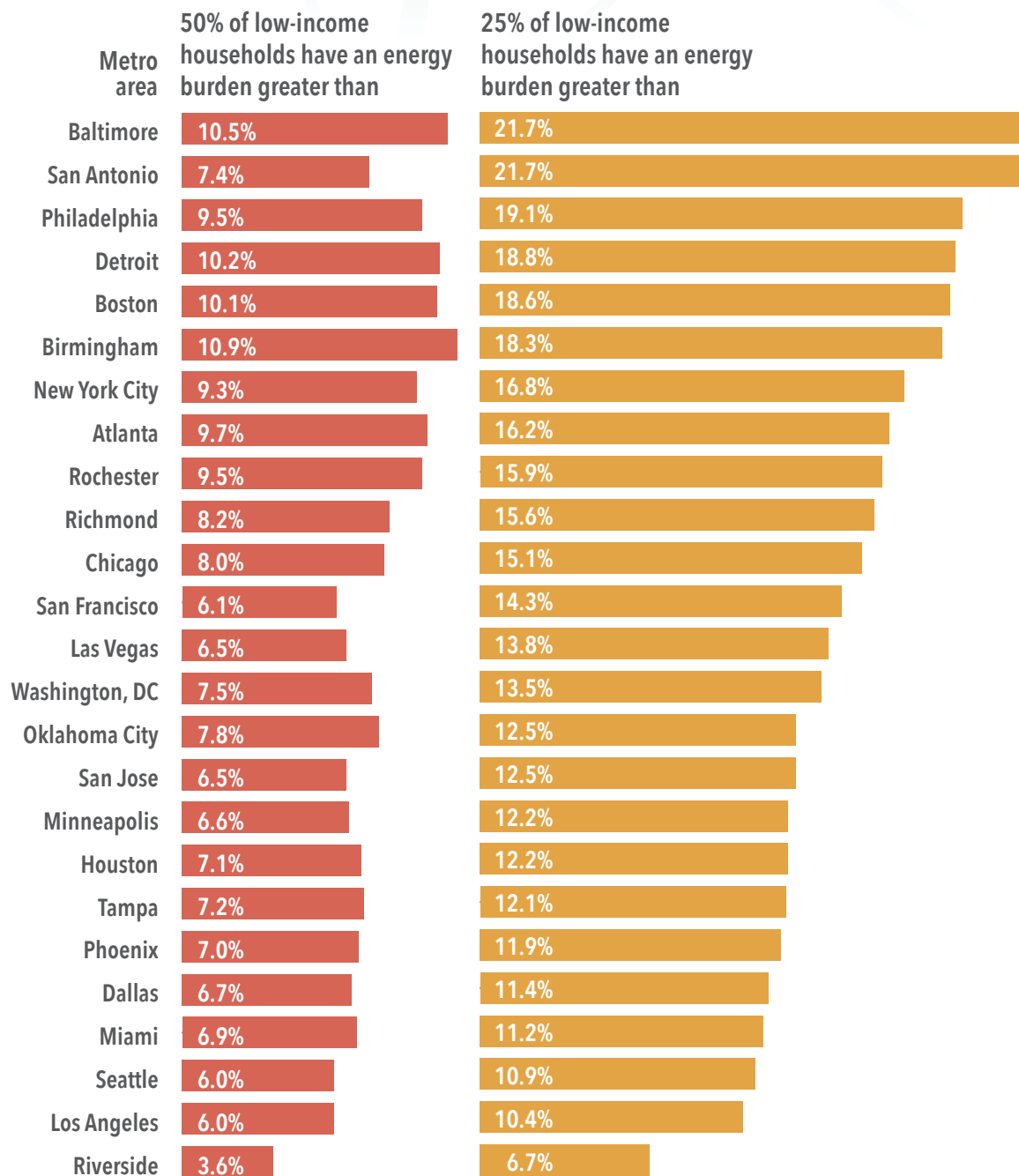
Median energy burdens do not tell the whole energy affordability story, as half of households in each group experience a higher energy burden than the median.



**TABLE 3. Median energy burdens in metro areas for all households and highly impacted groups, including low-income, Black, Hispanic, older adult (65+), renters, low-income multifamily residents, and those residing in buildings built before 1980**

<b>Metro area</b>	<b>All households</b>	<b>Low-income (≤ 200% FPL)</b>	<b>Black</b>	<b>Hispanic</b>	<b>Older adults (65+)</b>	<b>Renters</b>	<b>Low-income multifamily*</b>	<b>Built before 1980</b>
<b>National data</b>	3.1%	8.1%	4.2%	3.5%	4.2%	3.4%	3.1%	3.4%
<b>Atlanta</b>	3.5%	9.7%	4.1%	4.7%	5.1%	3.7%	6.6%	4.5%
<b>Baltimore</b>	3.0%	10.5%	3.8%	3.3%	4.1%	3.2%	2.5%	3.6%
<b>Birmingham</b>	4.2%	10.9%	5.6%	4.8%	5.8%	5.2%	6.8%	5.1%
<b>Boston</b>	3.1%	10.1%	3.7%	3.6%	4.4%	3.2%	6.6%	3.2%
<b>Chicago</b>	2.7%	8.0%	4.1%	3.0%	3.7%	3.1%	6.4%	2.9%
<b>Dallas</b>	2.9%	6.7%	3.3%	3.8%	3.8%	2.9%	5.0%	3.5%
<b>Detroit</b>	3.8%	10.2%	5.3%	4.5%	5.2%	4.6%	6.0%	4.3%
<b>Houston</b>	3.0%	7.1%	3.5%	3.4%	4.1%	3.3%	5.8%	3.4%
<b>Las Vegas</b>	2.8%	6.5%	3.2%	3.0%	3.4%	3.0%	5.3%	3.6%
<b>Los Angeles</b>	2.2%	6.0%	3.6%	2.6%	3.2%	2.4%	4.8%	2.3%
<b>Miami</b>	3.0%	6.9%	3.4%	3.1%	4.2%	3.1%	5.5%	3.3%
<b>Minneapolis</b>	2.2%	6.6%	2.6%	2.7%	3.0%	2.3%	4.3%	2.5%
<b>New York City</b>	2.9%	9.3%	3.6%	3.8%	4.2%	3.3%	8.0%	3.0%
<b>Oklahoma City</b>	3.3%	7.8%	3.9%	4.2%	4.0%	3.9%	6.5%	3.8%
<b>Philadelphia</b>	3.2%	9.5%	4.4%	5.2%	4.4%	3.9%	6.5%	3.6%
<b>Phoenix</b>	3.0%	7.0%	3.2%	3.6%	4.0%	2.8%	4.6%	3.6%
<b>Richmond</b>	2.6%	8.2%	3.4%	2.9%	3.5%	2.9%	5.0%	3.1%
<b>Riverside</b>	3.6%	8.7%	3.9%	3.7%	5.1%	4.0%	6.1%	4.3%
<b>Rochester</b>	3.8%	9.5%	5.1%	5.4%	4.8%	4.3%	6.0%	4.0%
<b>San Antonio</b>	3.0%	7.4%	3.1%	3.4%	4.1%	3.1%	4.8%	3.9%
<b>San Francisco</b>	1.4%	6.1%	2.4%	1.2%	2.4%	1.4%	4.9%	1.4%
<b>San Jose</b>	1.5%	6.5%	1.8%	1.9%	2.4%	1.5%	4.7%	1.6%
<b>Seattle</b>	1.8%	6.0%	2.3%	2.0%	2.4%	1.8%	4.1%	2.0%
<b>Tampa</b>	2.8%	7.2%	3.6%	3.5%	3.8%	2.8%	4.9%	3.3%
<b>Washington, DC</b>	2.0%	7.5%	2.9%	2.7%	2.9%	2.0%	5.2%	2.3%

\* Low-income multifamily households are below 200% FPL and in a building with five or more units.

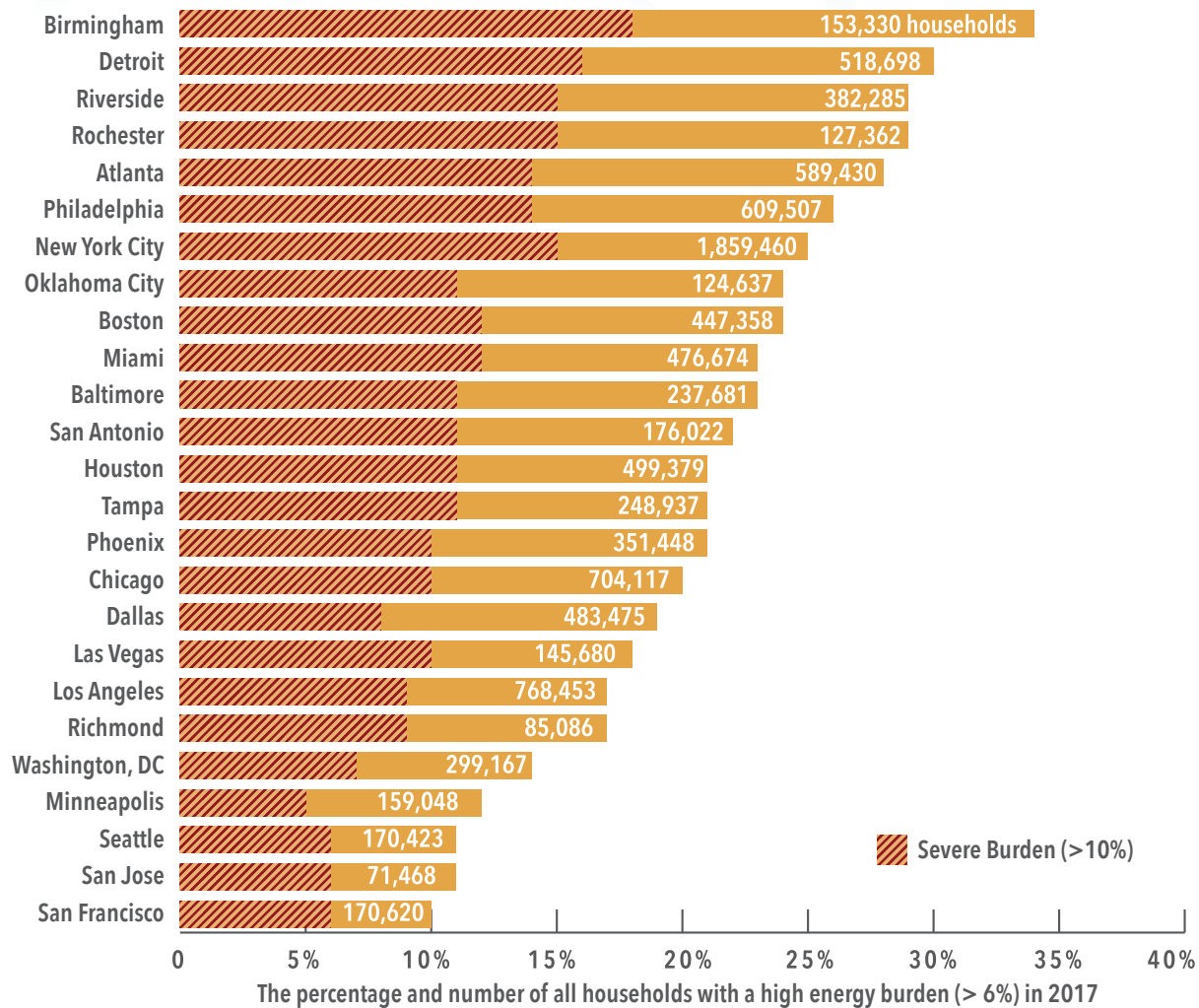
**FIGURE 5. Energy burden experienced by 50% and 25% of low-income households in 25 metro areas**

### METRO DATA: HIGH AND SEVERE ENERGY BURDENS

The percentage of households experiencing a high energy burden varied across the select metro areas, with up to one-third of residents in some cities facing a high energy burden. Figure 6 shows the percentage and total

number of households in each metro area that experience high and severe energy burdens. Six metro areas have a greater percentage of households with a high energy burden than the national average (25%), including Birmingham (34%), Detroit (30%), Riverside (29%), Rochester (29%), Atlanta (28%), and Philadelphia (26%).

**FIGURE 6. The percentage and number of all households with a high energy burden (> 6%) in each of the 2017 AHS MSAs**



**Appendix B** includes data on high and severe energy burdens in each metro area in our sample. In nine metro areas, 12% or more of households experienced a severe energy burden, spending more than 10% of their income on energy bills; among these are 1.1 million households in New York City, 333,000 in Philadelphia, and 288,000 in Atlanta.

As these findings illustrate, high and severe energy burdens are both a national and a local challenge. Even though some metro areas have lower percentages of households with high energy burdens than the national average, each city has tens to hundreds of thousands of households with high energy burdens. In addition, both the national energy burden trends and the metro-level trends show similar patterns of energy burden vulnerability for specific groups and are therefore likely reflected in other metro areas nationally as well. This indicates that both the metro areas studied and

other cities have energy burden disparities in their communities. They also have opportunities to create policy and programs to lower these energy burdens for their residents.

By focusing on the needs of those who are disproportionately burdened—particularly at the intersection of criteria such as of low-income, communities of color, older adults, and renters—policymakers can set policies and create programs that have the greatest impact on energy insecurity. As they do so, they should recognize that many households—especially those with high energy use due to building inefficiencies—experience much higher than average energy burdens. These households are therefore likely to need targeted and long-lasting interventions, such as energy efficiency and weatherization, to achieve long-term affordability.

# Low-Income Weatherization Can Reduce High Energy Burdens



Energy efficiency and weatherization provide a long-term solution to reducing high energy burdens, while also complementing bill payment assistance and programs aimed at energy-saving education and behavior change. *Weatherization* refers to programs that address the efficiency of the building envelope and building systems (such as unit heating, cooling, lighting, windows, and water heating) through energy audits; these audits identify cost-effective energy efficiency upgrades provided through energy efficiency programs. Other low-income energy efficiency programs may include additional measures such as appliance replacements, efficient lighting, and health and safety measures. While these recommendations focus on weatherization and energy efficiency as a long-term solution to reducing high energy burdens, these investments can be combined with renewable energy technologies and/or electrification strategies to further reduce energy bills.

Energy efficiency programs and investments that provide comprehensive building upgrades—such as insulation, air sealing, heating and cooling systems, appliances, lighting, and other baseload measures—can strongly impact long-term energy affordability, as low-income households tend to live in older buildings and have older, less-efficient appliances than higher income households (Cluett, Amann, and Ou 2016). Research suggests that weatherization measures can reduce energy use by 25–35% (DOE 2014, 2017; DOE 2011). Assuming a 25% reduction in energy use and using the 2017 AHS data, we estimate that energy efficiency and

weatherization can reduce the energy burden of the average low-income household by 25%.<sup>18</sup>

Low-income energy efficiency and weatherization programs are especially important in the wake of the economic recession and pandemic. These programs can both reduce high energy burdens and help stimulate the economy through local job creation and workforce development. Policies that accelerate investment in, improve the design of, and better target low-income energy efficiency, weatherization, and housing retrofit programs can have a high impact on long-term energy affordability.

<sup>18</sup> We assume a 25% savings from energy efficiency upgrades based on the U.S. Department of Energy's estimate (DOE 2014) and use the median low-income household values to calculate a 25% reduction. We reduced the median low-income energy bill by 25% from \$1,464 to \$1,098. Using the median low-income household income of \$18,000, this equates to a reduced energy burden of 6.1%. Reducing the median low-income energy burden from 8.1% to 6.1% is a 25% reduction. Following this same methodology, our 2016 metro energy burden report estimates a 30% reduction based on the 2011 and 2013 AHS data.

# Strategies to Accelerate, Improve, and Better Target Low-Income Housing Retrofits, Energy Efficiency, and Weatherization



Many local and state governments, utilities, and community-based organizations have already begun to identify energy efficiency as a key strategy for lowering high energy burdens. To date, we have identified nine cities (Atlanta, Cincinnati, Houston, Minneapolis, New Orleans, Oakland, Philadelphia, Pittsburgh, Saint Paul) and six states (Colorado, New Jersey, New York, Oregon, Pennsylvania, Washington) that have set energy-burden-focused policies, goals, or programs with energy efficiency as a key component (see **Appendix C**). For example, the State of Oregon's *Ten-Year Plan to Reduce the Energy Burden in Oregon Affordable Housing* states that its goal is to "reduce the energy burden on the low-income population in Oregon, while prioritizing energy efficiency to achieve that reduction" (OR DOE, OR PUC, and OHCS 2019). At the city level, Philadelphia's Clean Energy Vision Plan set a goal to eliminate the energy burden for 33% of Philadelphians. To accomplish this, the city has designed and funded multiple pilot programs to reduce high energy use in multifamily and single-family buildings. See **Appendix C** for more information on energy-burden-focused city- and state-led actions.

**FIGURE 7. Key strategies to lower high energy burdens by better targeting low-income energy efficiency programs, ramping up investment, and improving program design and best practices**

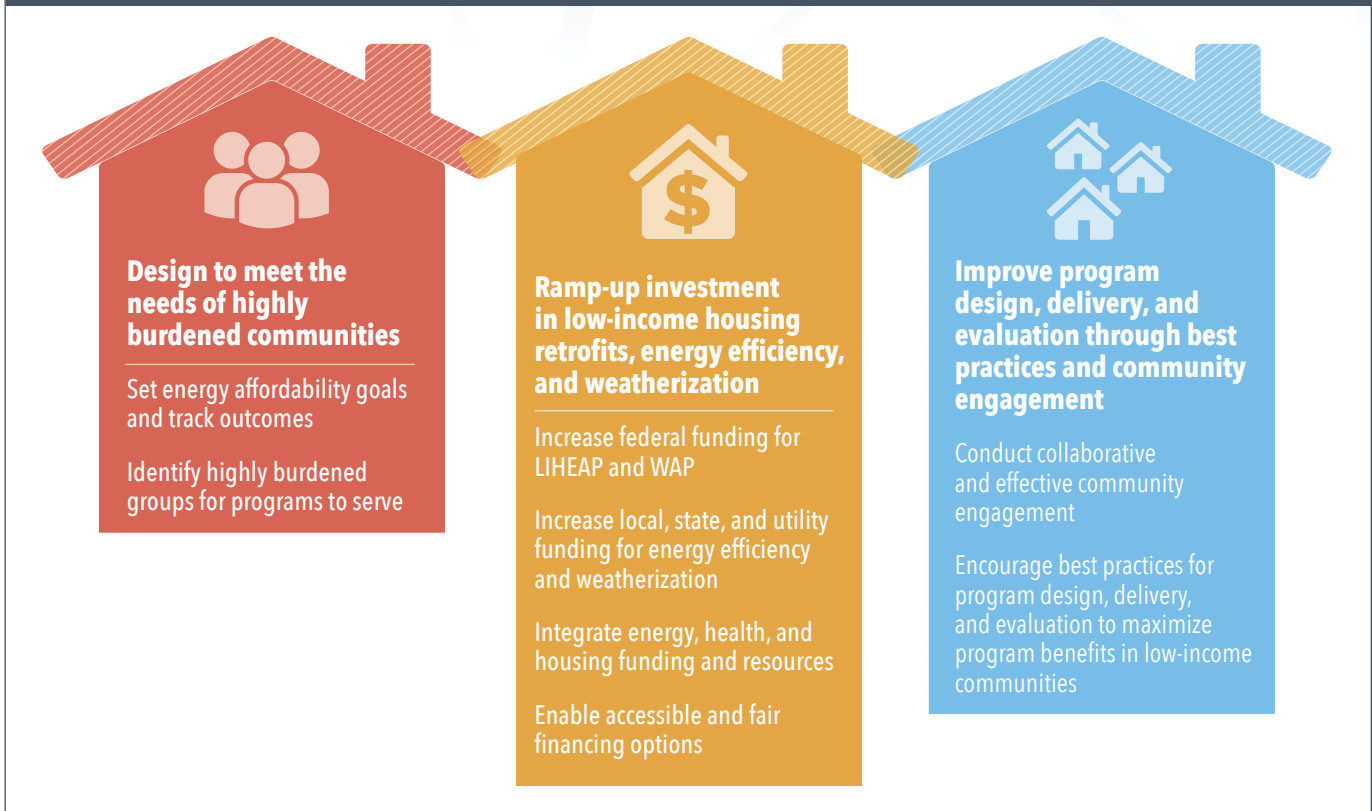


Figure 7 illustrates the key strategies to design programs to meet the needs of highly burdened communities, increase funding, and improve program design to have the greatest impact.

## Design to Meet the Needs of Highly Burdened Communities

Focusing low-income energy efficiency and weatherization investment on residents with the highest burdens can greatly alleviate energy insecurity. Local and state governments and utilities can conduct more granular and detailed energy insecurity studies or analyses to help identify which local communities have the highest burdens. They can also use other energy equity and justice-related metrics and indicators to target resources to and investment in these communities. One tool for doing this analysis is the U.S. Department of Energy (DOE) Low Income Energy Affordability Data (LEAD) tool (see text box 1). Policymakers and program implementers can use a community-based approach to develop programs to invest in communities with high burdens. Cities and states can also set energy affordability goals and policies, and then track outcomes to ensure that the communities most impacted by energy insecurity receive the benefits of energy efficiency investments.

### TEXT BOX 1. ENERGY BURDEN ASSESSMENTS: LOW INCOME ENERGY AFFORDABILITY DATA (LEAD) TOOL

The Department of Energy's Low Income Energy Affordability Data Tool (LEAD), developed with the National Renewable Energy Laboratory, aims to help states, communities, and other stakeholders create better energy strategies and programs by improving their understanding of low-income housing and community energy characteristics. LEAD is a web-accessible interactive platform that allows users to build their own state, county, and census tract and city profiles with specific household energy characteristics associated with various income levels and housing type, vintage, and tenure. The tool provides three principal metrics—energy burden, annual average housing energy costs, and housing counts—along with map and chart-based visualizations (Ma et al. 2019). States and local governments have begun using the LEAD tool in planning. For example, New Jersey cited its use of LEAD in the development of its new Office of Clean Energy Equity (New Jersey Legislature 2020).

LEAD is available for free at [energy.gov/eere/slsc/maps/lead-tool](https://energy.gov/eere/slsc/maps/lead-tool).

## SET ENERGY AFFORDABILITY GOALS AND TRACK OUTCOMES

State and local policymakers can set energy affordability and energy burden goals as a first step to addressing energy insecurity in their communities. Examples of such goals include reducing energy burdens by certain percentages, lowering energy burdens for all households to a certain threshold, or targeting resources toward individuals with high energy burdens. By focusing on the needs of those who are disproportionately burdened—particularly at the intersection of criteria such as income, race and ethnicity, and age—policymakers can set policies and create programs that have the greatest impact on addressing energy insecurity. Table 4 lists cities that have established energy burden and affordability goals.

**Appendix C** includes additional city and state energy burden policies.

To establish energy burden goals, cities, states, and utilities can conduct baseline studies to understand the state of energy burdens, poverty, housing, and access to energy efficiency investments in their communities. They can then establish an appropriate goal and strategies to accomplish that goal.

Coordinating goal setting with other state and local priorities can help cities to streamline their efforts. Some cities—such as Minneapolis and New Orleans—include energy burden goals in their climate action plans as a strategy to reduce greenhouse gas emissions and achieve more equitable outcomes. States such as New

York have also used energy burdens in statewide energy affordability policy plans.

Energy burden maps and visualizations are a useful tool for cities and states to achieve more equitable and affordable energy in their communities, move resources toward overburdened communities, and address other climate and equity goals. The DOE's LEAD tool provides one way to create energy burden visualizations. Plans should include specific strategies for lowering high energy burdens, as well as methods and strategies to track iterative progress.

In addition to goals, some cities have begun using energy burden as an equity indicator metric. For example, the city of Oakland includes energy cost burden as a metric in its *2018 Equity Indicators* report (City of Oakland 2018) to measure equity within essential housing services. The city found that energy burdens were higher for Black, Hispanic, and Asian households in the city as compared to white households. Similarly, the Minneapolis Climate Action Plan indicates that reporting on plan progress should also include equity indicators to measure whether energy burden reductions are equitable (City of Minneapolis 2013). Text box 2 offers examples of how governors and policymakers in four states—Pennsylvania, New York, Oregon, and Washington—created goals and policies around energy burdens to address energy insecurity in their states. To date, energy burden goals are largely set and acted upon by climate and energy officials at the city and state level. Such metrics and goals are rarely part of larger

**TABLE 4. Cities with energy burden goals and strategies**

City	Description	Data source
<b>Atlanta</b>	The Resilience Strategy includes action to lift energy burden on 10% of Atlanta households.	City of Atlanta 2017
<b>Cincinnati</b>	The Green Cincinnati Plan set a goal to reduce household energy burdened by 10% compared to current levels.	City of Cincinnati 2018
<b>Houston</b>	The Climate Action Plan includes a goal to promote weatherization programs to reduce residential energy consumption and focus on reducing energy burdens of low-income populations.	City of Houston 2020
<b>Minneapolis</b>	The Climate Action Plan states that the city will prioritize neighborhoods with high energy burdens for strategy implementation.	City of Minneapolis 2013
<b>New Orleans</b>	The Climate Action Plan includes two strategies to reduce the high energy burdens of the city's residents.	City of New Orleans 2017
<b>Philadelphia</b>	The Clean Energy Vision Plan set a goal to eliminate the energy burden for 33% of Philadelphians.	City of Philadelphia 2018
<b>Saint Paul</b>	The city set a 10-year goal to reduce resident energy burden so that no household will spend more than 4% of its income on energy bills.	City of Saint Paul 2017

## TEXT BOX 2. CASE STUDIES: STATE-LED ENERGY AFFORDABILITY EFFORTS

**New York Energy Affordability Goal.** In 2016, Governor Andrew M. Cuomo became one of the first U.S. government officials to issue a policy aimed at addressing high energy burdens. Through the state's first ever Energy Affordability policy, he aims to ensure that no New Yorker spends more than 6% of their household income on energy (New York 2016). New York continues to explore pathways to reducing energy burden to 6% for all New Yorkers through a combination of enhanced bill assistance, energy efficiency, and increased coordination among state agencies responsible for energy, bill assistance, and affordable housing.

Oregon's Strategies to Achieve Affordability. Issued by Governor Kate Brown in 2017, Executive Order 17-20 targets state agencies to improve energy efficiency. Section 5(b) emphasizes a prioritization of energy efficiency in affordable housing to reduce utility bills (Oregon 2017). In response to this directive, the Oregon Housing and Community Service Department partnered with the DOE and the Public Utility Commission to develop an assessment to identify the energy burden of Oregon's low-income population and also prioritize energy efficiency. The interagency assessment concluded that energy costs for low-income Oregonians are nearly \$350 million per year, and it identified more than \$113 million annual potential energy cost savings that can be achieved through low-income energy efficiency programs across the state (OR DOE, OR PUC, and OHCS 2019). The order identifies a number of strategies to achieve these cost savings, such as adopting energy codes for new buildings and including retrofit measures, such as smart thermostats and replacing electric resistance heating.

Pennsylvania Energy Affordability Study. In 2019, the Pennsylvania Public Utility Commission (PA PUC) released a report that examined home energy affordability for the state's low-income customers (Pennsylvania PUC 2019a). The report's goal was to determine what constitutes an affordable energy burden for low-income households in the state, which would advise changes to the bill payment assistance programs to achieve these affordable energy burden levels. In 2020, the PA PUC set a new policy to direct the state's regulated utilities to ensure that low-income customers spend no more than 10% of their income on energy bills and that the lowest-income customers spend no more than 6% of their income on energy bills (Pennsylvania PUC 2019b).

Washington Clean Energy Transformation Act. In 2019, Governor Jay Inslee passed the Clean Energy Transformation Act (CETA), which sets specific goals to achieve 100% clean electricity across Washington by 2045. Under CETA, the Washington Department of Commerce will assess the energy burdens of low-income households and the energy assistance offered by electric utilities. The department will consult with local advocates of vulnerable populations and low-income households to improve energy assistance programs. The department will publish a statewide summary to include the estimated level of energy burden and energy assistance among electric customers, identify drivers of energy burden and energy efficiency potential, and assess the effectiveness of current utility programs and mechanisms to reduce energy burdens (Washington State Department of Commerce 2020).

public health strategies and priorities despite their wide-reaching health implications.

### IDENTIFY HIGHLY BURDENED GROUPS FOR PROGRAMS TO SERVE

Overburdened households, especially Black, Native American, Hispanic, and other communities of color, often are either marginalized and overlooked by utilities' energy efficiency program marketing or face additional barriers to program participation, such as high cost or financing barriers (Leventis, Kramer, and Schwartz 2017). Creating targeted energy efficiency marketing beyond direct billing mailers can drive positive outcomes for the whole system.

Policymakers can also look beyond energy burden as an indicator to identify highly burdened groups, taking into account factors such as income, unemployment

rates, race and ethnicity, geography, education, and multiple other stressors—including air pollution and health indicators. By using metrics beyond energy burden, policymakers and program implementers can better invest resources in communities that experience the highest levels of marginalization underinvestment, and negative social and health impacts (Lin et al. 2019). Policymakers can design and implement programs that meet the needs of highly burdened groups through robust community engagement. For example, local governments can design programs to improve access to affordable, energy-efficient housing by mandating or incentivizing stringent energy efficiency standards, streamlining permit and inspection processes, and amending zoning codes for construction of more housing units, while also using neighborhood approaches to involve and empower community members in these processes (Samarripas and de Campos Lopes 2020).

### TEXT BOX 3. MEETING THE NEEDS OF HIGHLY BURDENED GROUPS: CASE STUDIES

**Minneapolis Green Zones:** The Minneapolis Climate Action Plan’s Environmental Justice Working Group developed the idea of *Green Zones*, a place-based policy initiative aimed at improving health and supporting economic development. The city used data to identify two such zones—a Northern Green Zone and a Southern Green Zone—where residents face disproportionate burdens across areas such as equity, displacement, air quality, brownfields and soil contamination, housing, green jobs, food access, and greening (City of Minneapolis 2020). Once created, the city designed programs to direct investment into these communities. The Green Zones provide an example of how policymakers can work to identify highly burdened communities and create programs that meet the needs of residents in these areas.

**Energy Burden as a Program Qualification: Efficiency Vermont.** Efficiency Vermont (EVT), the energy efficiency program implementer for the state’s utility-funded energy efficiency programs, conducted a 2018 study of equity measurements to better understand how the clean energy industry defines, collects, analyzes, and reports data on equity. This study informed changes to the design of EVT’s Targeted High Use Program, which launched in 2011 and originally qualified customers based on two factors: income (< 80% of Area Median Income [AMI]) and a minimum energy use of 10,000 kWh/year. The program historically served approximately 350 households per year, working with the DOE’s Weatherization Assistance Program (WAP) to conduct energy assessments and then install LEDs and water-saving measures, identify appliances for replacement, and replace high-efficiency heat pumps and heat pump water heaters where appropriate. Through its equity analysis, EVT determined that the energy use threshold was too high and excluded many customers with high energy burdens—but lower energy use—from accessing the program. In 2019, EVT changed the program qualification to two factors: income (< 80% AMI) and electric energy burden ( $\geq 3\%$ ). This change allowed it to recenter the program around energy burden reduction by qualifying not only more customers but also those who have high energy burdens yet may have previously been disqualified based on their energy use.

Efforts to alleviate high energy burdens should aim not only to identify those with high burdens and energy use but also to understand who has been overlooked by past efforts and develop strategies to address the needs of these households. Text box 3 contains additional case studies of city- and utility-led strategies to meet the needs of their overburdened communities.

### Accelerate Investment in Low-Income Housing Retrofits, Energy Efficiency, and Weatherization

The current need for low-income energy efficiency and weatherization far exceeds allocated resources. In 2017, utility-led energy efficiency administrators allocated only 5% of electric and 22% of natural gas energy efficiency expenditures to low-income programs (CEE 2019). This funding allocation shows that energy efficiency funds are not currently distributed to ensure that low-income households have equitable access to these investments and their benefits.

Policymakers and advocates can work toward leveraging and allocating additional funding for low-income energy efficiency and weatherization programs. They can also help ensure that these programs follow best practices to increase their impact. Following are several useful strategies for ramping up additional funding for low-income energy efficiency and weatherization.

### INCREASE FEDERAL FUNDING FOR LIHEAP AND WAP

Although an estimated 36 million U.S. households are currently eligible for weatherization, the DOE’s Weatherization Assistance Program (WAP) has served only 7 million households over the past 40 years (Bullen 2018; DOE 2016). WAP serves about 100,000 homes per year through DOE and leveraged funds, which is far fewer than both the eligible households nationally and the 15.7 million severely energy burdened households estimated in this study (NASCS 2020b). At the current rate, it would take 360 years to weatherize all eligible households through WAP—assuming no more households become WAP-eligible over time.

Congress funds WAP and allows funds to be transferred to the program from the Department of Health and Human Services’ Low-Income Home Energy Assistance Program (LIHEAP). WAP can also utilize additional leveraged funds. States can transfer 15% (or up to 25% with a waiver) of LIHEAP bill assistance funds to WAP to supplement DOE weatherization funding. Over the past 10 years, annual expenditures directed toward weatherization have ranged from \$1 billion to \$3 billion per year, with the American Recovery and Reinvestment Act greatly increasing low-income funding for WAP (Brown et al. 2019). The National Association for State Community Services Programs’ 2018 funding report estimates that WAP grantees had access to \$1.1 billion in total available funding in 2018, with \$247 million direct base funding from the DOE, \$453

million from LIHEAP-transferred funding, and \$408 million from utilities, state-sourced revenue, and other sources (NASCS 2020b). Non-DOE WAP funds in 2018 added an additional \$861 million, or \$3.48 for every DOE-invested dollar (NASCS 2020b).

The federal government has the ability to increase both WAP and LIHEAP budgets to better meet households' needs. From 2008 to 2018, DOE base funding for WAP has fluctuated from a high of \$450 million in 2009 to a low of \$68 million in 2012 (DOE 2009, 2012). In 2020, Congress allocated \$305 million to WAP—a 23% increase (\$58 million) compared to the funds allocated in 2018 (DOE 2020). Even so, leveraging additional state, local, and other funding helps supplement and increase available weatherization funds. In addition, states can decide to increase the LIHEAP percentage they transfer to WAP to better support the program. Further, it is essential that the increased demand for adequate cooling systems be assessed in the allocation of WAP and LIHEAP funds. For households across the South, rising temperatures and the increasing frequency and duration of heat waves are likely to increase cooling needs—and thus energy expenses (Berardelli 2019).

The COVID-19 pandemic has added to the urgency of increasing support for low-income bill payment assistance. On May 8, 2020, the federal government authorized \$900 million in supplemental LIHEAP funding to help “prevent, prepare for, or respond to” home energy needs surrounding the national emergency created by COVID-19 (HHS 2020). On May 15, 2020, the U.S. House of Representatives passed the Health and Economic Recovery Omnibus Emergency Solutions (HEROES) Act, which would add an additional \$1.5 billion for LIHEAP to address energy access and security issues resulting from the COVID-19 pandemic (116<sup>th</sup> Congress 2020). As of publication, the Senate has not passed this legislation.

## **INCREASE STATE, LOCAL, AND UTILITY FUNDING FOR ENERGY EFFICIENCY AND WEATHERIZATION**

Funding from states, local governments, and utilities can also support low-income energy efficiency and weatherization efforts. In many states, PUCs can set low-income energy efficiency spending and/or savings requirements—as well as energy burden reduction targets—for their regulated utilities. As of 2017, of the 27 states with electric and/or natural gas Energy Efficiency Resource Standards (EERS), 18 had low-income energy efficiency spending requirements in place (Berg and Drehobl 2018; Gilleo 2019). States and local governments can also fund and implement their own energy efficiency and weatherization programs separately from WAP or as

**Policy approaches can be aligned to leverage funding resources and maximize benefits for residents, including reduced energy burdens and safer and healthier housing.**

a WAP add-on. They can, for example, allocate funds—such as from Community Development Block Grants (CDGB)—to joint or independent energy efficiency and weatherization programs.

**Appendix C** and text box 4 include examples of cities and states that created independent energy efficiency and weatherization programs to address high energy burdens.

## **INTEGRATE ENERGY, HEALTH, AND HOUSING FUNDING AND RESOURCES.**

High energy burdens, housing, and health are inextricably linked. In our study, many of the groups who experience high energy burdens also live in inadequate housing and disproportionately suffer from a variety of other harms, including higher than average exposures to environmental pollution (Tessum et al. 2019) and higher than average rates of certain preventable illnesses and diseases (CDC 2013). Although the recent COVID-19 pandemic has sharply illustrated this disparity, the same story plays out across a variety of preventable harms.<sup>19</sup> Policy approaches can be aligned to leverage funding resources and maximize benefits for residents, including reduced energy burdens and safer and healthier housing.

The benefits of these programs can be much greater when the goals of saving energy and protecting health are sought in tandem. Typical energy efficiency and weatherization services can provide a range of health benefits. Poorly sealed building envelopes allow pests, moisture, and air pollution to infiltrate (Institute of Medicine 2011), which can harm respiratory health through pest allergies, mold growth, and lung disease. Leaky windows, faulty HVAC systems, and poor insulation can lead to cold drafts and extreme home temperatures during summer and winter months. This can trigger heat-related illnesses and asthma attacks, as well as exacerbate other respiratory illnesses (AAFA 2017; American Lung Association 2020; CDC 2016). Addressing these issues through energy efficiency and weatherization will result in improved health outcomes; it will also reduce household energy burdens.

<sup>19</sup> For more on the disparities among COVID-19 fatalities, see Malcolm and Sawani (2020); Hooper, Nápoles, and Pérez-Stable (2020); and CDC (2020).

#### TEXT BOX 4. CITY- AND STATE-FUNDED ENERGY AFFORDABILITY PILOT PROGRAMS

**Philadelphia:** To meet its energy burden goals, Philadelphia has partnered on multiple pilot programs to reduce high energy burdens for low-income single and multifamily households. In 2017, the Philadelphia Energy Authority (PEA) launched its Multifamily Affordable Housing Pilot program in partnership with public and private-sector groups, including the local electric and natural gas utilities, property owners, energy service companies, program implementers, contractors, and technology providers (PEA 2020a). The program's goal was to deliver deep energy savings of more than 30% to low-income multifamily building residents in the city. In 2018, PEA and partners completed the program's first phase, which included low-cost measures and measures to collect energy data. These data were then used in the second phase to design deeper savings measures, such as HVAC and building envelope measures.

In response to COVID-19, PEA is developing a platform with its partners and advocates to coordinate and streamline low-income homeowner services aimed at improving home safety, health, affordability, and comfort (PEA 2020b). Set to launch in 2021, PEA's Built to Last pilot program aims to deliver comprehensive home improvements that will reduce energy burden while improving health and safety. The program will serve 80–100 homes and will streamline benefit screening, property assessment, and construction management. To cover program costs, Built to Last aims to combine available funding with grants and microfinancing options. PEA plans to deploy the Built to Last program at a larger scale in 2022 (PEA 2020b).

**Pittsburgh.** The city recognized that while Pittsburgh residents have some of the lowest utility rates in the country, they still pay almost twice the national average for their energy bills, leading to high energy burdens. Over the course of a few years, Pittsburgh developed a Climate Action Plan and launched both its resilience strategy (OnePGH) and its equality indicator project. These three projects helped the city identify residential energy burden as one of the primary challenges that local communities face (City of Pittsburgh 2019). As part of the Bloomberg Mayor's Challenge, Pittsburgh created Switch PGH to address high energy burdens through a civic engagement tool that gamifies home improvement (Mayors Challenge 2018). Switch PGH helps residents make lasting energy efficiency behavior changes and incentivizes home upgrades to reduce energy burdens.

**Colorado.** The Colorado State Energy Office awarded GRID Alternatives, a solar installer that focuses on the low-income market, a \$1.2 million grant to launch a demonstration project with the goal of reducing the energy burden for more than 300 low-income households. The program also aimed to improve understanding of how to make community solar programs with low-income participants mutually beneficial for both utilities and participants (Cook and Shah 2018) Through this program, households saved from 15% to more than 50% on their utility bills, with an average annual savings of \$382.

Myriad programs exist to address health and safety issues within homes, as well as to preserve and grow the affordable housing stock. Opportunities exist to integrate these programs and resources to more comprehensively address the energy, health, and housing needs of the households most in need of assistance.<sup>20</sup> For example, many homes must defer energy efficiency investments due to a home's physical issues, such as those related to structural deficiencies, moisture, and/or mold. According to Rose et al. (2015), WAP agencies estimated that such issues led to a 1–5% deferral rate for WAP income-eligible homes. In some areas, however, the problem is worse. In western Wisconsin, for example, a Community Action Agency and WAP provider serving four counties reported a deferral rate approaching 60% (NASCSP 2020a). Addressing nonenergy-related housing issues would allow more homes to be weatherization-ready.

Integrating programs creates opportunities to streamline

administration and reduce operating redundancies that can leave more funding for energy efficiency and weatherization measures that enable households to save on energy costs. Pooling resources and establishing cross-sector referral networks not only stretches program budgets, but it also can make programs more accessible for residents by streamlining eligibility and enrollment processes. For instance, offering a single contact point or a streamlined process can give participants a variety of services simultaneously to meet their energy, health, and housing needs (Levin, Curry, and Capps 2019). This can help mitigate barriers that arise when people have to navigate multiple separate services with varying eligibility requirements and enrollment processes. Efficiency Vermont's Healthy Homes Initiative (HHI) is one such example. A partnership between the state's WAP partners and community-based organizations that offer health interventions, HHI is coordinated through Vermont's Office of Economic Opportunity. Using

<sup>20</sup> ACEEE recently published several reports exploring the intersection of health and energy, including *Protecting the Health of Vulnerable Populations with In-Home Energy Efficiency: A Survey of Methods for Demonstrating Health Outcomes* ([www.aceee.org/research-report/h1901](http://www.aceee.org/research-report/h1901)); *Making Health Count: Monetizing the Health Benefits of In-Home Services Delivered by Energy Efficiency Programs* ([www.aceee.org/research-report/h2001](http://www.aceee.org/research-report/h2001)); and *Braiding Energy and Health Funding for In-Home Programs: Federal Funding Opportunities* ([www.aceee.org/research-report/h2002](http://www.aceee.org/research-report/h2002)).

One Touch, an electronic platform for healthy home resources, HHI has established a robust referral network and successfully integrated healthy home principles into its residential energy efficiency program design.

The health sector is also beginning to realize the efficiencies of combining health and energy assessments and interventions (Hayes and Gerbode 2020). For example, a single contractor could be trained to both identify and address a family's asthma triggers, energy efficiency needs, and fall risks, thereby reducing the associated logistical burden on residents who might otherwise have to coordinate each service individually. Efforts such as this are beginning to appear across the country. In 2015, the state of Washington directed more than \$4 million in competitive grants to fund collaborations among clinical practitioners, home retrofitters, and community service organizations as a means of empowering clinicians and others to refer participants for a range of coordinated services (e.g., comprehensive in-home repairs and community health worker visits) (Levin, Curry, and Capps 2019). In New York, the State Energy Research and Development Authority (NYSERDA) recently kicked off a value-based payment pilot program that seeks to implement a healthy homes approach; through this program, Medicaid managed care organizations will partly cover residential upgrades when healthcare cost savings and benefits to residents are verified (NYSERDA 2018). Such cross-sectoral approaches to energy efficiency and weatherization seek to address some of the major root causes of health and energy inequities while making enrollment and participation feasible and accessible for residents. The benefits of energy efficiency cut across the health and energy sectors; by working to integrate resources, policymakers can maximize these benefits.

Housing policy can also help ensure that energy efficiency is integrated into efforts to upgrade and expand the affordable housing stock. State and local governments can play a key role in these integrating approaches. For example, a growing number of state housing finance agencies (HFAs)—state-chartered entities responsible for ensuring affordable housing across states—have included energy efficiency requirements in their allocation criteria for low-cost financing programs such as federal Low-Income Housing Tax Credits and grant programs administered to local governments. The same is true for local housing authorities, which increasingly incorporate energy efficiency into the maintenance and repair of their subsidized housing stock (EPA 2018). Text box 5 offers a brief case study of how one local government systematically required energy efficiency in its rental certification process, ensuring that all types of rental housing meet a specific level of energy performance.

## **ENABLE ACCESSIBLE AND FAIR FINANCING OPTIONS**

Many low-income households face barriers—such as credit eligibility—to investing in energy efficiency; these barriers can prevent them from participating in energy efficiency programs or installing energy efficiency upgrades that require financing for up-front costs. With the right consumer protections in place, financing can enable households to undertake cost-effective energy efficiency investments to lower their energy usage and bills. Local and state governments, utilities, private lenders, and nonprofit or community-based organizations can act to create and/or enable low- or no-cost financing options (i.e., payments are offset by energy cost savings) for energy efficiency investments.

Several types of financing instruments, such as on-bill payment (i.e., loan repayments included on the utility bill) and energy service agreements are becoming more common (Leventis, Kramer, and Schwartz 2017). Similarly, opportunities such as Commercial Property Assessed Clean Energy (C-PACE) can increase energy efficiency financing in the affordable multifamily sector. SEE Action's 2017 report, *Energy Efficiency Financing for Low- and Moderate-Income Households*, provides a comprehensive overview of the pros and cons of various financing options for both single and multifamily low-income households (Leventis, Kramer, and Schwartz 2017).

## **Improve program design, delivery, and evaluation through best practices and community engagement**

Program designers and implementers can collaborate and effectively engage with a community to create programs that fit its specific needs rather trying to fit the community into an existing program design. They can also incorporate best practices into their program design, delivery, and evaluation, and can emulate successful peer program models to increase program effectiveness and impact.

## **CONDUCT COLLABORATIVE AND EFFECTIVE COMMUNITY ENGAGEMENT**

To create programs that effectively reduce high energy burdens, energy efficiency and renewable energy program designers and implementers can work to engage and include local stakeholders throughout the program planning and implementation processes.

By connecting with, listening to, and partnering with community-serving organizations and community members in highly impacted communities, program

## TEXT BOX 5. THE CITY OF BOULDER'S SMARTREGS PROGRAM

In 2010, the city council in Boulder, Colorado, adopted SmartRegs, a program that requires all rental housing units in the city to demonstrate that their efficiency approximates or exceeds the standards set by the 1999 Energy Code. The program was integrated into the city's existing rental license program, which requires a rental property to obtain and renew its rental license every four years. This renewal entails an inspection for health and safety measures, and SmartRegs added energy efficiency requirements that must be met to certify that the property is approved for rental. All single- and multifamily units that offer long-term licensed rental housing are subject to the requirement. For larger multifamily buildings, a sample of representative apartments can be inspected.

Boulder also offers a companion EnergySmart program that provides technical assistance, help with selecting contractors for energy efficiency improvements, and financial incentives beyond those offered by the local utility. EnergySmart is funded primarily by Boulder County and provides services to all municipalities in the county.

SmartRegs has been recognized not only for saving energy and related costs but also for leading to widescale upgrades in the city's rental housing stock. Over the course of the eight-year compliance timeline, nearly all of the approximately 23,000 licensed rental units have become compliant (City of Boulder 2020a). The most common upgrades were attic, crawlspace, and wall insulation. The average upgrade cost has been about \$3,000 per unit, of which an average of \$579 was paid by city- and utility-sponsored rebates. As of 2018, the city estimates that the program has saved about 1.9 million kWh of electricity, 460,000 therms of natural gas, \$520,000 in energy costs, and 3,900 million metric tons of carbon dioxide. The city estimates the total investment in the program at just over \$8 million, including nearly \$1 million in rebates (City of Boulder 2020b).

administrators can identify the best measures, financing options, delivery methods, and marketing strategies to help residents reduce high energy burdens and meet their needs. Achieving this connection requires partnering with the community on program design and identifying and addressing barriers to participation for key stakeholders. This often requires engagement and trust-building over a long time period.

Robust community engagement incorporates the voices of and/or delegates power to community members. Such engagement can help develop neighborhood-centered programs that are most successful when combined with consistent funding, quality delivery infrastructure, and targeted outreach and engagement (USDN 2019). For more information on best practices in stakeholder engagement, see the DOE's Clean Energy for Low-Income Communities (CELICA) Online Toolkit at [betterbuildingssolutioncenter.energy.gov/CELICA-Toolkit/stakeholder-engagement](https://betterbuildingssolutioncenter.energy.gov/CELICA-Toolkit/stakeholder-engagement).

To include residents with high energy burdens in policy and program design, cities, states, and utilities can establish working groups, task forces, committees, and other structures that give residents a formal decision-making role. Creating this engagement when energy insecurity strategies, goals, and/or programs are first being developed allows for more input and direction from community members. Local energy planning efforts can also start with a community needs assessment led by a formal body of community residents. Local government and community leaders can then use this assessment's

findings to drive local energy affordability policies and program developments based on the findings' prioritized needs and strategies.

Policymakers and program implementers can minimize stakeholder and community participation barriers by funding or compensating participants for their time and participation in stakeholder engagement processes. For example, offering stipends to compensate participants for their time and expertise, setting realistic time expectations, creating accessible logistics, and offering additional incentives can increase participation and access (Curti, Andersen, and Write 2018). Other incentives to reduce engagement barriers include childcare, meals, and transit passes.

Policymakers can also move to a model of *energy democracy* in which community residents are innovators, planners, and decision makers on how to use and create energy in a way that is local, renewable, affordable, and just (Fairchild and Weinrub 2017). Communities that have transitioned to an energy democracy have shifted away from "an extractive economy, energy, and governance system to one that is regenerative, provides reparations, transforms power structures, and creates new governance and ownership practices (ECC 2019)." The Emerald Cities Collaborative led the creation of an *Energy Democracy Scorecard*, which provides a framework for communities to move toward an energy democracy. Policymakers can work to create energy democracy frameworks in their communities by working with community members to recognize power

imbalances and create dialogues about systemic barriers that must be addressed in order to correct long-standing injustices and inequalities in the energy and related sectors. This can help move the energy planning model to one of community self-determination and shared ownership. For more information, see [emeraldcities.org/about/energy-democracy-scorecard](http://emeraldcities.org/about/energy-democracy-scorecard).

## ENCOURAGE BEST PRACTICES FOR PROGRAM DESIGN, DELIVERY, AND EVALUATION TO MAXIMIZE BENEFITS IN LOW-INCOME COMMUNITIES

Researchers from ACEEE and other organizations have established numerous best practice strategies and case

studies of ways to improve and expand low-income energy efficiency programs and investments (Aznar et al. 2019; Nowak, Kushler, and Witte 2019; EDF 2018; Gileo, Nowak, and Drehobl 2017; Samarripas and York 2019; Cluett, Amann, and Ou 2016; Ross, Jarrett, and York 2016; Reames 2016).

Table 5 includes low-income program best practices across five categories: coordination, collaboration, and segmentation; funding and financing; measures, messaging, and targeting; evaluation and quality control; and renewables and workforce development. **Appendix D** offers more detailed descriptions and examples of each of these best practices.

**TABLE 5. Low-income program best practices by category**

<b>Coordination, collaboration, and segmentation</b>	<b>Funding and financing</b>	<b>Measures, messaging, and targeting</b>	<b>Evaluation and quality control</b>	<b>Renewables and workforce development</b>
Community engagement and participatory planning	Leverage diverse funding sources	Include health and safety measures and healthier building materials	Collect and share metrics	Integrate energy efficiency and solar
Statewide coordination models	Inclusive financing models	Prioritize deep energy-saving measures	Conduct robust research and evaluation	Support the development of a diverse and strong energy efficiency workforce
One-stop-shop program models	Align utility and housing finance programs	Integrate direct-installation and rebate programs	Include quality control	
Market segmentation		Target high energy users and vulnerable households	Incorporate nonenergy benefits	
Fuel neutral programs		Incorporate new and emerging technologies in low-income programs		
		Effectively message programs in ways that provide clear value and actionable guidance		

# Conclusions and Further Research



High energy burdens and energy insecurity are well-documented and pervasive national issues. Even in 2017, a time of economic prosperity, well over one-quarter of all U.S. households experienced a high energy burden. As this indicates, we need a renewed focus on equitable clean energy development and just energy transitions to ensure that investments in energy efficiency and renewable energy address energy insecurity. Climate change also underscores the urgency in addressing high household energy burdens. As temperatures continue to rise and heat waves become more common, access to clean, affordable energy is needed more than ever. We need cross-sectoral approaches that address the intersection of energy, health, and housing in the face of climate change.

Both nationally and in metro areas, this study finds that certain groups pay disproportionately more of their income on energy costs, including low-income households, communities of color, older adults, renters, and those residing in older buildings. Even though each metro area has a unique energy burden landscape, all cities have energy security inequities and can work to address them through collaborative policy and program decisions. Policymakers at the local, state, and utility levels can direct energy efficiency and renewable energy investments to disadvantaged and historically underinvested communities. They can then measure and ensure that these investments provide equitable benefits to local jobs, community health, and residential energy affordability.

Energy burdens are not the sole indicator of energy insecure households but rather provide one metric for determining energy insecurity. Further research is needed to identify the main physical drivers of high energy burdens, as well as the policies best suited to address the needs of the most highly energy burdened households. To better understand their communities' energy insecurity landscape, cities and states—and their energy, health, and housing agencies—as well as utilities are well-positioned to conduct detailed energy burden analyses, including qualitative data collection and interviews. Such studies would enable a first step toward setting more targeted energy affordability and energy burden goals and creating equitable, cross-sectoral policies and programs for achieving greater access to affordable energy for all.

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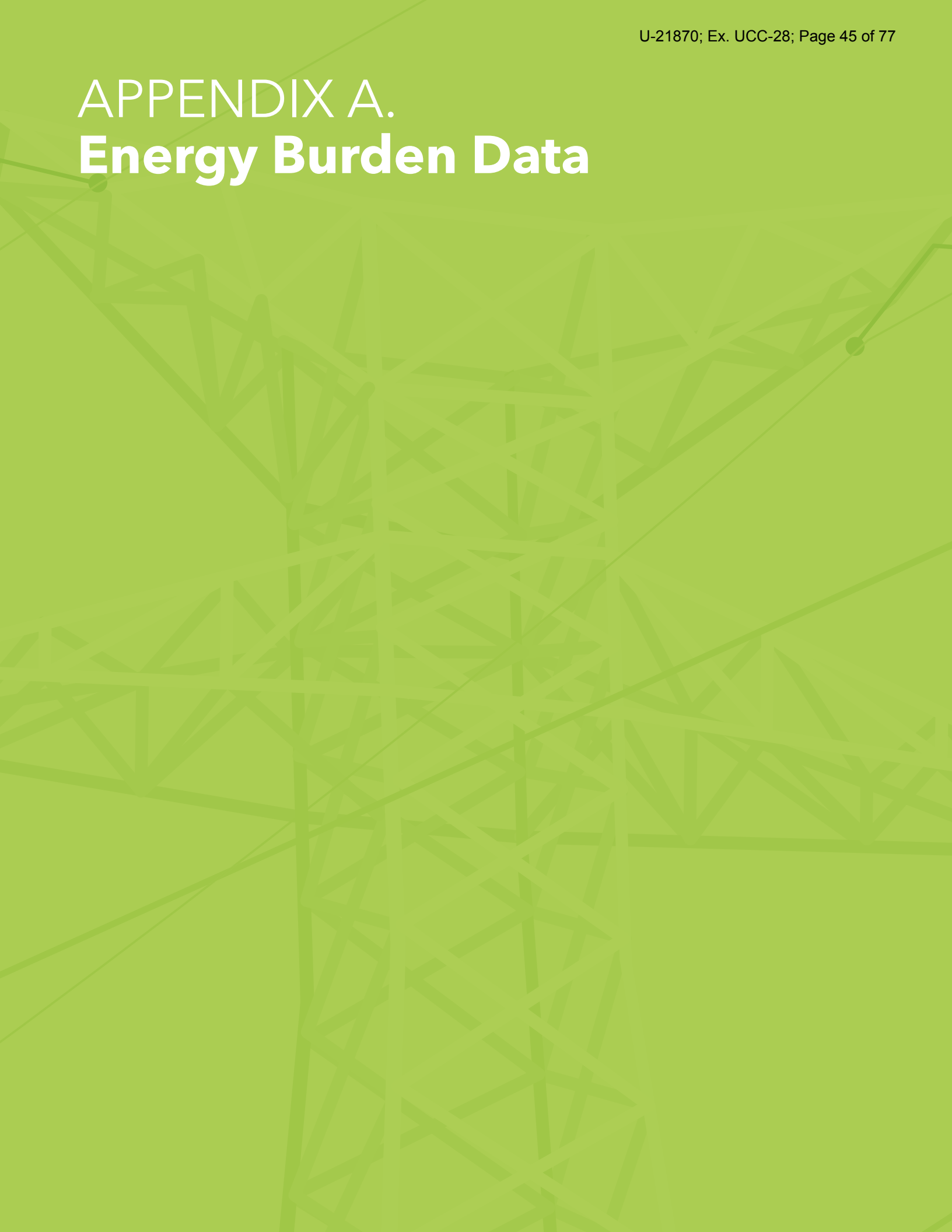
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# APPENDIX A.

# **Energy Burden Data**



## Appendix A.1–National Energy Burden Data

**A1.** National energy burden data including sample sizes, median energy burdens, median income, median monthly energy bills, and the percentage of households in each group with a high and severe burden

Subgroups	Sample size	Median energy burden	Median annual income	Median annual energy expenditures	High burden percentage (>6%)	Severe burden percentage (>10%)
All households	53,539	3.1%	\$58,000	\$1,800	25%	13%
Low-income ( $\leq$ 200% FPL)	16,685	8.1%	\$18,000	\$1,464	67%	40%
Low-income with adult over 65	6,018	9.3%	\$15,000	\$1,440	74%	47%
Low-income with child under six	2,665	7.1%	\$26,400	\$1,800	59%	33%
Low-income with disability	5,759	8.7%	\$14,660	\$1,344	69%	43%
Non-low-income ( $>$ 200% FPL)	36,854	2.3%	\$84,005	\$2,040	6%	1%
White (non-Hispanic)	33,219	2.9%	\$65,000	\$1,920	23%	11%
Black	7,747	4.2%	\$36,000	\$1,560	36%	21%
Hispanic	8,435	3.5%	\$47,400	\$1,680	28%	14%
Native American	1,003	4.2%	\$40,000	\$1,680	36%	19%
Older adults (65+ years)	15,750	4.2%	\$40,015	\$1,800	36%	19%
Renters	20,455	3.4%	\$36,000	\$1,320	30%	17%
Owners	33,082	3.0%	\$75,000	\$2,160	22%	11%
Single family	37,423	3.1%	\$70,020	\$2,160	24%	12%
Multifamily (5+ units)	9,936	2.4%	\$35,450	\$960	22%	12%
Low-income multifamily (5 + units, $\leq$ 200% FPL)	4,563	5.6%	\$14,300	\$960	47%	26%
Small multifamily (2-4 units)	3,708	3.4%	\$34,700	\$1,200	29%	17%
Manufactured homes	2,440	5.3%	\$34,800	\$1,800	45%	25%
Buildings built before 1980	28,013	3.4%	\$50,040	\$1,800	29%	15%
Buildings built after 1980	25,525	2.8%	\$66,000	\$1,920	21%	11%

## Appendix A.2—Regional Energy Burden Data

**A2.1.** Regional energy burdens, including sample sizes for each region, median energy burdens, median monthly energy bill, and the percentage with high and severe burdens

Region	Sample size	Median energy burden	Median annual income	Median annual energy expenditures	Upper-quartile energy burden	High burden percentage (>6%)	Severe burden percentage (>10%)
East North Central	7,422	3.6%	\$52,500	\$1,920	6.8%	29%	15%
East South Central	2,177	4.4%	\$39,400	\$1,800	8.5%	38%	21%
Middle Atlantic	4,851	3.4%	\$60,000	\$2,040	6.8%	29%	16%
Mountain	3,932	2.9%	\$57,625	\$1,680	5.2%	21%	11%
New England	2,778	3.5%	\$71,985	\$2,640	6.7%	29%	15%
Pacific	11,177	2.3%	\$69,800	\$1,680	4.5%	18%	9%
South Atlantic	11,363	3.2%	\$56,120	\$1,920	6.2%	26%	14%
West North Central	2,412	3.1%	\$55,100	\$1,800	5.8%	25%	12%
West South Central	7,427	3.3%	\$52,000	\$1,800	6.0%	25%	13%
National	53,539	3.1%	\$58,000	\$1,800	6.0%	25%	13%

**A2.2.** Regional median energy burdens for income-based groups

Region	Low-income (≤200% FPL)	Low-income with older adults (65+)	Low-income with child under 6	Low-income with disability	Low-income multifamily (5+ units, ≤200% FPL)	Non-low-income (>200% FPL)
East North Central	9.1%	9.8%	8.2%	9.2%	6.0%	2.6%
East South Central	9.1%	10.0%	8.6%	9.9%	6.6%	2.9%
Middle Atlantic	9.4%	10.7%	7.9%	10.2%	6.9%	2.6%
Mountain	6.9%	8.4%	5.7%	7.7%	4.5%	2.2%
New England	10.5%	11.6%	9.6%	10.8%	5.6%	2.9%
Pacific	6.8%	7.5%	5.4%	6.9%	5.3%	1.7%
South Atlantic	8.4%	9.5%	7.7%	8.8%	5.8%	2.3%
West North Central	7.9%	9.1%	7.1%	7.9%	4.7%	2.5%
West South Central	7.7%	9.6%	6.6%	9.0%	5.8%	2.4%
National	8.1%	9.3%	7.1%	8.7%	5.6%	2.3%

**A2.3.** Regional median energy burdens based on race/ethnicity, age, and tenure status

Region	White (non-Hispanic)	Black	Hispanic	Older adults (65+ years)	Renter	Owner
East North Central	3.4%	5.1%	3.4%	4.7%	4.2%	3.3%
East South Central	4.0%	6.2%	5.0%	5.7%	5.3%	4.0%
Middle Atlantic	3.2%	4.4%	4.5%	4.8%	3.8%	3.2%
Mountain	2.6%	3.3%	3.7%	3.8%	3.0%	2.8%
New England	3.4%	4.0%	4.6%	4.8%	3.6%	3.5%
Pacific	2.1%	3.2%	3.0%	3.3%	2.5%	2.2%
South Atlantic	2.9%	4.0%	3.4%	4.4%	3.5%	3.0%
West North Central	3.0%	4.6%	3.3%	3.9%	3.9%	2.9%
West South Central	2.9%	4.0%	4.0%	4.4%	3.6%	3.1%
National	2.9%	4.2%	3.5%	4.2%	3.4%	3.0%

**A2.4.** Regional median energy burdens based on building type

Region	Single family	Multifamily (5+ units)	Low-income multifamily (5+ units, ≤200% FPL)	Built before 1980	Built after 1980
East North Central	3.6%	3.0%	6.0%	4.0%	2.9%
East South Central	4.3%	3.9%	6.6%	4.9%	3.9%
Middle Atlantic	3.5%	2.5%	6.9%	3.6%	2.9%
Mountain	2.9%	2.3%	4.5%	3.3%	2.7%
New England	3.6%	2.4%	5.6%	3.7%	3.1%
Pacific	2.4%	1.9%	5.3%	2.3%	2.3%
South Atlantic	3.2%	2.5%	5.8%	3.6%	2.9%
West North Central	3.1%	2.6%	4.7%	3.4%	2.7%
West South Central	3.3%	2.6%	5.8%	3.9%	3.0%
National	3.1%	2.4%	5.6%	3.4%	2.8%

**A2.5.** Regional upper-quartile energy burdens for income-based groups (25% of households in each group have a burden above the upper-quartile threshold)

Region	Low-income (≤200% FPL)	Low-income with older adults (65+)	Low-income with child under 6	Low-income with disability	Low-income multifamily	Non-low-income (>200% FPL)
East North Central	16.4%	17.6%	14.2%	15.9%	10.6%	3.9%
East South Central	15.7%	15.7%	18.7%	17.2%	12.0%	4.2%
Middle Atlantic	17.6%	20.1%	15.6%	18.5%	12.9%	4.0%
Mountain	12.0%	15.3%	9.6%	13.6%	8.4%	3.3%
New England	19.3%	21.7%	15.4%	19.2%	10.8%	4.5%
Pacific	12.0%	13.7%	10.2%	12.0%	9.2%	2.8%
South Atlantic	14.7%	15.9%	12.4%	15.7%	10.0%	3.6%
West North Central	14.1%	14.5%	13.7%	14.6%	8.7%	3.6%
West South Central	12.9%	17.5%	10.1%	16.5%	10.2%	3.5%
National	14.4%	16.3%	12.0%	15.6%	10.1%	3.6%

**A2.6.** Regional upper-quartile energy burdens based on race/ethnicity, age, and tenure status (25% of households in each group have a burden above the upper-quartile threshold)

Region	White (non-Hispanic)	Black	Hispanic	Older adults (65+ years)	Renter	Owner
East North Central	6.4%	10.0%	6.1%	8.4%	8.4%	6.1%
East South Central	7.4%	12.3%	9.2%	10.3%	10.9%	7.2%
Middle Atlantic	6.2%	9.8%	8.6%	9.3%	8.0%	6.1%
Mountain	4.8%	6.3%	6.2%	7.0%	5.7%	4.9%
New England	6.3%	8.1%	9.3%	9.5%	7.8%	6.0%
Pacific	4.1%	6.5%	5.6%	6.4%	5.1%	4.1%
South Atlantic	5.5%	8.0%	6.2%	8.4%	7.4%	5.5%
West North Central	5.5%	9.3%	6.1%	7.3%	7.8%	5.2%
West South Central	5.1%	7.6%	7.1%	8.6%	7.3%	5.4%
National	5.5%	8.4%	6.5%	8.1%	7.1%	5.4%

**A2.7.** Regional upper-quartile energy burdens based on building type (25% of households in each group have a burden above the upper-quartile threshold)

Region	Single family	Multifamily (5+ units)	Low-income multifamily ( $\leq 200\%$ FPL, 5+ units)	Built before 1980	Built after 1980
East North Central	6.6%	6.5%	10.6%	7.4%	5.7%
East South Central	7.8%	8.2%	12.0%	9.6%	7.5%
Middle Atlantic	6.7%	6.5%	12.9%	7.0%	5.9%
Mountain	5.0%	4.7%	8.4%	5.9%	4.8%
New England	6.4%	6.1%	10.8%	7.2%	5.6%
Pacific	4.4%	4.3%	9.2%	4.7%	4.3%
South Atlantic	6.0%	5.3%	10.0%	7.2%	5.5%
West North Central	5.7%	5.5%	8.7%	6.4%	5.1%
West South Central	5.9%	5.4%	10.2%	7.4%	5.2%
National	5.8%	5.3%	10.1%	6.7%	5.3%

## Appendix A.3–Metro-Level Energy Burden Data

**A3.1.** Metro-level energy burdens, including sample sizes for each city, median energy burdens, median monthly energy bill, and percentage with high burden and severe burden

Metro area	Sample size	Median energy burden	Median annual income	Median annual energy expenditures	Upper-quartile energy burden	High burden percentage (>6%)	Severe burden percentage (>10%)
Atlanta	1,957	3.5%	\$60,000	\$2,280	6.5%	28%	14%
Baltimore	1,741	3.0%	\$75,100	\$2,280	5.5%	23%	11%
Birmingham	1,755	4.2%	\$53,300	\$2,280	7.4%	34%	18%
Boston	1,728	3.1%	\$81,925	\$2,640	5.8%	24%	12%
Chicago	1,788	2.7%	\$65,350	\$1,800	4.8%	20%	10%
Dallas	2,472	2.9%	\$60,000	\$1,920	4.9%	19%	8%
Detroit	1,917	3.8%	\$57,000	\$2,160	6.9%	30%	16%
Houston	2,164	3.0%	\$60,000	\$1,800	5.3%	21%	11%
Las Vegas	1,968	2.8%	\$54,700	\$1,560	4.8%	18%	10%
Los Angeles	2,351	2.2%	\$61,900	\$1,440	4.4%	17%	9%
Miami	1,978	3.0%	\$48,050	\$1,440	5.5%	23%	12%
Minneapolis	1,943	2.2%	\$81,000	\$1,920	3.6%	12%	5%
New York City	1,510	2.9%	\$67,500	\$1,920	6.0%	25%	15%
Oklahoma City	2,111	3.3%	\$52,000	\$1,800	5.8%	24%	11%
Philadelphia	1,852	3.2%	\$66,500	\$2,160	6.3%	26%	14%
Phoenix	2,000	3.0%	\$60,000	\$1,800	5.2%	21%	10%
Richmond	1,933	2.6%	\$69,000	\$1,920	4.7%	17%	9%
Riverside	2,070	3.6%	\$58,750	\$2,160	6.7%	29%	15%
Rochester	1,807	3.8%	\$56,000	\$2,160	6.7%	29%	15%
San Antonio	2,014	3.0%	\$55,000	\$1,800	5.4%	22%	11%
San Francisco	1,950	1.4%	\$100,000	\$1,440	2.9%	10%	6%
San Jose	2,043	1.5%	\$109,000	\$1,560	2.9%	11%	6%
Seattle	2,162	1.8%	\$79,800	\$1,440	3.3%	11%	6%
Tampa	1,701	2.8%	\$52,000	\$1,560	5.3%	21%	11%
Washington, DC	2,214	2.0%	\$100,000	\$2,160	3.9%	14%	7%
National	53,539	3.1%	\$58,000	\$1,800	6.0%	25%	13%

**A3.2.** Metro-level median energy burdens for income-based groups

<b>Metro area</b>	<b>Low-income (≤200% FPL)</b>	<b>Low-income with older adults (65+)</b>	<b>Low-income with child under 6</b>	<b>Low- income with disability</b>	<b>Low-income multifamily (5+ units, ≤200% FPL)</b>	<b>Non-low- income (&gt;200% FPL)</b>
Atlanta	9.7%	12.6%	8.1%	10.4%	6.6%	2.7%
Baltimore	10.5%	11.4%	7.8%	10.0%	7.5%	2.6%
Birmingham	10.9%	12.9%	9.3%	10.7%	6.8%	3.0%
Boston	10.1%	11.8%	9.5%	10.4%	6.6%	2.6%
Chicago	8.0%	9.5%	5.9%	8.0%	6.4%	2.1%
Dallas	6.7%	10.0%	6.0%	8.1%	5.0%	2.4%
Detroit	10.2%	12.0%	8.6%	10.7%	6.0%	2.8%
Houston	7.1%	9.9%	5.8%	9.6%	5.8%	2.2%
Las Vegas	6.5%	8.3%	5.0%	6.5%	5.3%	2.2%
Los Angeles	6.0%	6.4%	4.9%	6.1%	4.8%	1.6%
Miami	6.9%	8.0%	5.0%	7.6%	5.5%	2.1%
Minneapolis	6.6%	8.7%	4.7%	7.0%	4.3%	2.0%
New York City	9.3%	11.4%	7.5%	11.0%	8.0%	2.1%
Oklahoma City	7.8%	9.5%	6.1%	8.7%	6.5%	2.6%
Philadelphia	9.5%	10.4%	8.1%	10.1%	6.5%	2.4%
Phoenix	7.0%	8.3%	5.6%	7.3%	4.6%	2.4%
Richmond	8.2%	10.3%	6.9%	8.4%	5.0%	2.3%
Riverside	8.7%	10.6%	6.7%	9.6%	6.1%	2.7%
Rochester	9.5%	10.1%	7.9%	9.4%	6.0%	2.9%
San Antonio	7.4%	9.5%	6.0%	8.6%	4.8%	2.4%
San Francisco	6.1%	7.0%	4.7%	6.6%	4.9%	1.2%
San Jose	6.5%	8.1%	4.4%	7.6%	4.7%	1.2%
Seattle	6.0%	6.8%	4.4%	6.0%	4.1%	1.6%
Tampa	7.2%	8.0%	5.6%	8.0%	4.9%	2.1%
Washington, DC	7.5%	9.3%	5.9%	8.3%	5.2%	1.8%
National	8.1%	9.3%	7.1%	8.7%	5.6%	2.3%

**A3.3.** Metro-level median energy burdens based on race/ethnicity, age, and tenure status

<b>Metro area</b>	<b>White (non-Hispanic)</b>	<b>Black</b>	<b>Hispanic</b>	<b>Older adults (65+)</b>	<b>Renter</b>	<b>Owner</b>
Atlanta	3.1%	4.1%	4.7%	5.1%	3.7%	3.4%
Baltimore	2.8%	3.8%	3.3%	4.1%	3.2%	2.9%
Birmingham	3.8%	5.6%	4.8%	5.8%	5.2%	3.9%
Boston	3.0%	3.7%	3.6%	4.4%	3.2%	3.0%
Chicago	2.4%	4.1%	3.0%	3.7%	3.1%	2.5%
Dallas	2.6%	3.3%	3.8%	3.8%	2.9%	3.0%
Detroit	3.5%	5.3%	4.5%	5.2%	4.6%	3.6%
Houston	2.5%	3.5%	3.4%	4.1%	3.3%	2.7%
Las Vegas	2.7%	3.2%	3.0%	3.4%	3.0%	2.7%
Los Angeles	1.8%	3.6%	2.6%	3.2%	2.4%	2.1%
Miami	2.5%	3.4%	3.1%	4.2%	3.1%	2.8%
Minneapolis	2.2%	2.6%	2.7%	3.0%	2.3%	2.2%
New York City	2.6%	3.6%	3.8%	4.2%	3.3%	2.7%
Oklahoma City	3.1%	3.9%	4.2%	4.0%	3.9%	3.1%
Philadelphia	2.9%	4.4%	5.2%	4.4%	3.9%	3.0%
Phoenix	2.8%	3.2%	3.6%	4.0%	2.8%	3.1%
Richmond	2.4%	3.4%	2.9%	3.5%	2.9%	2.6%
Riverside	3.4%	3.9%	3.7%	5.1%	4.0%	3.4%
Rochester	3.6%	5.1%	5.4%	4.8%	4.3%	3.6%
San Antonio	2.7%	3.1%	3.4%	4.1%	3.1%	3.0%
San Francisco	1.2%	2.4%	1.2%	2.4%	1.4%	1.4%
San Jose	1.4%	1.8%	1.9%	2.4%	1.5%	1.5%
Seattle	1.8%	2.3%	2.0%	2.4%	1.8%	1.8%
Tampa	2.6%	3.6%	3.5%	3.8%	2.8%	2.9%
Washington, DC	1.7%	2.9%	2.7%	2.9%	2.0%	2.0%
National	2.9%	4.2%	3.5%	4.2%	3.4%	3.0%

**A3.4.** Metro-level median energy burdens based on building type

<b>Metro area</b>	<b>Single family</b>	<b>Multifamily (5+ units)</b>	<b>Low-income multifamily (5+ units, ≤200% FPL)</b>	<b>Built before 1980</b>	<b>Built after 1980</b>
Atlanta	3.7%	2.5%	6.6%	4.5%	3.3%
Baltimore	3.2%	2.5%	7.5%	3.6%	2.4%
Birmingham	4.1%	3.5%	6.8%	5.1%	3.6%
Boston	3.1%	2.2%	6.6%	3.2%	2.6%
Chicago	2.6%	2.7%	6.4%	2.9%	2.2%
Dallas	3.1%	2.2%	5.0%	3.5%	2.7%
Detroit	3.8%	2.5%	6.0%	4.3%	3.0%
Houston	3.0%	2.5%	5.8%	3.4%	2.7%
Las Vegas	2.8%	2.4%	5.3%	3.6%	2.7%
Los Angeles	2.3%	2.1%	4.8%	2.3%	2.1%
Miami	2.9%	2.9%	5.5%	3.3%	2.6%
Minneapolis	2.3%	1.8%	4.3%	2.5%	2.0%
New York City	3.0%	2.4%	8.0%	3.0%	2.4%
Oklahoma City	3.2%	3.3%	6.5%	3.8%	2.9%
Philadelphia	3.3%	2.7%	6.5%	3.6%	2.5%
Phoenix	3.1%	2.1%	4.6%	3.6%	2.8%
Richmond	2.6%	2.1%	5.0%	3.1%	2.3%
Riverside	3.5%	3.9%	6.1%	4.3%	3.3%
Rochester	3.7%	3.2%	6.0%	4.0%	3.4%
San Antonio	3.0%	2.6%	4.8%	3.9%	2.7%
San Francisco	1.5%	1.3%	4.9%	1.4%	1.4%
San Jose	1.6%	1.2%	4.7%	1.6%	1.3%
Seattle	1.9%	1.5%	4.1%	2.0%	1.7%
Tampa	2.8%	2.2%	4.9%	3.3%	2.5%
Washington, DC	2.2%	1.4%	5.2%	2.3%	1.9%
National	3.1%	2.4%	5.6%	3.4%	2.8%

**A3.5.** Metro-level upper-quartile energy burdens for income-based groups (25% of households in each group have a burden above the upper-quartile threshold)

<b>Metro area</b>	<b>Low-income (≤200% FPL)</b>	<b>Low-income with older adults (65+)</b>	<b>Low-income with child under 6</b>	<b>Low-income with disability</b>	<b>Low-income multifamily</b>	<b>Non-low-income (&gt;200% FPL)</b>
Atlanta	16.2%	19.1%	12.8%	17.9%	11.7%	4.1%
Baltimore	21.7%	34.0%	10.9%	27.1%	5.5%	3.8%
Birmingham	18.3%	20.0%	17.1%	17.7%	13.9%	4.6%
Boston	18.6%	21.8%	16.0%	21.4%	11.7%	4.2%
Chicago	15.1%	17.5%	11.2%	13.2%	12.7%	3.1%
Dallas	11.4%	17.1%	8.5%	15.4%	7.9%	3.6%
Detroit	18.8%	21.2%	13.6%	19.8%	9.6%	4.3%
Houston	12.2%	20.2%	9.0%	22.0%	9.8%	3.2%
Las Vegas	13.8%	21.8%	8.0%	13.7%	10.9%	3.2%
Los Angeles	10.4%	11.4%	8.4%	11.2%	8.7%	2.6%
Miami	11.2%	13.3%	10.0%	13.0%	10.0%	3.0%
Minneapolis	12.2%	14.8%	6.9%	12.6%	7.7%	2.9%
New York City	16.8%	21.8%	14.1%	18.6%	15.0%	3.4%
Oklahoma City	12.5%	14.0%	9.9%	12.4%	10.2%	3.7%
Philadelphia	19.1%	24.9%	14.7%	20.0%	12.1%	3.8%
Phoenix	11.9%	15.3%	9.2%	12.7%	7.3%	3.5%
Richmond	15.6%	22.0%	10.4%	19.2%	8.8%	3.3%
Riverside	15.0%	16.6%	10.7%	16.5%	9.9%	3.9%
Rochester	15.9%	20.0%	14.0%	14.7%	9.9%	4.3%
San Antonio	13.3%	16.6%	9.2%	16.2%	9.2%	3.5%
San Francisco	14.3%	14.3%	8.5%	14.4%	11.0%	2.0%
San Jose	12.5%	14.9%	7.6%	14.9%	8.9%	2.0%
Seattle	10.9%	12.0%	9.2%	9.9%	6.8%	2.4%
Tampa	12.1%	12.1%	10.7%	12.7%	9.2%	3.2%
Washington, DC	13.5%	17.6%	8.9%	15.0%	9.1%	2.9%
National	14.4%	16.3%	12.0%	15.6%	10.1%	3.6%

**A3.6.** Metro-level upper-quartile energy burdens based on race/ethnicity, age, and tenure status (25% of households in each group have a burden above the upper-quartile threshold)

<b>Metro area</b>	<b>White (non-Hispanic)</b>	<b>Black</b>	<b>Hispanic</b>	<b>Older adults (65+)</b>	<b>Renter</b>	<b>Owner</b>
Atlanta	5.4%	8.1%	7.4%	9.8%	7.2%	6.2%
Baltimore	5.0%	8.3%	4.9%	8.0%	6.7%	5.1%
Birmingham	6.7%	11.8%	8.7%	10.7%	10.4%	6.8%
Boston	5.6%	8.1%	7.7%	9.0%	6.8%	5.6%
Chicago	4.2%	8.5%	4.9%	7.5%	6.0%	4.4%
Dallas	4.3%	5.8%	6.0%	7.0%	5.1%	4.8%
Detroit	6.3%	9.4%	7.2%	9.0%	8.9%	6.3%
Houston	4.4%	6.6%	6.1%	8.0%	6.2%	4.8%
Las Vegas	4.6%	6.1%	5.0%	6.1%	5.3%	4.3%
Los Angeles	3.6%	6.5%	5.0%	6.1%	5.1%	3.8%
Miami	4.4%	6.9%	5.8%	8.3%	6.4%	5.0%
Minneapolis	3.5%	4.4%	4.5%	5.4%	4.2%	3.5%
New York City	5.4%	8.2%	7.9%	10.1%	7.2%	5.3%
Oklahoma City	5.4%	7.4%	6.6%	7.7%	6.8%	5.2%
Philadelphia	5.2%	10.2%	9.2%	8.4%	7.9%	5.5%
Phoenix	4.8%	6.2%	6.0%	7.0%	5.2%	5.2%
Richmond	4.1%	7.0%	5.8%	6.8%	5.5%	4.4%
Riverside	6.7%	7.3%	6.9%	9.2%	7.2%	6.4%
Rochester	6.2%	11.6%	11.4%	9.0%	8.1%	6.1%
San Antonio	4.6%	5.2%	6.4%	7.9%	5.5%	5.3%
San Francisco	2.5%	5.3%	3.6%	4.7%	3.0%	2.8%
San Jose	2.8%	3.7%	3.4%	5.0%	3.1%	2.8%
Seattle	3.2%	4.5%	4.1%	5.1%	3.6%	3.2%
Tampa	5.0%	7.1%	6.3%	6.5%	5.6%	5.2%
Washington, DC	3.0%	5.1%	5.1%	6.0%	4.4%	3.6%
National	5.5%	8.4%	6.5%	8.1%	7.1%	5.4%

**A3.7.** Metro-level upper-quartile energy burdens based on building type (25% of households in each group have a burden above the upper-quartile threshold)

Metro area	Single family	Multifamily (5+ units)	Low-income multifamily ( $\leq 200\%$ FPL, 5+ units)	Built before 1980	Built after 1980
Atlanta	6.6%	5.3%	11.7%	8.1%	5.8%
Baltimore	5.5%	5.5%	5.5%	6.9%	4.0%
Birmingham	7.3%	6.5%	13.9%	9.7%	6.3%
Boston	5.6%	5.6%	11.7%	6.2%	4.9%
Chicago	4.5%	5.3%	12.7%	5.5%	4.0%
Dallas	5.1%	4.2%	7.9%	6.0%	4.6%
Detroit	6.8%	6.0%	9.6%	7.5%	5.7%
Houston	5.1%	5.1%	9.8%	6.1%	4.8%
Las Vegas	4.7%	4.7%	10.9%	6.7%	4.4%
Los Angeles	4.4%	4.4%	8.7%	4.5%	4.1%
Miami	5.2%	5.5%	10.0%	6.2%	4.8%
Minneapolis	3.6%	3.3%	7.7%	3.9%	3.3%
New York City	6.3%	6.6%	15.0%	5.9%	6.4%
Oklahoma City	5.5%	6.8%	10.2%	6.9%	4.7%
Philadelphia	6.2%	5.8%	12.1%	7.0%	4.9%
Phoenix	5.1%	4.2%	7.3%	6.0%	4.6%
Richmond	4.7%	4.0%	8.8%	6.0%	3.9%
Riverside	6.5%	6.9%	9.9%	7.8%	5.8%
Rochester	6.5%	6.3%	9.9%	7.1%	5.9%
San Antonio	5.5%	4.3%	9.2%	7.5%	4.5%
San Francisco	3.0%	2.6%	11.0%	2.9%	2.8%
San Jose	3.0%	2.6%	8.9%	3.1%	2.5%
Seattle	3.2%	3.2%	6.8%	3.6%	3.1%
Tampa	5.2%	4.4%	9.2%	6.5%	4.5%
Washington, DC	4.0%	3.2%	9.1%	4.5%	3.2%
National	5.8%	5.3%	10.1%	6.7%	5.3%

# APPENDIX B.

# **High and Severe Energy Burdens**

This section includes 2017 population data from the American Housing Survey (AHS) Table Creator for both national and metropolitan statistical area samples. [www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html](http://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html).

## Appendix B.1–National High and Severe Energy Burdens

**B1.1.** Total national households in each subgroup, and each subgroup’s total households with a high energy burden (≥6%) and total households with severe energy burden (≥10%)

Category	Subgroup	Total households	Percentage highly burdened (≥6%)	Total highly burdened households (≥6%)	Percentage severely burdened (≥10%)	Total severely burdened households (≥10%)
Income	All households	121,560,000	25%	30,585,830	13%	15,861,674
	Low-income (≤200% FPL)	38,551,000	67%	25,776,144	40%	15,383,432
	Non-low-income (>200% FPL)	83,009,000	6%	5,214,246	1%	738,779
Race/ ethnicity	Black	16,552,000	36%	5,995,213	21%	3,469,788
	Native American	1,483,000	36%	541,155	19%	283,884
	Hispanic	16,496,000	28%	4,572,335	14%	2,250,966
	White (non-Hispanic)	80,550,000	23%	21,924,520	11%	10,485,640
Age	Older adults (65+)	34,929,000	36%	12,487,949	19%	6,701,933
Tenure	Renters	43,993,000	30%	13,218,332	17%	7,290,945
	Owners	77,567,000	22%	17,174,847	11%	8,431,501
Housing type	Low-income multifamily (5+ units) and low-income (≤200% FPL)	9,345,000	47%	4,413,429	26%	2,408,442
	Small multifamily (2-4 units)	8,363,000	47%	3,949,653	26%	2,155,356
	Manufactured homes	6,727,000	45%	2,999,580	25%	1,709,320
	Built before 1980	55,723,000	29%	15,911,480	15%	8,392,366
	Single family	85,791,000	24%	20,831,649	12%	10,476,575
	Multifamily (5+ units)	20,605,000	22%	4,572,668	12%	2,449,125
	Built after 1980	65,838,000	21%	14,114,223	11%	7,137,071

## Appendix B.2—Regional High and Severe Energy Burdens

**B2.1.** Total households in each region, and each region's total households with a high energy burden ( $\geq 6\%$ ) and total households with severe energy burden ( $\geq 10\%$ )

Region	Total households in region	Percentage highly burdened ( $\geq 6\%$ )	Total highly burdened households ( $\geq 6\%$ )	Percentage severely burdened ( $\geq 10\%$ )	Total severely burdened households ( $\geq 10\%$ )
East North Central	18,522,000	29%	5,371,380	15%	2,778,300
East South Central	7,417,000	38%	2,818,460	21%	1,557,570
Middle Atlantic	16,019,000	29%	4,645,510	16%	2,563,040
Mountain	8,916,000	21%	1,872,360	11%	980,760
New England	5,809,000	29%	1,684,610	15%	871,350
Pacific	18,305,000	18%	3,294,900	9%	1,647,450
South Atlantic	23,974,000	26%	6,233,240	14%	3,356,360
West North Central	8,527,000	25%	2,131,750	12%	1,023,240
West South Central	14,070,000	25%	3,517,500	13%	1,829,100
National	121,560,000	25%	30,585,830	13%	15,861,674

**B2.2.** Total low-income households in each region, and each region's total low-income households with a high energy burden ( $\geq 6\%$ ) and total low-income households with severe energy burden ( $\geq 10\%$ )

Region	Total low-income households in region	Percentage highly burdened ( $\geq 6\%$ )	Total highly burdened low-income households ( $\geq 6\%$ )	Percentage severely burdened ( $\geq 10\%$ )	Total severely burdened low-income households ( $\geq 10\%$ )
East North Central	5,979,000	74%	4,424,460	45%	2,690,550
East South Central	2,976,000	74%	2,202,240	46%	1,368,960
Middle Atlantic	4,827,000	72%	3,475,440	48%	2,316,960
Mountain	2,719,000	58%	1,577,020	33%	897,270
New England	1,621,000	75%	1,215,750	52%	842,920
Pacific	5,064,000	57%	2,886,480	33%	1,671,120
South Atlantic	8,042,000	69%	5,548,980	41%	3,297,220
West North Central	2,297,000	66%	1,516,020	39%	895,830
West South Central	5,026,000	66%	3,317,160	36%	1,809,360
National	38,551,000	67%	25,776,144	40%	15,383,432

**B2.3.** Total Black households in each region, and each region's total Black households with a high energy burden ( $\geq 6\%$ ) and total Black households with severe energy burden ( $\geq 10\%$ )

Region	Total Black households in region	Percentage highly burdened ( $\geq 6\%$ )	Total highly burdened Black households ( $\geq 6\%$ )	Percentage severely burdened ( $\geq 10\%$ )	Total severely burdened Black households ( $\geq 10\%$ )
East North Central	2,336,000	43%	1,004,480	25%	584,000
East South Central	1,595,000	51%	813,450	31%	494,450
Middle Atlantic	2,437,000	38%	926,060	25%	609,250
Mountain	359,000	27%	96,930	13%	46,670
New England	401,000	33%	132,330	17%	68,170
Pacific	1,077,000	26%	280,020	15%	161,550
South Atlantic	5,485,000	35%	1,919,750	20%	1,097,000
West North Central	585,000	40%	234,000	24%	140,400
West South Central	2,277,000	34%	774,180	19%	432,630
National	16,552,000	36%	5,995,213	21%	3,469,788

**B2.4.** Total Hispanic households in each region, and each region's total Hispanic households with a high energy burden ( $\geq 6\%$ ) and total Hispanic households with severe energy burden ( $\geq 10\%$ )

Region	Total Hispanic households in region	Percentage highly burdened ( $\geq 6\%$ )	Total highly burdened Hispanic households ( $\geq 6\%$ )	Percentage severely burdened ( $\geq 10\%$ )	Total severely burdened Hispanic households ( $\geq 10\%$ )
East North Central	1,083,000	26%	281,580	12%	129,960
East South Central	197,000	38%	74,860	23%	45,310
Middle Atlantic	2,052,000	38%	779,760	22%	451,440
Mountain	1,721,000	27%	464,670	13%	223,730
New England	563,000	40%	225,200	23%	129,490
Pacific	4,466,000	23%	1,027,180	11%	491,260
South Atlantic	2,695,000	26%	700,700	12%	323,400
West North Central	360,000	26%	93,600	15%	54,000
West South Central	3,359,000	31%	1,041,290	15%	503,850
National	16,496,000	28%	4,572,335	14%	2,250,966

**B2.5.** Total older adult (65+) households in each region, and each region's total older adult (65+) households with a high energy burden ( $\geq 6\%$ ) and total older adult (65+) households with severe energy burden ( $\geq 10\%$ )

<b>Region</b>	<b>Total older adult (65+) households in MSA</b>	<b>Percentage highly burdened (<math>\geq 6\%</math>)</b>	<b>Total highly burdened older adult households (<math>\geq 6\%</math>)</b>	<b>Percentage severely burdened (<math>\geq 10\%</math>)</b>	<b>Total severely burdened older adult households (<math>\geq 10\%</math>)</b>
East North Central	4,711,000	39%	1,837,290	20%	942,200
East South Central	1,902,000	49%	931,980	26%	494,520
Middle Atlantic	4,228,000	41%	1,733,480	23%	972,440
Mountain	2,258,000	30%	677,400	15%	338,700
New England	1,578,000	41%	646,980	24%	378,720
Pacific	4,328,000	27%	1,168,560	14%	605,920
South Atlantic	6,402,000	37%	2,368,740	21%	1,344,420
West North Central	2,202,000	32%	704,640	17%	374,340
West South Central	3,058,000	37%	1,131,460	21%	642,180
<b>National</b>	<b>34,929,000</b>	<b>36%</b>	<b>12,487,949</b>	<b>19%</b>	<b>6,701,933</b>

**B2.6.** Total renting households in each region, and each region's total renting households with a high energy burden ( $\geq 6\%$ ) and total renting households with severe energy burden ( $\geq 10\%$ )

Region	Total renting households in region	Percentage highly burdened ( $\geq 6\%$ )	Total highly burdened renting households ( $\geq 6\%$ )	Percentage severely burdened ( $\geq 10\%$ )	Total severely burdened renting households ( $\geq 10\%$ )
East North Central	5,945,000	37%	2,199,650	21%	1,248,450
East South Central	2,458,000	46%	1,130,680	28%	688,240
Middle Atlantic	6,279,000	34%	2,134,860	21%	1,318,590
Mountain	3,091,000	24%	741,840	12%	370,920
New England	2,092,000	34%	711,280	19%	397,480
Pacific	7,910,000	21%	1,661,100	11%	870,100
South Atlantic	8,395,000	31%	2,602,450	17%	1,427,150
West North Central	2,616,000	34%	889,440	19%	497,040
West South Central	5,207,000	31%	1,614,170	17%	885,190
National	43,993,000	30%	13,218,332	17%	7,290,945

## Appendix B.3–Metro Area High and Severe Energy Burdens

**B3.1.** Total households in each MSA, and each MSA's total households with a high energy burden ( $\geq 6\%$ ) and total households with severe energy burden ( $\geq 10\%$ )

Metro area	Total households in MSA	Percentage highly burdened ( $\geq 6\%$ )	Total highly burdened households ( $\geq 6\%$ )	Percentage severely burdened ( $\geq 10\%$ )	Total severely burdened households ( $\geq 10\%$ )
Atlanta	2,108,800	28%	589,430	14%	287,711
Baltimore	1,047,600	23%	237,681	11%	120,345
Birmingham	447,000	34%	153,330	18%	80,995
Boston	1,853,800	24%	447,358	12%	230,652
Chicago	3,526,500	20%	704,117	10%	362,906
Dallas	2,564,700	19%	483,475	8%	216,838
Detroit	1,723,300	30%	518,698	16%	269,687
Houston	2,329,000	21%	499,379	11%	249,689
Las Vegas	798,600	18%	145,680	10%	80,347
Los Angeles	4,395,700	17%	768,453	9%	390,770
Miami	2,090,600	23%	476,674	12%	249,435
Minneapolis	1,379,600	12%	159,048	5%	71,714
New York City	7,428,000	25%	1,859,460	15%	1,111,740
Oklahoma City	515,900	24%	124,637	11%	57,920
Philadelphia	2,308,400	26%	609,507	14%	332,798
Phoenix	1,685,600	21%	351,448	10%	165,189
Richmond	489,500	17%	85,086	9%	46,342
Riverside	1,314,500	29%	382,285	15%	197,493
Rochester	439,700	29%	127,262	15%	64,726
San Antonio	805,700	22%	176,022	11%	88,011
San Francisco	1,706,200	10%	170,620	6%	100,622
San Jose	657,700	11%	71,468	6%	38,953
Seattle	1,485,700	11%	170,423	6%	83,837
Tampa	1,182,800	21%	248,937	11%	127,945
Washington, DC	2,178,800	14%	299,167	7%	149,583
<b>National</b>	<b>120,062,818</b>	<b>25%</b>	<b>30,585,830</b>	<b>13%</b>	<b>15,861,674</b>

**B3.2.** Total low-income households in each MSA, and each MSA's total low-income households with a high energy burden ( $\geq 6\%$ ) and total low-income households with severe energy burden ( $\geq 10\%$ )

Metro area	Total low-income households in MSA	Percentage highly burdened ( $\geq 6\%$ )	Total highly burdened low-income households ( $\geq 6\%$ )	Percentage severely burdened ( $\geq 10\%$ )	Total severely burdened low-income households ( $\geq 10\%$ )
Atlanta	589,900	79%	466,021	48%	283,152
Baltimore	241,200	77%	185,724	52%	125,424
Birmingham	156,000	82%	127,920	54%	84,240
Boston	412,700	74%	305,398	51%	210,477
Chicago	1,025,400	68%	697,272	39%	399,906
Dallas	692,500	49%	339,325	31%	214,675
Detroit	551,700	80%	441,360	51%	281,367
Houston	731,100	61%	445,971	34%	248,574
Las Vegas	253,700	55%	139,535	33%	83,721
Los Angeles	1,371,300	50%	685,650	27%	370,251
Miami	820,900	57%	467,913	31%	254,479
Minneapolis	256,900	57%	146,433	32%	82,208
New York City	2,248,400	70%	1,573,880	48%	1,079,232
Oklahoma City	155,400	68%	105,672	37%	57,498
Philadelphia	652,300	74%	482,702	48%	313,104
Phoenix	507,800	59%	299,602	32%	162,496
Richmond	122,100	64%	78,144	40%	48,840
Riverside	453,700	71%	322,127	44%	199,628
Rochester	137,400	73%	100,302	46%	63,204
San Antonio	260,800	62%	161,696	35%	91,280
San Francisco	326,600	51%	166,566	32%	104,512
San Jose	121,500	54%	65,610	32%	38,880
Seattle	290,000	50%	145,000	28%	81,200
Tampa	377,900	61%	230,519	36%	136,044
Washington, DC	399,200	60%	239,520	36%	143,712
National	38,551,000	67%	25,776,144	40%	15,383,432

**B3.3.** Total Black households in each MSA, and each MSA's total Black households with a high energy burden ( $\geq 6\%$ ) and total Black households with severe energy burden ( $\geq 10\%$ )

<b>Metro area</b>	<b>Total Black households in MSA</b>	<b>Percentage highly burdened (<math>\geq 6\%</math>)</b>	<b>Total highly burdened Black households (<math>\geq 6\%</math>)</b>	<b>Percentage severely burdened (<math>\geq 10\%</math>)</b>	<b>Total severely burdened Black households (<math>\geq 10\%</math>)</b>
Atlanta	789,500	36%	284,220	21%	165,795
Baltimore	324,100	34%	110,194	20%	64,820
Birmingham	137,000	47%	64,390	30%	41,100
Boston	157,900	32%	50,528	16%	25,264
Chicago	682,800	37%	252,636	21%	143,388
Dallas	466,000	25%	116,500	14%	65,240
Detroit	427,900	43%	183,997	23%	98,417
Houston	482,400	29%	139,896	15%	72,360
Las Vegas	112,600	26%	29,276	18%	20,268
Los Angeles	372,200	27%	100,494	15%	55,830
Miami	459,500	29%	133,255	18%	82,710
Minneapolis	113,000	15%	16,950	7%	7,910
New York City	1,459,600	32%	467,072	21%	306,516
Oklahoma City	61,000	32%	19,520	17%	10,370
Philadelphia	542,900	39%	211,731	25%	135,725
Phoenix	107,200	26%	27,872	15%	16,080
Richmond	153,500	28%	42,980	15%	23,025
Riverside	129,300	30%	38,790	17%	21,981
Rochester	48,000	44%	21,120	29%	13,920
San Antonio	61,500	20%	12,300	11%	6,765
San Francisco	157,900	24%	37,896	15%	23,685
San Jose	20,600	14%	2,884	11%	2,266
Seattle	94,100	14%	13,174	6%	5,646
Tampa	144,500	28%	40,460	18%	26,010
Washington, DC	631,200	21%	132,552	10%	63,120
<b>National</b>	<b>16,552,000</b>	<b>36%</b>	<b>5,995,213</b>	<b>21%</b>	<b>3,469,788</b>

**B3.4.** Total Hispanic households in each MSA, and each MSA's total Hispanic households with a high energy burden ( $\geq 6\%$ ) and total Hispanic households with severe energy burden ( $\geq 10\%$ )

Metro area	Total Hispanic households in MSA	Percentage highly burdened ( $\geq 6\%$ )	Total highly burdened Hispanic households ( $\geq 6\%$ )	Percentage severely burdened ( $\geq 10\%$ )	Total severely burdened Hispanic households ( $\geq 10\%$ )
Atlanta	168,100	35%	58,835	14%	23,534
Baltimore	42,800	21%	8,988	8%	3,424
Birmingham	14,400	40%	5,760	18%	2,592
Boston	184,900	30%	55,470	17%	31,433
Chicago	561,600	19%	106,704	9%	50,544
Dallas	592,600	25%	148,150	10%	59,260
Detroit	55,200	38%	20,976	15%	8,280
Houston	706,000	25%	176,500	11%	77,660
Las Vegas	186,600	18%	33,588	10%	18,660
Los Angeles	1,589,200	20%	317,840	10%	158,920
Miami	884,800	24%	212,352	12%	106,176
Minneapolis	60,500	16%	9,680	10%	6,050
New York City	1,544,500	33%	509,685	19%	293,455
Oklahoma City	52,300	29%	15,167	16%	8,368
Philadelphia	154,100	45%	69,345	24%	36,984
Phoenix	378,300	25%	94,575	11%	41,613
Richmond	25,100	24%	6,024	11%	2,761
Riverside	579,000	31%	179,490	15%	86,850
Rochester	25,500	44%	11,220	26%	6,630
San Antonio	400,900	27%	108,243	14%	56,126
San Francisco	284,300	12%	34,116	8%	22,744
San Jose	139,200	13%	18,096	7%	9,744
Seattle	109,600	15%	16,440	7%	7,672
Tampa	188,300	27%	50,841	16%	30,128
Washington, DC	252,700	19%	48,013	6%	15,162
National	16,496,000	28%	4,572,335	14%	2,250,966

**B3.5.** Total older adult (65+) households in each MSA, and each MSA's total older adult (65+) households with a high energy burden ( $\geq 6\%$ ) and total older adult (65+) households with severe energy burden ( $\geq 10\%$ )

<b>Metro area</b>	<b>Total older adult (65+) households in MSA</b>	<b>Percentage highly burdened (<math>\geq 6\%</math>)</b>	<b>Total highly burdened older adult households (<math>\geq 6\%</math>)</b>	<b>Percentage severely burdened (<math>\geq 10\%</math>)</b>	<b>Total severely burdened older adult households (<math>\geq 10\%</math>)</b>
Atlanta	490,700	44%	215,908	24%	117,768
Baltimore	107,700	34%	36,618	18%	19,386
Birmingham	127,800	48%	61,344	27%	34,506
Boston	516,400	38%	196,232	22%	113,608
Chicago	976,800	31%	302,808	16%	156,288
Dallas	540,500	29%	156,745	17%	91,885
Detroit	493,400	41%	202,294	22%	108,548
Houston	503,200	34%	171,088	20%	100,640
Las Vegas	204,400	26%	53,144	15%	30,660
Los Angeles	1,184,600	26%	307,996	14%	165,844
Miami	712,800	35%	249,480	20%	142,560
Minneapolis	339,300	22%	74,646	10%	33,930
New York City	2,162,800	39%	843,492	26%	562,328
Oklahoma City	123,800	35%	43,330	17%	21,046
Philadelphia	674,400	37%	249,528	21%	141,624
Phoenix	502,700	30%	150,810	14%	70,378
Richmond	131,100	29%	38,019	15%	19,665
Riverside	368,300	42%	154,686	24%	88,392
Rochester	133,600	39%	52,104	20%	26,720
San Antonio	188,100	35%	65,835	18%	33,858
San Francisco	498,900	18%	89,802	10%	49,890
San Jose	171,000	20%	34,200	11%	18,810
Seattle	361,100	19%	68,609	9%	32,499
Tampa	402,500	30%	120,750	14%	56,350
Washington, DC	546,800	25%	136,700	14%	76,552
<b>National</b>	<b>34,929,000</b>	<b>36%</b>	<b>12,487,949</b>	<b>19%</b>	<b>6,701,933</b>

**B3.6.** Total renting households in each MSA, and each MSA's total renting households with a high energy burden ( $\geq 6\%$ ) and total renting households with severe energy burden ( $\geq 10\%$ )

Metro area	Total renting households in MSA	Percentage highly burdened ( $\geq 6\%$ )	Total highly burdened renting households ( $\geq 6\%$ )	Percentage severely burdened ( $\geq 10\%$ )	Total severely burdened renting households ( $\geq 10\%$ )
Atlanta	794,400	31%	246,264	16%	127,104
Baltimore	369,100	30%	110,730	16%	59,056
Birmingham	141,700	47%	66,599	28%	39,676
Boston	715,000	28%	200,200	15%	107,250
Chicago	1,238,200	26%	321,932	14%	173,348
Dallas	1,060,200	20%	212,040	10%	106,020
Detroit	527,300	40%	210,920	21%	110,733
Houston	896,000	27%	241,920	14%	125,440
Las Vegas	400,900	21%	84,189	12%	48,108
Los Angeles	2,280,900	21%	478,989	11%	250,899
Miami	853,900	27%	230,553	15%	128,085
Minneapolis	407,700	14%	57,078	7%	28,539
New York City	3,643,800	29%	1,056,702	19%	692,322
Oklahoma City	169,200	30%	50,760	15%	25,380
Philadelphia	614,800	35%	215,180	19%	116,812
Phoenix	593,300	21%	124,593	10%	59,330
Richmond	174,500	23%	40,135	13%	22,685
Riverside	479,300	33%	158,169	16%	76,688
Rochester	144,300	36%	51,948	20%	28,860
San Antonio	305,300	22%	67,166	11%	33,583
San Francisco	375,100	13%	48,763	8%	30,008
San Jose	272,200	12%	32,664	7%	19,054
Seattle	613,600	13%	79,768	7%	42,952
Tampa	418,000	23%	96,140	13%	54,340
Washington, DC	801,800	17%	136,306	8%	64,144
National	43,993,000	30%	13,218,332	17%	7,290,945

# APPENDIX C.

# City- and State-Led Actions to Address High Energy Burdens

## C1. City-led actions to reduce high energy burdens

Metro area	Strategy/action	Year enacted	Description	Data source
Atlanta	Plan with energy burden strategy	2017	The Clean Energy plan includes energy burden as a key strategy for achieving the city's clean energy future.	City of Atlanta 2019
	Plan with energy burden goal	2017	The Resilience Strategy includes action to lift energy burden on 10% of Atlanta households.	City of Atlanta 2017
Cincinnati	Plan with energy burden goal	2018	The Green Cincinnati Plan set a goal to reduce household energy burdened by 10% compared to current levels.	City of Cincinnati 2018
	City-led program to reduce energy burdens	2020	The city partnered with Duke Energy Ohio to address the high energy burdens by launching a low-income multifamily energy efficiency pilot program called Warm Up Cincy.	City of Cincinnati 2020
Houston	Plan with energy burden strategy	2018	The Climate Action Plan includes a goal to promote weatherization programs to reduce residential energy consumption and focus on reducing energy burdens of low-income populations.	City of Houston 2020
Minneapolis	Plan with energy burden goal	2013	The Climate Action Plan states that the city will prioritize neighborhoods with high energy burdens for strategy implementation.	City of Minneapolis 2013
	Equity indicator	2013	Climate Action Plan reporting should also include equity indicators to measure whether energy burden reductions are equitable.	
New Orleans	Plan with energy burden goal	2017	The Climate Action Plan includes two strategies to reduce the high energy burdens of the city's residents.	City of New Orleans 2017
Oakland	Equity indicator	2018	Oakland includes energy cost burden as a metric in its 2018 Equity Indicators report.	City of Oakland 2018
Philadelphia	Plan with energy burden goal	2018	The Clean Energy Vision Plan set a goal to eliminate the energy burden for 33% of Philadelphians.	City of Philadelphia 2018
Pittsburgh	City-led program to reduce energy burdens	2019	As part of the Bloomberg Mayor's Challenge, the city created Switch PGH to address high burdens through a civic engagement tool.	City of Pittsburgh 2019
Saint Paul	Plan with energy burden goal	2017	The city set a goal to reduce resident energy burden within 10 years so that no household spends more than 4% of its income on energy bills.	City of Saint Paul 2017

See Appendix for data sources

**C2. State-led actions to reduce high energy burden**

State	Strategy/action	Year enacted	Description	Data source
Colorado	Demonstration project/pilot program	2018	The Energy Office awarded GRID Alternatives a \$1.2 million grant to launch a project to reduce the energy burden of 300 low-income households through renewable energy and energy efficiency investments.	Cook and Shah 2018
New Jersey	State legislation	2020	The NJ Clean Energy Equity Act (S. 2484) aims to use solar, storage, and energy efficiency to bring low-income households and environmental justice communities within or below the state's average energy burden.	New Jersey Legislature 2020
New York	Governor-led executive order	2016	Governor Andrew M. Cuomo issued the Energy Affordability policy to work toward a goal of no New Yorker spending more than 6% of their household income on energy.	New York 2016
Oregon	Governor-led executive order	2018	In response to Governor Kate Brown's Executive Order 17-20, the Oregon Department of Energy, the Oregon Public Utility Commission, and the Oregon Housing and Community Services Department conducted an assessment and created a 10-year plan to reduce energy burdens in Oregon affordable housing.	OR DOE, OR PUC, and OHCS 2018
Pennsylvania	Public Utility Commission study	2019	The Pennsylvania PUC released a report that assessed home energy affordability for low-income customers in the state.	Pennsylvania Public Utility Commission 2019
	Public Utility Commission policy	2020	The Pennsylvania PUC set a new policy to direct utilities to ensure that low-income customers spend no more than 10% (6% for lowest-income customers) of their income on energy bills.	Pennsylvania Public Utility Commission 2019
Washington	Governor-led executive order	2019	As part of Governor Jay Inslee's Clean Energy Transformation Act, the Washington Department of Commerce assessed the energy burdens for low-income households and the energy assistance offered by electric utilities.	Washington State Department of Commerce 2020

# APPENDIX D.

# **Low-Income Energy Efficiency Program Best Practices**

This section contains short descriptions of some best practices for low-income energy efficiency programs: coordination, collaboration, and segmentation; funding and financing; effective measures and targeting; evaluation and quality control; and coordination of energy efficiency and renewable energy investments.

## Coordination, collaboration, and segmentation

### Community engagement and participatory planning

can ensure that programs are designed to meet community needs and build trust. By involving the community in the planning process, energy efficiency programs create outcomes that best meet community needs, leverage community networks to achieve higher program participation, and improve visibility and support within the community for program implementers (e.g., a utility or local government). Participatory planning requires effort from program planners, who can follow a set of best practices for optimal success.<sup>21</sup> For example, Professor Tony Reames conducted a community engagement study of Kansas City, Missouri, to understand barriers that low-income households face in participating in weatherization. This stakeholder engagement led to the development of innovative strategies to overcome barriers, such as hiring an all-African American staff to help build trust within the local community.<sup>22</sup>

**Statewide coordination models** enable consistent low-income program delivery across utilities, WAP implementers, and local jurisdictions. Some states have one implementer for the state's low-income programs who ensures that similar program offerings are available to all customers in the state. States such as California, New Jersey, New York, Colorado, and Massachusetts offer statewide low-income program models that aim to coordinate resources from multiple sources through a single program. For example, California's Energy Saving Assistance Program is offered by all regulated investor-owned utilities across the state. Massachusetts is served by the Low-Income Energy Affordability Network (LEAN), which includes community action agencies, public and private housing owners, government organizations, and public utilities that all work together to provide low-income efficiency solutions in the state.

**One-stop-shop program models** minimize barriers and allow low-income households to access all available resources in one place. The models provide a single point of contact, universal intake applications, comprehensive technical assistance, and streamlined access to program resources.<sup>23</sup> One-stop-shop models should be replicated in various locations and combine each location's available offerings. Through its Energize Delaware program model, for example, the nonprofit Delaware Sustainable Energy Utility (DESEU) offers a one-stop-shop resource that focuses on a whole-building approach and consolidates available resources directed at both low-income customers and owners of affordable multifamily buildings.

**Market segmentation** designs programs to meet the specific needs of subsets of highly burdened households, such as people living in affordable multifamily buildings or manufactured housing. Low-income customers are a diverse segment with diverse energy needs. By segmenting customers by key demographic categories, program designers can then work to identify a specific customer segment's energy usage characteristics and program needs. This can lead to more impactful outreach, relationship building, program design, and results. For instance, Eversource partnered with Oracle Utilities-Opower to develop a first-of-kind approach to digitally characterizing and targeting customers that require assistance. This analytical approach can guide utilities in creating programs that are specific to a resident subset or area.<sup>24</sup>

**Fuel-neutral programs** allow energy efficiency measures to be completed simultaneously in a home regardless of the electric and/or natural gas utilities that service it. This is critical for addressing the high costs associated with delivered fuels (oil, propane) and for coordinating across electric and natural gas utilities. For example, New York's Clean Energy Fund, designed to deliver on the state's Reforming the Energy Vision (REV) commitments, implements energy efficiency initiatives on a fuel-neutral basis. By taking a fuel-neutral approach, New York State can increase energy efficiency at the lowest cost, enable greater greenhouse gas reductions, and stimulate local economic development.<sup>25</sup>

<sup>21</sup> Calvert, K., I. McVey, and A. Kantamneni. 2017. "Placing the 'Community' in Community Energy Planning. Prepared for *Guelph's Community Energy Initiative Task Force* by the Community Energy Knowledge-Action Partnership. DOI: 10.13140/RG.2.2.22817.30562. [www.researchgate.net/publication/319141113\\_Placing\\_the\\_'Community'\\_in\\_Community\\_Energy\\_Planning](http://www.researchgate.net/publication/319141113_Placing_the_'Community'_in_Community_Energy_Planning).

<sup>22</sup> Reames, T. 2016. "A Community-Based Approach to Low-Income Residential Energy Efficiency Participation Barriers." *The International Journal of Justice and Sustainability* Vol 21. [www.tandfonline.com/doi/abs/10.1080/13549839.2015.1136995](http://www.tandfonline.com/doi/abs/10.1080/13549839.2015.1136995).

<sup>23</sup> Energy Efficiency for All, *One-Stop Shops for the Multifamily Sector*. [assets.ctfassets.net/ntcn17ss1ow9/30B8LUDt8GTegjPE8claf/8c5e68405c9692afb9f11fe898b8653e/EEFA\\_OneStopShop\\_Fact\\_Sheet\\_2.pdf](https://assets.ctfassets.net/ntcn17ss1ow9/30B8LUDt8GTegjPE8claf/8c5e68405c9692afb9f11fe898b8653e/EEFA_OneStopShop_Fact_Sheet_2.pdf).

<sup>24</sup> Lin, J., K.M. Rodgers, S. Kabaca, M. Frades, and D. Ware. 2020. "Energy Affordability in Practice: Oracle Utilities Opower's Business Intelligence to Meet Low and Moderate Income Need at Eversource." *The Electricity Journal*. 33 (9): 1-11. [doi.org/10.1016/j.tej.2019.106687](https://doi.org/10.1016/j.tej.2019.106687).

<sup>25</sup> NYSERDA. Reforming the Energy Vision: Clean Energy Fund, Frequently Asked Questions. [www.nyserda.ny.gov/-/media/Files/About/Clean-Energy-Fund/clean-energy-fund-qa.pdf](http://www.nyserda.ny.gov/-/media/Files/About/Clean-Energy-Fund/clean-energy-fund-qa.pdf).

## Funding and financing

**Leveraging diverse funding sources** allows programs to address health and safety issues and include greater investment and available measures. Funding for low-income energy efficiency programs often comes from electric and natural gas utility ratepayer dollars, federal WAP and LIHEAP funds, state and local funds, nonprofit resources, and other private funding sources. Leveraging funding from various sources can give program implementers greater flexibility, as some federal and utility funding sources limit the types of measures they fund. Leveraging diverse funding sources can lead to a more comprehensive program outcome that has the flexibility to address health and safety issues and incorporate more complex sets of energy efficiency investments.

**Inclusive financing models**, such as no-interest loans, loan guarantees, and the elimination of credit requirements, are designed to help low-income households overcome up-front cost barriers to accessing traditional private financing options. Inclusive financing options include Pay As You Save (PAYS) programs and on-bill tariff models, which allow low-income households to install energy efficiency investments that are paid off over time on the customer's bill.<sup>26</sup> In the low-income multifamily sector, limiting or eliminating up-front costs to building owners can help them undertake more substantial energy efficiency projects and overcome barriers related to the competition for scarce funding for capital projects. Low-interest financing and on-bill repayment can help owners spread out their energy efficiency project costs over time.

**Align utility and housing finance programs** to encourage energy efficiency upgrades in low-income multifamily buildings. Incorporating utility-customer funding in the current climate of affordable housing refinance and redevelopment can yield deeper, more comprehensive energy efficiency improvements. These extensive renovations may involve replacing outdated building systems, and utility-customer funds can be used to help cover the incremental cost of installing more-efficient equipment than would otherwise be required. For example, the Connecticut Green Bank coordinates closely with the state's energy efficiency initiatives led by the state agencies and local utilities to align incentives for affordable financing for both energy efficiency upgrades and rooftop solar installations. The Connecticut Green Bank's financing opportunities complement the available funding for energy efficiency upgrades from

the Connecticut Housing Finance Authority and the Connecticut Department of Housing.<sup>27</sup>

## Effective measures, messaging, and targeting

**Include health and safety measures and healthier building materials** to reduce deferral rates and improve indoor air quality, comfort, and long-term health outcomes for program participants. Programs often address health and safety concerns through leveraged funds. However, rather than disqualifying households due to building health and safety issues such as structural problems, mold, or asbestos, utilities and program implementers can combine funding streams to provide health and safety services. For example, the Bronx Healthy Buildings Program aims to reduce asthma-related hospital visits and address the social determinants of health through education, organizing, workforce development, and building upgrades. Energy audits, building inspections, and tenant organizing aim to identify needed repairs and opportunities for energy efficiency improvements.<sup>28</sup>

**Prioritize deep energy-saving measures** through a single program and/or engagement to achieve high levels of energy savings. Using trusted contractor networks to deliver programs that include savings-based incentives lets contractors focus on deep savings rather than limiting projects to simple direct-install measures. For example, Oncor's Targeted Weatherization Low-Income program first prioritizes deep energy-saving measures such as building-shell weatherization and air sealing, and then focuses on additional measures such as air-conditioning, refrigeration, and lighting.<sup>29</sup>

**Integrate direct-installation and rebate programs** to encourage more extensive improvements. For low-income single and multifamily projects, direct-installation programs that offer no-cost energy efficiency measures can provide an opportunity to connect with building owners, complete an on-site energy assessment, and encourage owners to take advantage of rebates for more extensive improvements such as HVAC upgrades, weatherization, common-area lighting retrofits, and other building-shell improvements.

**Targeting high energy users and vulnerable households** to generate the greatest energy savings and impact. By using utility data to identify households with the highest energy use, energy efficiency providers can achieve the greatest energy savings. Even so, energy use should be looked at in combination with other factors

<sup>26</sup> For more information on inclusive financing options, see SEE Action, 2017. *Energy Efficiency Financing for Low- and Moderate Income Households: Current State of the Market, Issues, and Opportunities*. [lbl.gov/sites/default/files/news/lmi-final0811.pdf](http://lbl.gov/sites/default/files/news/lmi-final0811.pdf).

<sup>27</sup> See ACEEE's 2018 report, *Our Powers Combined: Energy Efficiency and Solar in Affordable Multifamily Buildings*. [aceee.org/research-report/u1804-buildhealthchallenge.org/communities/awardee-bronx-nyc/](https://www.aceee.org/research-report/u1804-buildhealthchallenge.org/communities/awardee-bronx-nyc/).

<sup>29</sup> Gilileo, A., S. Nowak, and A. Dreihobl. 2017. *Making a Difference: Strategies for Successful Low-Income Energy Efficiency Programs*. Washington, DC: ACEEE. [aceee.org/sites/default/files/publications/researchreports/u1713.pdf](https://www.aceee.org/sites/default/files/publications/researchreports/u1713.pdf).

that lead to household energy vulnerability. Although high energy use can lead to high savings, households with lower energy use can still experience high energy burdens. Efficiency Vermont, for example, changed its program qualification to focus on low-income households with high energy burden rather than low-income households with high energy use. This let the program qualify more customers and target needs to the most vulnerable households.<sup>30</sup>

**Incorporate new and emerging technologies in low-income programs.** Expanding the technology scope of low-income energy efficiency programs to technologies they do not traditionally incorporate—such as solar PV, smart meters, energy storage, and electric vehicles—can significantly improve energy affordability and equitable access to these technologies for low-income households.<sup>31</sup> Unless we ensure that new technologies are available to low-income and underinvested communities, inequities in access to these technologies will continue to grow. Programs that incorporate these emerging technologies can address access barriers for low-income communities and ensure more equitable distribution of their benefits.

**Effectively message programs in ways that provide clear value and actionable guidance.** Effective messaging helps achieve high program participation and builds trust and understanding of program benefits. Investing in energy efficiency often takes time and resources for both single and multifamily building owners. Although programs typically focus on energy savings and energy cost reductions benefits, programs must also market the many nonenergy benefits that result from energy efficiency improvements. Further, they should include actionable guidance—that is, clear steps that residents and building owners can take to learn more about program services and enroll in the program.

## Evaluation and quality control

**Collect and share metrics** on program outcomes, equity impacts, and other tracked data to hold implementers accountable to program requirements and goals. These metrics can include factors such as race and/or ethnicity, income status, property ownership, energy burden, and energy vulnerability. Often, program implementers publish demand-side management reports that include metrics on low-income program savings, spending, and customers served. Implementers can report additional equity factors such as energy burden data, demographic

data, and participation distribution. For example, VEIC published the *State of Equity Measurement: A Review of Practices in the Clean Energy Industry*, a guide that offers an overview of energy industry metrics for measuring program equity.<sup>32</sup> These include metrics to define target populations, determine disparate impacts, and include representative voices in program design, implementation, evaluation, and oversight.

**Conduct robust research and evaluation** to assess achieved reductions in energy usage. Such evaluations help document and clarify program performance. Impact evaluations measure the direct and indirect benefits from programs, while process evaluations provide systematic assessments of how programs operate. By completing robust evaluations, program planners can determine how to best improve their programs for greater impact and efficiency, and better meet the needs of the target community.

**Include quality control** as a core element of the services to ensure that energy efficiency services are effective, and homes are left in a safe condition. Many program implementers incorporate ongoing training for contractors and quality control professionals, viewing this as critical to program success and devoting project funding to regular trainings. Some program administrators also include strict quality control requirements for all projects rather than for a sample, which helps incentivize contractors to perform high-quality work. For example, Ouachita Electric Cooperative's HELP PAY program, a tariff-based residential energy efficiency financing program, evaluates every project after completion and facilitates trainings for its contractors in quality control techniques to ensure that all contractors understand the assessment methodologies.<sup>33</sup>

**Incorporate nonenergy benefits** into testing. Without monetizing nonenergy benefits, utility-operated low-income energy efficiency programs cost more to implement per household—and are less cost effective by traditional measures—than utility-operated energy efficiency programs serving higher income groups. However, low-income energy programs deliver benefits beyond energy savings to low-income households that are not typically incorporated into traditional cost-effectiveness testing methods. The *National Standard Practice Manual* discusses how low-income program benefits can be considered at the societal level.<sup>34</sup> States can decide to adjust cost-effectiveness tests for

<sup>30</sup> Efficiency Vermont. 2020. *Targeted Communities Program Update*. [www.energycvermont.com/trade-partners/targeted-communities-program-update](http://www.energycvermont.com/trade-partners/targeted-communities-program-update).

<sup>31</sup> Brown, M., A. Soni, M. Lapsa, and K. Southworth. 2020. *Low-Income Energy Affordability: Conclusions from a Literature Review*. ORNL/TM-2019/1150. [info.ornl.gov/sites/publications/Files/Pub124723.pdf](http://info.ornl.gov/sites/publications/Files/Pub124723.pdf).

<sup>32</sup> Levin, E., E. Palchak, and R. Stephenson. 2019. *The State of Equity Measurement: A Review of Practices in the Clean Energy Industry*. Winooski, VT: VEIC. [www.veic.org/Media/default/documents/resources/reports/equity\\_measurement\\_clean\\_energy\\_industry.pdf](http://www.veic.org/Media/default/documents/resources/reports/equity_measurement_clean_energy_industry.pdf).

<sup>33</sup> Gilleo, A., S. Nowak, and A. Dreihobl. 2017. *Making a Difference: Strategies for Successful Low-Income Energy Efficiency Programs*. Washington, DC: ACEEE. [aceee.org/sites/default/files/publications/researchreports/u1713.pdf](http://aceee.org/sites/default/files/publications/researchreports/u1713.pdf).

<sup>34</sup> National Efficiency Screening Project. 2017. *National Standard Practice Manual*. [nationalefficiencyscreening.org/wp-content/uploads/2017/05/NSPM\\_May-2017\\_final.pdf](http://nationalefficiencyscreening.org/wp-content/uploads/2017/05/NSPM_May-2017_final.pdf). Page 58: Societal Low-Income Impacts.

low-income programs to incorporate these additional benefits. For example, Vermont uses the societal cost test as its primary test and incorporates a 15% adder for nonenergy benefits for low-income customers in its cost-effectiveness screening tool. Similarly, Colorado uses the total resource cost test and includes a 50% adder to account for the benefits from low-income programs.

### Renewables and workforce

**Integrate energy efficiency and solar** program offerings to maximize participant benefits. To do this, combined renewable and energy efficiency programs should first invest in energy efficiency to reduce the home's overall energy needs, and then invest in renewable energy so that individual households can install the right size solar system or many households can access community solar options. For example, the Connecticut Green Bank collaborates with PosiGen, a private company, to deliver both solar and energy efficiency to low-income customers. The Green Bank helps PosiGen generate capital to provide 20-year solar leases combined with energy

efficiency upgrades to program participants, leading to the most cost-effective investment.<sup>35</sup>

**Support the development of a diverse and strong energy efficiency workforce** that represents the local community. Ensure that training opportunities are linked to high-quality, well-paid, and stable careers in the energy efficiency and clean energy workforce sector. States and local governments, utilities, and other program implementers can focus on diversifying suppliers, increasing the worker pipeline by offering training for both contracting firms and students, and partnering with skills-training providers and state agencies—all while working to overcome barriers faced by historically excluded community members. Implementers can also co-deliver training for energy efficiency and renewable energy technologies. For example, the Chicago-based nonprofit Elevate Energy coordinates a Clean Energy Jobs Accelerator that trains individuals from economically excluded communities for careers in solar and energy efficiency.

<sup>35</sup> EDF (Environmental Defense Fund) and APPRISE (Applied Public Policy Research Institute for Study and Evaluation). 2018. Low-Income Energy Efficiency. New York. [www.edf.org/sites/default/files/documents/liee\\_national\\_summary.pdf](http://www.edf.org/sites/default/files/documents/liee_national_summary.pdf).

## **Energy burden and air conditioning adoption in New York City under a warming climate**

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## **Energy burden and air conditioning adoption in New York City under a warming climate**

### **Abstract**

Global climate change has increased the need for cooling indoor spaces, leading to a rise in adoption of air conditioning. This adoption, while decreasing health risks, can increase energy use and pose economic burdens in low income households. Here, we estimate the burden associated with cooling, as well as potential extreme heat exposure without it in the largest city in the US, New York using a coupled weather and building energy model, utility pay scales, and household income data from the US Census.

Results show uneven distribution of AC economic burden, with lower income neighborhoods experiencing the largest relative costs. High-burden neighborhoods see the largest climate-driven increases in spite of lower enthalpy increases. These neighborhoods also have the most exposure to indoor extreme heat, which may triple by end of century. Energy burden may pose a barrier to AC operation, with estimated cost in the lowest income households reaching up to 6.1% of income for a 100 m<sup>2</sup> dwelling, which could increase to 8% by end of century. We also explore adaptation strategies and quantify their impacts, finding that modifying traditional set points and reflective roofs can reduce energy burden significantly, by up to 20% in the highest burden neighborhoods.

**Keywords:** urban climate, heat risk, energy burden, urban heat island

## 1. Introduction

As temperatures continue to rise due to global climate change, so is the frequency and intensity of hazardous heat (Meehl and Tebaldi 2004). This increase in summer heat places unique challenges in cities, where population and infrastructure density may lead to higher mortality (Limaye et al. 2018) and critical systems failure (Chester et al. 2020). These increasing risks necessitate the use of adaptations to cool not only outdoor, but also indoor spaces. The most common indoor cooling in the US adaptation is air conditioning (AC). Although an effective tool to lower heat-related risks, AC adoption increases energy use while , with higher sensitivity in cities, where the majority of the global population resides (Waite et al. 2017), which may pose a significant challenge to sustainability goals focused being implemented in cities. Costs associated with this increased energy use may burden households unevenly, with low-income homes potentially being unable to prevent hazardous indoor heat.

### *1.1. Cooling cities in a changing climate*

With global air temperatures projected to rise significantly, AC adoption is also projected to increase. In the US, the number of households with AC has increased from 66.1 million in 1993 to over 100 million in 2015, representing an adoption rate change from 66.1% to 87% (Energy Information Agency 2015). Meanwhile, the International Energy Agency (IEA) projects global AC ownership to soar to two thirds of all households by 2050 (International Energy Agency 2018). This increase in adoption, coupled with longer and warmer cooling seasons, has led to projected increases between 320% (low development scenario) to 2270% (high development scenario) in global residential cooling energy demand (Santamouris 2016). These upcoming changes present challenges at various scales, from regional and city scale power generation to accommodate the additional electric demand for space cooling, to utility costs at the household level.

This growing need for space cooling may be exacerbated in cities, where ambient temperatures are often higher than in surrounding areas. This phenomenon, called the Urban Heat Island (UHI), forms due to traditional built structures limiting cooling at the land surface (e.g., evaporative and radiative cooling), while both storing and generating more heat (e.g., AC use, traffic) (Oke 1982) than natural landscapes. Studies also show that UHIs may intensify periods of extreme heat locally due to the positive land-atmosphere feedbacks that lead to the UHI in the first place (Li and Bou-Zeid 2013; Founda and Santamouris 2017; Ramamurthy et al. 2017; Ortiz et al. 2018b; Ao et al. 2019). Moreover, the United Nations projects that urban areas will absorb most population growth projected by 2050 (United Nations 2019), further increasing health risks and cooling costs associated with summer heat.

When including both urban and climate signals, projections of cooling energy demand in New York City (NYC), the largest city in the US, show end of century increases of up to 80% in the business as usual RCP8.5 scenario (Ortiz et al. 2018a). Projected increases exhibited geospatial variation due to differences in built environment configuration and meteorological processes across the city such as sea breeze penetration. Geographic differences in near surface temperature increases mean that costs related to AC use will increase differently throughout the city, with varying consequences across groups with variable capacity to bear increased costs. Long-term summer climate projections in NYC have shown that although water vapor content of the atmosphere is expected to increase, relative humidity might slightly decrease (Ortiz et al. 2019), suggesting that increases in electric load might be driven by temperature increases rather than moisture content. In addition, building energy usage is affected by user behavior and equipment installation and repair. These factors cause disparities between energy ratings and actual usage, often called a performance gap, and may also lead to hard-to-quantify cooling costs (Sunikka-Blank and Galvin 2012; Cali et al. 2016). The performance gap may also be associated

with socioeconomic factors (Palma et al. 2019), which can lead to already vulnerable populations being unevenly impacted by either high heat exposure or high costs of cooling.

### *1.2. Energy costs and burden*

Study of energy costs as they relate to household income and poverty has often focused on heating during the cold season (Bhattacharya et al. 2003; Roberts 2008; Hills 2012; Teller-Elsberg et al. 2016; Robinson et al. 2018). However, year-round temperatures are expected to increase (Coumou et al. 2013; Lehner et al. 2018) for growing portions of the world (Coumou and Robinson 2013), likewise increasing the need and cost of AC operation while decreasing the need for heat (Wang and Chen 2014). The 2019 New York City Panel on Climate Change (NPCC) reported that while since 1900 there are on average 1.85 fewer days below freezing per decade, summer heat waves are expected to become more frequent, longer, and more intense (González et al. 2019). In NYC, premature mortality associated with warming summers is projected to grow between 47% to 95% by mid-century (Knowlton et al. 2007). Studies have also shown that low-income and minority groups in cities are often more vulnerable to heat (Hamstead et al. 2018; Madrigano et al. 2015b) and bear a higher energy cost burden, attributed mostly to differences in building infrastructure and investment (Kontokosta et al. 2019).

This disparity in relative energy costs may play a role in adoption of AC units in NYC, as reported by Ito et al (2018), who also found that areas with lower AC adoption coincide with higher rates of heat-related mortality and hospitalizations. Heat-related mortality and other health impacts are known to affect lower income and vulnerable populations like the elderly (Rosenthal et al. 2014) at higher rates. Although state and local governments sometimes provide economic assistance for heating and cooling, such as with the Home Energy Assistance Program (HEAP), these initiatives often only offer assistance in upfront costs, leaving residents to bear the cost burden of AC operation. Recent work

focusing on Paris, France has also shown that while existing heat adaptation strategies (e.g., urban parks and white roofs) may partially offset heat risk and cooling loads, they are insufficient to completely eliminate projected increases, making AC an important tool to maintain thermal comfort and reduce heat-related illnesses (Viguie et al. 2020).

### *1.3. Modeling building energy demand at urban scales*

One way to quantify household energy expenditures and their sensitivity to climate is by use of building energy models. Building energy models typically fall between two umbrellas: physics and statistical models. Physics-based models use energy and mass balance relationships information to quantify energy inputs and outputs to building envelopes. These models are often designed to resolve single buildings in high detail, as in the case of the US Department of Energy developed EnergyPlus (Crawley et al. 2001). The advent of detailed representations of city-scale building stock has allowed the extension single building models to simulate energy demand at district and even city scales (Hong et al. 2016; Olivo et al. 2017; Ahmed et al. 2017). Statistical methods range from linear regression at the simplest levels to machine learning algorithms like support vector machines (Jain et al. 2014) and neural networks (Beccali et al. 2004; Neto and Fiorelli 2008). These methods use historical output (i.e., energy demand or consumption) and input (e.g., outdoor temperature, occupancy rates) variables to train a predictive model. The rise in energy use data due to use of utility smart meters and government reporting requirements has opened the door to predict energy demand at scales from single buildings (Jain et al. 2014; Yan and Liu 2020) to entire cities (Kontokosta and Tull 2017; Chen et al. 2020). An advantage of physics-based models is their reliance on detailed data on building materials, morphology, and technology, which allows study of a wide variety of energy efficiency technologies at the design stage across a variety of use cases and even outdoor climate conditions. Although statistical methods can include these data, they must be selected *a priori* or engineered through feature selection exercises.

A limitation to both of the traditional approaches is their consideration of the building envelope as a standalone entity. In reality, buildings and their surrounding environment are coupled via energy, mass, and momentum exchanges that not only control energy consumption, but often has a significant impact on outdoor climate. AC use is one of the mechanisms leading to the UHI as described above. In order to quantify building-atmosphere dynamics, a method that couples atmospheric and building energy modeling must be used. One way these interactions have been coupled with by embedding building consumption models with numerical weather models. Examples of this approach include the Building Energy Model (Salamanca et al. 2010) and Town Energy Budget (Masson 2000), which parameterize aggregate building energy interactions to a weather model's simulation grid. This approach has been used to simulate energy demand at urban scales in climates as varied as temperate New York City (Ortiz et al. 2018a), arid Phoenix (Salamanca et al. 2013), and tropical San Juan, Puerto Rico (Pokhrel et al. 2018).

Whereas previous work has estimated building energy use at the city scale and its impacts on urban and regional power demand, there has been little research quantifying the burden placed on households by this energy use. In this study we estimate household energy burdens associated with AC operation in cities, using NYC as a case study. We use a numerical weather prediction system coupled to a building energy model to estimate building energy demand at the household scale for an entire city. By employing the coupled weather-building energy model approach, we address potentially spatially uneven urban climate change in NYC and its relation to AC energy use, which itself forms a feedback with atmospheric processes due to energy and mass exchanges with buildings. In addition, by modeling the physical interactions between buildings and the atmosphere our study is able to account for synergies between warmer end-of-century summers and urban-scale processes like heat storage and anthropogenic heat generation, which may be missed in statistical-only analyses.

## 2. Methods

We use a high resolution configuration of the Weather Research and Forecasting model (WRF, Skamarock *et al* 2008) coupled with a modified multi-layer urban canopy and building energy model parameterization to study changes in building cooling demand under climate change conditions. We also characterize indoor heat exposure to highlight potential health risks associated with lack of AC use, as detailed in the following sections. Our modeling approach, with its inputs and outputs are summarize in Figure 1.

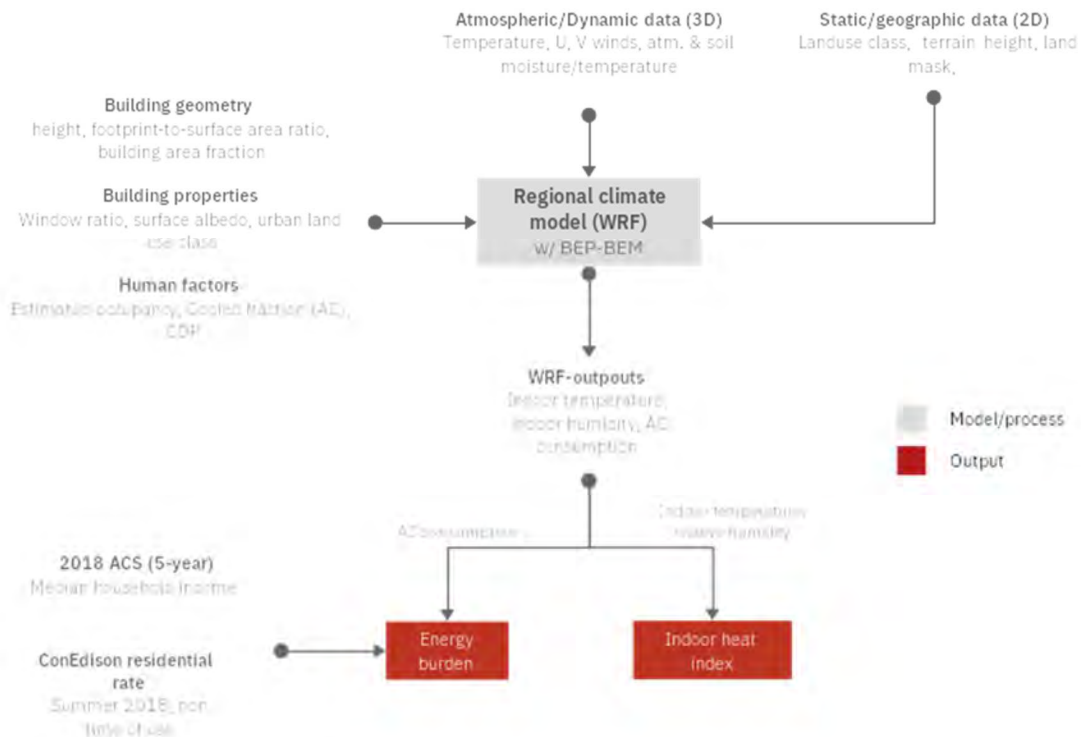


Figure 1: Experimental workflow detailing key inputs and outputs used to produce energy burden and indoor heat index.

### *2.1. High resolution urban climate modeling*

In order to resolve the fine scale atmospheric processes in NYC, we use WRF to dynamically downscale data from reanalysis for present-day conditions and a GCM for end-of-century climate. The dynamical downscaling technique used here consists of using coarse gridded datasets as initial and boundary conditions to a limited-area numerical weather prediction model that solves the set of equations of atmospheric fluid, mass, and energy in non-hydrostatic form.

Buildings modify the energy and momentum balance at the land surface, with urban morphology and AC use forming feedbacks with the surrounding atmosphere. In order to account for these energy and momentum exchanges between buildings and the atmosphere, simulations use the Building Effect Parameterization (BEP) and Building Energy Model (BEM) physics options in WRF (Martilli et al. 2002; Salamanca et al. 2010). BEP accounts for physical interactions between buildings and the atmosphere such as radiation shadowing and blocking, drag and turbulence effects in the urban canopy, dynamically computing momentum and energy fluxes at all overlapping atmospheric levels. BEM, on the other hand, dynamically computes the building envelope energy balance to estimate energy exchanges between the building and the atmosphere, accounting for conduction through all built surfaces, air mass exchanges, indoor heat generation from humans and equipment, and AC use. The dynamically calculated cooling (or heating) load is used to compute heat fluxes to the atmospheric layers that overlap with embedded BEM parameterization layers at each model time step. For each parameterized building envelope, an energy balance is performed to compute energy fluxes from radiation and advection to and from the urban canopy surfaces (i.e., roof and walls), while the AC subroutine works to remove indoor energy by adding work to the system. As BEP-BEM are a multi-layer urban parameterization, these heat fluxes are computed for as many layers in the atmospheric coordinate system overlap with the building vertical coordinate system. This urbanized version of WRF

has been evaluated in cities across a variety of climates like Beijing (Xu et al. 2018), Phoenix (Salamanca et al. 2015), New York (Ortiz et al. 2018b), and the Yangtze River Delta (Liao et al. 2014) to name several examples.

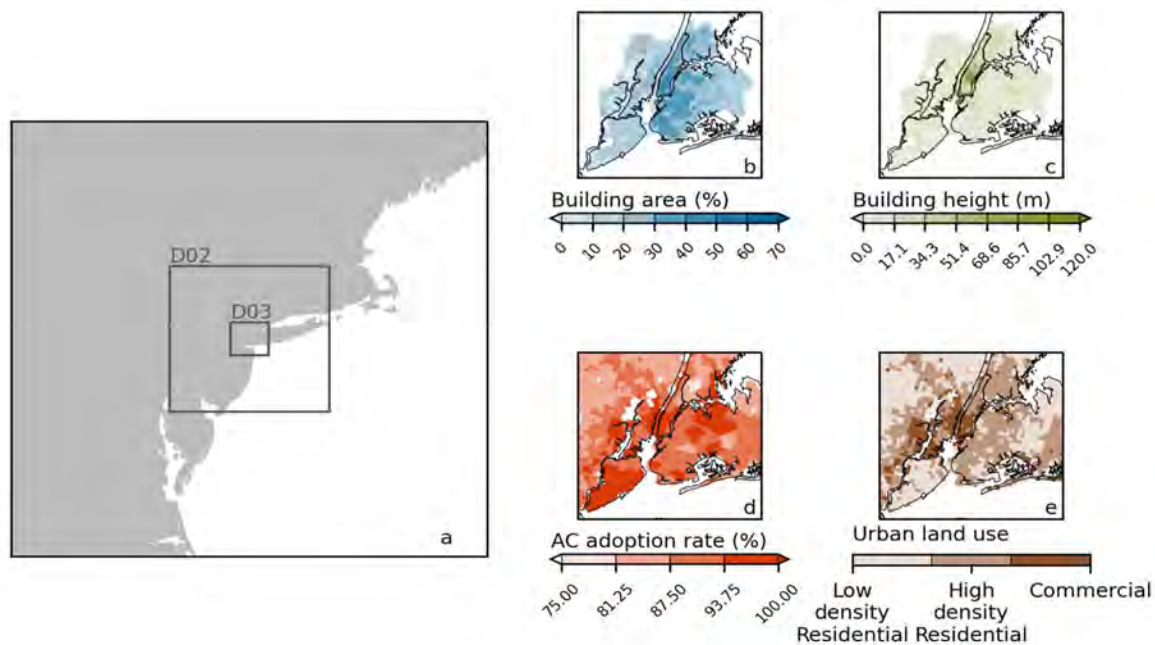


Figure 2: (a) WRF parent domain (map extent, 9 km resolution) configuration with nested domains D02 (3 km resolution) and D03 (1 km resolution). Urban parameters added to simulations include (b) grid building area fraction, (c) grid average building height, (d) grid AC adoption rate, and (e) urban land use classes.

Simulations use three domains (one parent, two nested) with horizontal resolution of 9 km, 3 km, and 1 km (Figure 2a) and 51 vertical levels, with 15 levels within the lowest 3 km of the atmosphere. The D03 domain resolution of 1 km is set to optimize use of the urban canopy parameters from the NUDAPT1km dataset (Burian and Shepherd 2008) which include spatially explicit sky view factor (SVF), roughness lengths, and frontal area densities at various angles and are in line with similar studies in Chinese cities (Xu et al 2018, Liao et al 2020), the US Southwest (2015), and NYC (Gamarro et al 2020, Ortiz et al 2019, Gutierrez et al 2015).

Table 1: Urban canopy and building energy parameters from the WRF lookup table.

Urban Parameter	Value
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Temperature set point ( $^{\circ}\text{C}$ )	22.22
Humidity set point ( $\text{kg}_{\text{vapor}}/\text{kg}_{\text{air}}$ )	0.01
Coefficient of performance	2.8
Window area fraction	0.33
Roof albedo	0.2
Roof emissivity	0.9
Peak equipment load ( $\text{W}/\text{m}^2$ )	16.0/20.0/26.0
Peak occupancy ( $\text{person}/\text{m}^2$ )	0.025/0.025/0.050
	(Low density res./High density res./Commercial)

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In order to take advantage of the urban physics parameterizations, additional detailed urban canopy parameters (UCPs) must be used. Here, we derived UCPs from a combination of public NYC tax-lot data, existing gridded datasets, and standards-based look-up tables. Urban land cover and geometry was adapted from the NYC Department of Planning MapPLUTO dataset (New York City Department of City Planning 2020), which provides heights and footprint areas of buildings at the tax-lot scale (Figure 2b-c). The tax-lot data was aggregated to the D03 domain's 1 km grid, with mean values of building height, surface-to-plant are ratio, and building area fraction. Urban land use was aggregated into three categories: low density residential, high density residential, and commercial/industrial based on the land use field in MapPLUTO (Figure 2e), following the encoding detailed in Gonzalez et al (2017). Urban land use aggregation used the most common land use found in each 1 km grid cell.

Panel Figure 2d shows the spatial distribution of the fraction of homes with AC units from Ito et al (2018), used in analysis of vulnerability to indoor extreme heat and AC energy cost burdens, detailed in in section 2.. Other parameters like roughness lengths were extracted from the default NUDAPT 1 km database for NYC (Burian and Shepherd 2008). In addition, building AC use has been updated in BEM to partition heat fluxes into both latent and sensible components by including evaporative cooling

processes (Gutiérrez et al. 2015a). This approach accounts for evaporative cooling used in modern AC systems and applied to the entire domain. BEP was also modified to include a variable drag coefficient as a function of building area fraction based on a set of fluid dynamics experiments (Santiago et al. 2008; Gutiérrez et al. 2015b).

Other parameters directly used by BEM (Table 1) follow previous work (Gutiérrez et al. 2015a; Ortiz et al. 2018a), which modify the urban parameter lookup table with values better aligned with recommendations by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). The use of constant lookup table values are a simplifying assumption that building parameters are relatively uniform across urban landuse classes. These constant parameters ignore some of the variations in building construction and AC technologies (e.g., COP differences between window and central AC) across the city and present an opportunity to further refine future simulations. These parameters include broad descriptions of building surface properties like roof emissivity and window area coverage, as well as characterizations of the building envelope. The latter include peak occupancy and electronic equipment loads, as well as the AC coefficient of performance, which is defined as the the ratio of the heat removed from the building to the atmosphere (i.e., from the hot reservoir to the cold reservoir) to the amount of work required to remove it. Other parameters include AC configurations for temperature and humidity which are often configurable by end users of building engineering staff on a day to day basis but remain static in the simulations performed here.

Other physics options were selected following previous work over the NYC region and are detailed in Table 2 (Ortiz et al. 2019). Simulations were carried out at a high performance computing facility, with each model run using 128 processors and using approximately 7 days of compute time. The high performance computing system uses Intel Sandy Bridge architecture processors, organized in 16-core nodes.

Table 2: Model physics parameterizations used in WRF simulations.

Model Physics	Parameterization
Land surface model	NOAH LSM (Tewari et al. 2004)
Cumulus	Kain-Fritsch (Kain 2004), off in D03
Microphysics	Thompson (Thompson et al. 2008)
Urban canopy	Building Effect Parameterization (BEP) (Martilli et al. 2002) Building Energy Model (BEM) (Salamanca et al. 2010) AC Evaporative Cooling Parameterization (Gutiérrez et al. 2015a) Variable Urban Drag Coefficient (Gutiérrez et al. 2015b)
Shortwave radiation	RRTMG (Iacono et al. 2008)
Longwave radiation	RRTM (Mlawer et al. 1997)
Planetary boundary layer	Mellor-Yamada-Janjic (Janjić 1994)

## 2.2. Simulation design

To study the impacts of warming climate conditions on demand-side AC costs, we use a typical, relatively recent summer, referred to here as PRESENT, then find its future analog based the distribution of daily minimum, mean, and maximum temperatures. To select a typical summer, we used historical daily maximum temperature records from the Central Park weather station between the years 2089-2019 and calculated the yearly minimum, mean, and maximum daily peak temperatures. Summer 2018 exhibited the closest to typical (i.e., 50<sup>th</sup> percentile) values of these metrics of any of the previous 10 years (Table 3).

The analog is found by use of the Central Park weather station. Then, we find the yearly minimum, mean, and maximum of daily maximum temperature, as well as its percentile rank in the 30-year period ending in 2018. For the future analog, we find the same yearly statistics in global model data for the 2070-2099 period, then find the year that lies closest to the percentile rank of summer 2018. The

closest year is found by finding the year with the minimum Euclidean distance to the chosen recent summer, as follows:

*FUTURE*

$$= \text{MIN} \left( \sqrt{(T_{min,2070-99} - T_{min,i})^2 + (T_{mean,2070-99} - T_{mean,i})^2 + (T_{max,2070-99} - T_{max,i})^2} \right)$$

Here,  $T_{min,2070-2099}$ ,  $T_{mean,2070-2099}$ ,  $T_{max,2070-2099}$  represent the yearly daily maximum temperature minima, mean, and maxima, respectively, while the subscript  $i$  denotes a particular year. The year with the closest matching temperatures was 2097, referred to from here onward as the FUTURE period, as shown in Table 3. PRESENT simulations use the North American Regional Reanalysis (NARR, Mesinger *et al* 2006) as initial and boundary conditions, while FUTURE simulations use a bias corrected Community Climate System Model version 4 (CCSM4) business as usual RCP 8.5 as initial and boundary conditions (Monaghan et al. 2014). NARR is a high resolution reanalysis product covering the North America and the Caribbean with a 32 km grid resolution and 29 vertical levels. CCSM4 is a general circulation model that couples an atmospheric, ocean, and ice sub-models to project future climate scenarios. The particular CCSM4 simulations used here are part of the fifth Coupled Model Inter-comparison Project (CMIP5) and use 26 vertical levels at  $1^\circ \times 1^\circ$  horizontal resolution. Both of these these initial and boundary conditions provide a coarse information on the region's winds, sea surface temperatures, and atmospheric and soil temperature and moisture content. As a result, our simulations account for changes in climatic conditions as a result of the global climate signal for all variables as modeled by the CCSM4 output. Table 4 summarizes the geospatial data inputs used as parameters as well as initial and boundary conditions used in all simulations. In order to model indoor heat exposure, a second set of PRESENT and FUTURE simulations were performed with 0% AC adoption. For these simulations, all AC-related heat fluxes are set to 0, while still allowing for

the computation of other heat fluxes to and from buildings related through indoor generation, radiative transfer and advection.

A third simulation, set in the PRESENT time period, uses the data from Ito et al (2018) as a measure of current AC adoption in NYC, shown in Figure 2d. AC adoption rates are included in the model by modifying the indoor energy balance in each urban-category grid cell by the fraction of homes with AC in BEM based on work exploring environmental and infrastructure impacts of AC adoption in NYC (Gamarro et al. 2020):

$$\begin{aligned} H_{out}^p &= H_{out} * \alpha \\ E_{out}^p &= H_{out} * \alpha \\ E_c &= \frac{1}{COP} (H_{out}^p + E_{out}^p) \end{aligned}$$

Here,  $H_{out}$  and  $E_{out}$  represent the building sensible and latent heat fluxes,  $E_c$  is the cooling electric demand,  $\alpha$  is the AC fraction, and superscript  $p$  denotes variables that account for fractional AC use. One limitation of this approach is the use of the same cooled fraction for all urban land uses, including commercial. However, due to the 1 km resolution of the model configuration combined with the city's household income spatial distribution, majority commercial land use grids coincide with the highest AC adoption rates at nearly 100%, which may be in line with commercial cooling practices. Results from this simulation are used to evaluate model performance against weather station data.

Table 3: Minimum, mean, and maximum of daily maximum temperatures of Summer 2018, and their percentile rank between 1989-2018 based on the Central Park weather station. FUTURE summer 2097 is selected from CESM1 data between 2070-2099 at the same percentile ranks.

	PRESENT	Percentile	FUTURE
Tmax <sub>min</sub>	21.2°C	73 <sup>rd</sup>	27.1°C
Tmax <sub>mean</sub>	28.6°C	53 <sup>rd</sup>	35.2°C
Tmax <sub>max</sub>	34.6°C	43 <sup>rd</sup>	42.5°C

Table 4: WRF simulation model inputs and urban canopy parameter source data.

	<b>Present</b>	<b>Future</b>
Initial and boundary conditions	North American Regional Reanalysis (32 km resolution)	CCSM4 (1° resolution)
Urban Canopy Parameters (geometric)		MapPLUTO (tax-lot resolution)
Urban Canopy Parameters (non-geometric)		NUDAPT1km (1 km resolution)

### 2.3. Energy burden and heat exposure indicators

To estimate energy burden, we use the AC demand output from BEM in our WRF simulations, census block group income data, and pay scales from the local utility, Consolidated Edison. AC demand is dynamically calculated in BEM and used by the model to estimate anthropogenic heat fluxes. We estimate the energy burden associated with AC use as:

$$Burden_{energy} = \frac{Cost_{AC,household}}{Income_{household}}$$

where  $Cost_{AC,household}$  is the electricity cost related to cooling 100 m<sup>2</sup> per grid point and  $Income_{household}$  is the median income of a household derived from the American Community Survey (ACS) 2017 5-year estimate. We obtained the energy cost by multiplying hourly AC demand from BEM and Consolidated Edison schedule 2 rates with no time-of-day pricing. The summer (i.e., schedule 2) rate for the 2018 May-September period was 0.2493 US \$ / kWh, which includes charges for generation, transmission, and local taxes. The energy consumption was obtained on a per-grid cell basis from BEM, which computes cooling loads in units of W/m<sup>2</sup>. We scaled the load to a 100 m<sup>2</sup> dwelling in order to provide burden values for a typical home size. Since ACS data is released at the

irregular census block group scale, it is interpolated to the regular 1 km resolution grid used in WRF simulations (Figure 3).

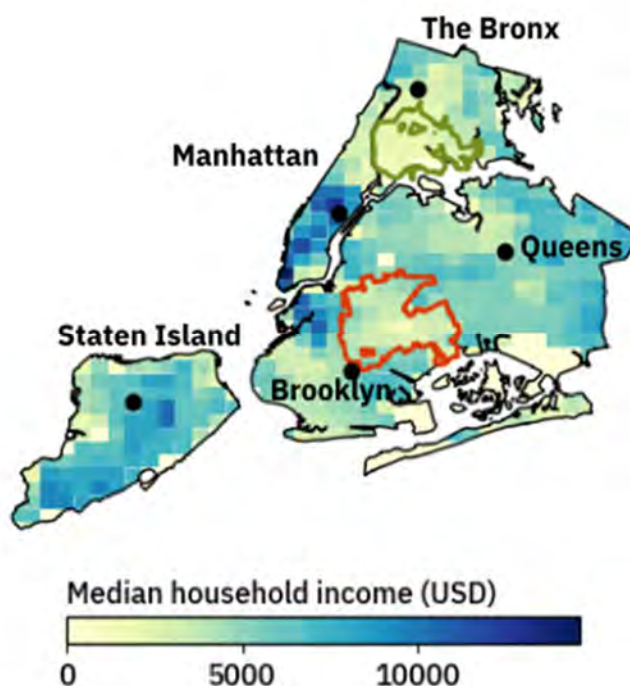


Figure 3: 5-year median household income estimate from the 2017 ACS, interpolated to WRF simulation grid. Green boundary represents the South Bronx region, while the orange boundary encloses East and Central Brooklyn. Black circles show locations of NYS Mesonet stations used in model evaluation.

This study estimates potential exposure to hazardous heat conditions using the indoor heat index. This potential exposure is calculated using a WRF simulation in which AC is turned off to explore the geospatial distribution of heat exposure when no cooling is available. The heat index (Steadman 1979) is a measure of “felt” or “apparent” temperature as experienced by humans that combines temperature and relative humidity. Originally developed as a table relating wet and dry bulb temperatures to heat index, it has since been adopted by the U.S. National Weather Service (NWS), usually using relative

humidity and air temperature. Here, heat index is estimated via the method used by the NWS based on the regression from Rothfuz (1990). The regression equation takes the following form

$$HI = C_1 + C_2T + C_3RH + C_4T * RH + C_5T^2 + C_6RH^2 + C_7RH * T^2 + C_8T * RH^2 + C_9T^2 * RH^2$$

where  $C_i$  are the regression coefficients:

$$\begin{aligned} C_1 &= -42.379 \\ C_2 &= 2.04901523 \\ C_3 &= 10.14333127 \\ C_4 &= -.22475541 \\ C_5 &= -6.83783 \times 10^{-3} \\ C_6 &= -5.481717 \times 10^{-2} \\ C_7 &= 1.22873 \times 10^{-3} \\ C_8 &= 8.5282 \times 10^{-4} \\ C_9 &= -1.99 \times 10^{-6} \end{aligned}$$

and the variables T and RH are indoor temperature in degrees Fahrenheit and relative humidity in percentage units from the BEM parameterization, respectively. Indoor temperature and relative humidity were averaged for all urban vertical levels, and the estimated heat index was assigned as a bulk per-grid point value. In addition, if RH is less than 13% and T lies between 80-112°F (26.67-44.44°C), an adjustment is subtracted from HI as follows:

$$ADJ = (13 - RH)/4 \sqrt{17 - |T - 95|/17}$$

If, however, RH is greater than 85% and T lies between 80-87°F (26.67-30°C), the adjustment term below is added to HI:

$$ADJ = (RH - 85)/10 * (87 - T)/5$$

Finally, if the above process yields a HI value below 80°F (26.67°C), the following equation is used instead, without additional adjustments:

$$HI = 0.5[T + 61 + (T - 68) * 1.2 + RH * 0.094]$$

Although the original formulation of the heat index was parameterized to include the impacts of clothing layers and skin heat transfer processes (e.g., convection, evaporation, and radiation), NWS adoption uses a series of assumptions such as light breeze (5 knots, or ~2.5 m/s), light clothing (short-sleeved shirt) and shaded conditions to facilitate development of warning systems, which are somewhat similar to indoor environments. The wind speed assumption used here is consistent with wind speeds commonly associated with ceiling fans in residences (Schmidt and Patterson 2001; Aynsley 2006). This formulation of the heat index computed with indoor values has been linked to higher incidence of cardiovascular and respiratory illness (Uejio et al. 2016), particularly among vulnerable populations in NYC (e.g., the elderly), and has been used to study indoor heat exposure during extreme heat events (Quinn et al. 2014). Although work by van Loenhout et al. (2016) found that heat index provided no additional predictive value when assessing heat-related impacts in elderly populations, they pose that this may be due to the relatively temperate conditions in their study and be of more use in warmer, more humid climates.

To estimate exposure of populations to hazardous heat conditions, we partition heat index values using the classification bands used by the NWS, then compute the number of hours when the heat index is in the *Very Hot* or higher (heat index > 40.6°C). These categories are of particular significance, as they are used by NWS and the NYC Department of Health to issue public warnings. Although authorities issue these warnings based on outdoor measurements, studies have shown that in the absence of air conditioning, temperatures decrease at a slower pace indoors compared to outdoors due to heat storage in building materials and lack of ventilation (Vant-Hull et al. 2018), increasing heat exposure relative to the outdoors.

## 2.4. Adaptation strategies

One way to offset energy usage increase from full AC adoption is widespread implementation of technologies like reflective roofs or higher AC set point values. The former can reduce energy demand by reducing radiative energy fluxes into the building envelope through the roof, while the latter reduces the cooling load by narrowing the indoor-outdoor temperature difference. We estimate potential reductions to energy burden via a second set of simulations implementing these two approaches.

We also use a set of 1 month simulations to study the sensitivity of the energy burden indicator to increases in roof albedo and target temperature and humidity. The simulations use the same input data and physics parameterizations as the base simulations, but run for only for July rather of the full summer to accommodate a larger. Table 5 details the roof albedo and AC target temperature combinations used in the sensitivity simulations. Finally, a second set of adaptation simulations using properties from high end reflective roof coatings and warmer indoor conditions are run for the entire 2018 summer period. These two simulations use a building roof albedo (i.e., reflectivity) to 0.89 represent the high end of commercially available technology (as per a review of commercial reflective roof coatings). In the second set of simulations, we change the temperature and humidity set points of the model AC to the upper of ASHRAR standards (ASHRAE 2017) for thermal comfort (25°C and 0.2 kg<sub>vapor</sub> / kg<sub>air</sub>).

Table 5: Albedo and target temperature values used in adpatation strategy sensitivity simulations. Items in bold font mark the high end adaptation used in the full summer simulations.

	Roof albedo	Target temperature / spec. humidity
Baseline	0.2	22.2°C (0.001 kg <sub>vapor</sub> / kg <sub>ai</sub> )
Albedo sensitivity	0.4	22.2°C (0.001 kg <sub>vapor</sub> / kg <sub>ai</sub> )
	0.6	22.2°C (0.001 kg <sub>vapor</sub> / kg <sub>ai</sub> )
	<b>0.89</b>	<b>22.2°C (0.001 kg<sub>vapor</sub> / kg<sub>ai</sub>)</b>
Target temperature sensitivity	0.2	23.3°C (0.001 kg <sub>vapor</sub> / kg <sub>ai</sub> )
	0.2	24.4°C (0.001 kg <sub>vapor</sub> / kg <sub>ai</sub> )
	<b>0.2</b>	<b>25.0°C (0.002 kg<sub>vapor</sub> / kg<sub>ai</sub>)</b>

### 3. Results

#### 3.1. Model evaluation

To evaluate model performance, we compare simulation results with temperature observations from the New York State Mesonet network, and estimated AC peak load demand from the New York Independent System Operator (NYISO). NYISO is a nonprofit, quasi-governmental entity tasked with managing the state of New York’s electric supply market. As part of the services it provides, it reports electric loads for each of the New York State load zones, of which NYC is one. To evaluate model performance in reproducing temperatures, a weather station was selected from each of the city’s five boroughs (Brooklyn, The Bronx, Manhattan, Queens, and Staten Island), collecting data at 2 m height above ground. Then, the closest model grid point is selected and compared against each stations’ recorded hourly temperatures.

Comparisons against the weather stations reveal that root mean square errors (RMSE) in simulations with present-day AC adoption rates ranging from 2.83-3.10°C. Errors are largest during nighttime, particularly when temperatures remained warm overnight (above 22°C), and simulated temperatures dropped to below 17°C. When considering full AC adoption, which in some neighborhoods represent an increase of around 25% AC adoption, RMSE is slightly higher in all boroughs except Staten Island. Although model improvement is modest when considering partial AC fractions, results are consistent with previous work by Xu et al (2018), which adopted a per urban class fractional cooled fraction for the city of Beijing.

Table 6: Location and error statistics for WRF simulations using Partial and full AC adoption.

Name	Latitude (°)	Longitude (°)	Partial AC RMSE (°C)	Full AC RMSE (°C)
Brooklyn	40.631762	-73.953678	3.10	3.18

Bronx	40.872481	-73.893522	2.83	2.90
Manhattan	40.767544	-73.964482	2.88	2.91
Queens	40.734335	-73.815856	3.09	3.20
Staten Island	40.604014	-74.148499	2.98	2.96

NYISO records total electric load for NYC at 5 minute intervals, which we resample to hourly mean values. Since NYISO reports supply-side electric loads, its values include signals related to transmission and distribution losses, lighting, transportation, and other non-AC energy use. We refer here to the loads not related to transmission losses as the base load. To disaggregate the total load for a closer comparison to the simulated AC electric load, we first account for transmission and distribution losses as well as the baseline (i.e., non cooling) loads.

We account for transmission and distribution losses by dividing hourly values by a loss factor of 6.67%. This load factor was obtained from the report on grid losses by the New York State Energy Research and Development Authority, using the state average as an approximation (Short and Swayne 2012). Then, we follow the methods detailed by Salamanca et al (2013) to separate electric loads into two components: one driven by meteorology (i.e., AC loads) and the other by human behavior (i.e., base loads). To estimate this human behavior component of the electric load, we extract the data from the day with the lowest load (C1) and the day with the lowest diurnal range (C2), defined as the difference between the daily maximum and minimum load in a given day. The base load is then computed from the average between these (Figure 4a):

$$Baseload = \frac{C1 + C2}{2}$$

Simulated AC demand from the Partial AC adoption simulation is clipped to the NYC boundary, then all grids are added to obtain hourly AC load. Comparing the disaggregated NYISO AC electric load with WRF simulated loads (Figure 4b) for average per-hour values, we find generally good

agreement, with a root mean squared error of 209 MW, or about 15.8% of the mean daily load. Differences between WRF and NYISO are largest in the afternoon peak and lowest in the early morning. This lower sensitivity of the WRF AC load to outdoor conditions might be due energy fluxes into buildings being too low as a result of some of the lack of detail in some of the lookup table parameters (e.g., roof and wall conductivity, emissivity) or underestimating temperature set points (e.g., commercial and office spaces might be overly cooled). The daily cycle also follows a similar hourly progression, albeit with a 1-2 hour lag at the beginning of the work day, with a small peak in the morning (10AM) and a larger peak in the late afternoon (3-4PM).

We note that the use of a bulk supply-side dataset to evaluate NYC-wide cooling loads presents challenges. We have mitigated this issue with two considerations here. As simulations only run for the NYC summer season (June-July-August) they are unlikely to encounter days where heating is active (indeed, mandatory heating season in NYC ends in May). Second, the method used to compute the baseline load uses the average of the days with smallest load, which arguably should have the least cooling or heating as well as the day with the smallest daily diurnal range to approximate its non-weather dependent. These two days were May 14, 2018 and June 10, 2018 which had peak temperatures of 21°C and 22°C, which are very close to standard temperature set points, and when we can assume cooling and heating loads to be negligible. In addition, there were no massive disruptions in public transportation or power outages during these days, ruling out extreme or anomalous baseline loads. In addition, differences in infrastructure use and actual AC usage may add uncertainty. Another point of uncertainty in simulated AC is that all urban grid cells are cooled unless the AC fraction parameter is zero. Additional data on building materials and AC performance may make these results more in line with observations and sensitive to the day to day weather variation.

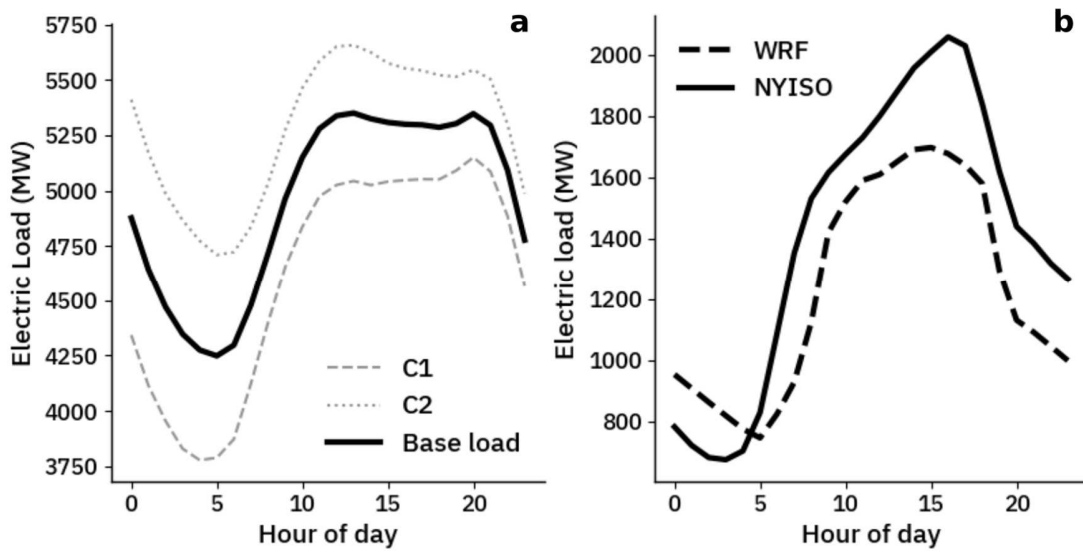


Figure 4: (a) Hourly daily base load for and its two components and (b) Hourly daily AC electric loads for summer 2018 estimated from WRF simulations and NYISO supply-side load.

### 3.2. Indoor heat exposure

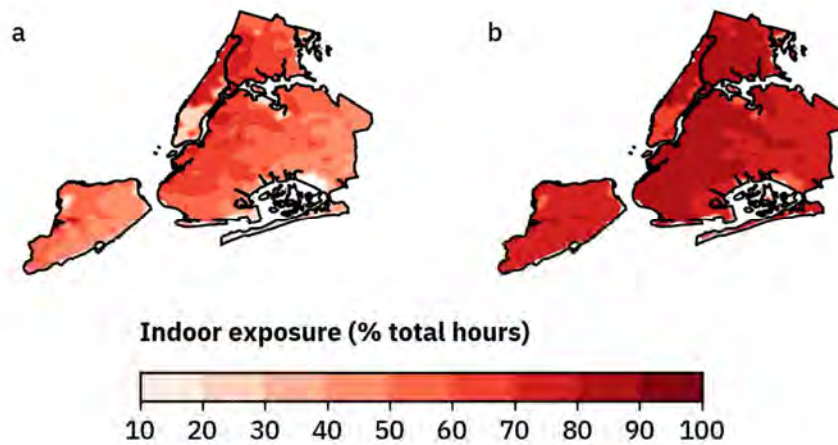


Figure 5: Percent of summer (JJA) hours when indoor heat index reaches or exceeds Very Hot threshold in the (a) PRESENT and (b) FUTURE simulations.

Figure 5 shows indoor heat exposure, presented as the percent of summer (June-July-August) hours that reach or exceed  $40.6^{\circ}\text{C}$ . In the PRESENT simulation (Figure 5a), heat index meets or exceeds the *Very Hot* threshold between 10 and 70 percent of days. Locations near midtown and downtown Manhattan, where commercial land use uses half as much occupancy than in residential areas (Figure 2b-c), experiences the fewest hours of exposure. Locations with highest hours of exposure are characterized by residential units where occupancy is double that of commercial land use, as shown in Figure 2e and Table 1. As occupancy acts as a source of sensible and latent heat in BEM, this leads to significant differences in the indoor moist air enthalpy across the city (SI Figure 4). A less intense spatial gradient of hot temperatures is also consistent with previous characterizations of the NYC UHI, with an afternoon breeze cooling southern areas of NYC and moving the core of the UHI to the northwest Bronx and upper Manhattan (Gedzelman et al. 2003). These results, however, only capture days between June 1 – August 31, which caps the number of hours to 2208 (92 days, 24 hours each).

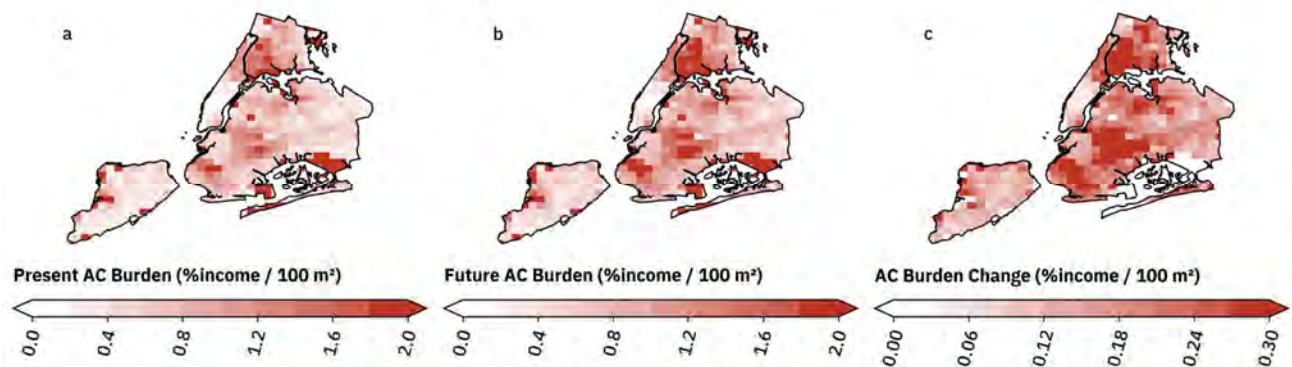


Figure 6: AC utility cost burden for the (a) PRESENT and (b) FUTURE simulations, as well as (c) the difference between the two.

### 3.3. Energy Burden

Results show that AC Burden varies across NYC, with values in the PRESENT simulation ranging from near zero to over 2% of total income per 100 m<sup>2</sup>, with 99<sup>th</sup> percentile value of 2.4% per 100 m<sup>2</sup>. In the PRESENT simulation (Figure 6a), highest burden areas are located in the South Bronx and Easter/Central Brooklyn (boundaries shown in Figure 3). Relatively low incomes drive these high burden areas, with the lowest income households earning under 2500 USD per month, which is lower than the NYC published poverty threshold of 32402 USD annual income (New York City Office of the Mayor 2017). Grids within the south Bronx are particularly notable, as they both experience the highest share of summer hours above 40.6°C, and the center of afternoon outdoor UHI as shown by Gedzelman et al (2003). Meanwhile, high incomes in most of Manhattan (> 10000 USD per month) lead to relatively low energy burden of less than 0.1% income per 100 m<sup>2</sup>. These burdens could be, however, significantly lower for high income households, as ACS income brackets stop at 250000 USD annual income, skewing collected survey data.

In the FUTURE simulation (Figure 6b), AC burden increases in all grids as a function of warming summer temperatures. Although mean energy burden for the entire city is 0.9% income per 100 m<sup>2</sup>, the lowest income neighborhoods experience up to 8% income per 100 m<sup>2</sup>. Meanwhile, the top 1% of grids have a burden of 3.2% income per 100 m<sup>2</sup>. Since energy burden calculations do not consider income changes, grids with highest burden values remain in the present-day low income neighborhoods. Changes between FUTURE and PRESENT (Figure 6c) show that AC burden increases are larger in already vulnerable areas. These areas also coincide with the neighborhoods with lowest AC adoption rates (Figure 2d) and household income (Figure 3). There is an inverse relationship between the change in AC burden and monthly income, with higher income areas experiencing less than 4 times the increase in burden (Figure 9). Although relative costs of AC increase at higher rates in

these regions, they also experience the longest projected hours exposed to *Very Hot* conditions when no AC is used. AC burden change varies with building characteristics.

Urban form and building properties also have an impact on thermal loading and outdoor conditions, as has been which in turn may impact indoor climates. In general, more densely built areas (Figure 7a) with less tall (Figure 7b) buildings experience the largest increases in AC burden. The tallest, most slender buildings (i.e., with high ratio of total surface area to footprint area, Figure 7c), like those found in the large commercial districts in the city experience almost no increases in AC burden over time. However, without accounting for those buildings, AC burden increases with increasing surface to plan area ratios. A similar pattern is observed built area fraction, where the very highest burdens lie in regions with relatively low built-up area. These patterns may be due to differences in neighborhoods populated with large single-family homes versus other areas with densely packed multi-family housing that is common in less lower income areas like the south Bronx and upper Manhattan.

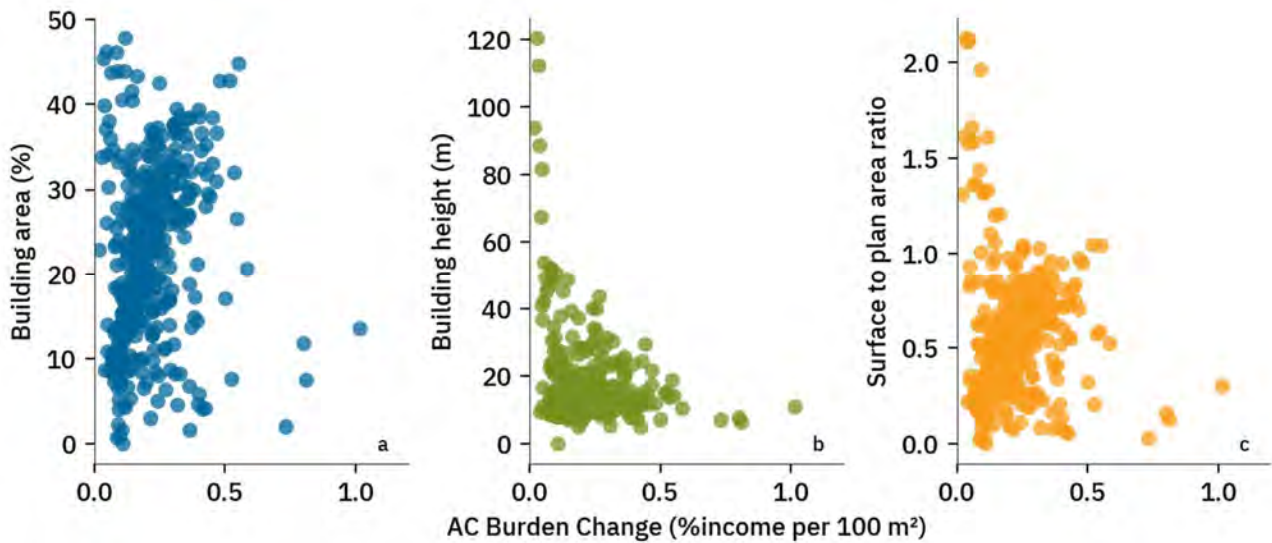


Figure 7: Scatter plots of AC burden change against grid (a) building area fraction, (b) building height, and (c) building surface to plan area.

We also quantify changes in indoor thermal heat using moist enthalpy. We estimate moist enthalpy using the ASHRAE approximation (American Society of Heating 2017):

$$h = 1.006T + q(2501 + 1.805 * T)$$

Here,  $h$  is the indoor moist enthalpy,  $T$  is the indoor temperature, and  $q$  is the indoor specific humidity. Simulation results (Figure 8a-b) show that the geospatial pattern is mostly influenced by the urban land class (Figure 2e), with distance to the coast playing a smaller role. Although buildings in commercial landuse have lower moist enthalpy than those of the two residential urban land classes, they experience a slightly higher percent change between PRESENT and FUTURE simulation, close to 2% higher (Figure 8c). Areas with low relative change coincide with low income neighborhoods where the energy burden and its projected increase is also highest, so we conclude that household income is the main driver of the energy burden in NYC.

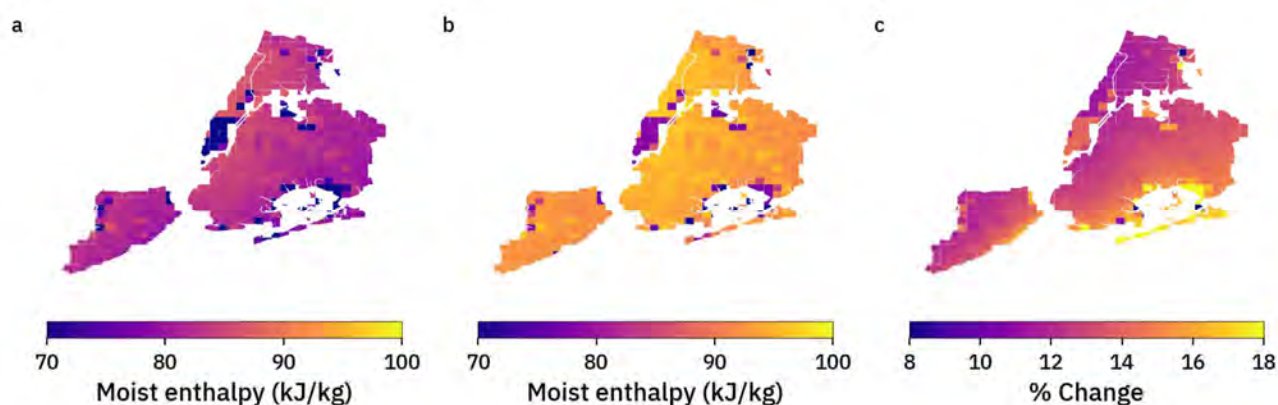


Figure 8: Mean indoor moist enthalpy for (a) PRESENT, (b) FUTURE, and (%) the percent change between them.

These results highlight some of the impacts important to discussions of heat adaptation measures. Although low income neighborhoods experience the longest exposure time to indoor extreme heat, they also see the highest relative costs of AC operation. Warmer end of century summers exacerbate the differences between high and low income groups both in terms of indoor heat exposure and utility costs. Previous work has shown that periods of increased spending on heating during cold weather negatively impacts spending on food in low income families (Bhattacharya et al. 2003). Barring any economic assistance to offset increasing cooling costs, increasingly hot summers may have a similar impact on household budgets, lowering health outcomes either by reduced food or reduced cooling spending.

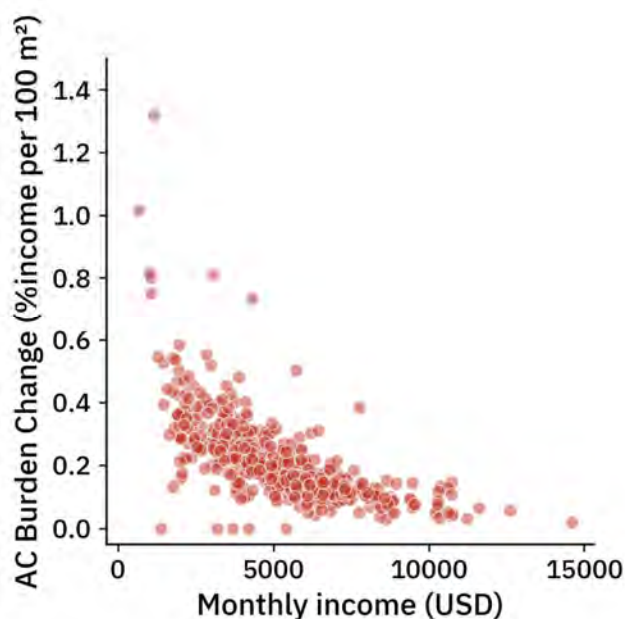


Figure 9: Grid-point change in AC burden between the PRESENT and FUTURE simulations as a function of 2017 ACS income.

### 3.4. Energy burden reduction strategies

Results from the sensitivity analysis is summarized in Figure 10. Overall, results show decreasing burden as adaptation magnitude increases, with increases in set point resulting in the largest decreases in burden. Median energy burden for the albedo simulations (Figure 10a) range from 0.80 %income/100 m<sup>2</sup> in the baseline simulation to 0.62 %income/100 m<sup>2</sup> in the maximum adaptation scenario. However, impacts are significantly larger in high burden locations, with burdens going from 8.7%income/100 m<sup>2</sup> in the baseline simulation to 6.7 %income/100 m<sup>2</sup> in the maximum albedo simulation. Energy burden is more sensitive to changes in set point (Figure 10b), with median values going from 0.80 %income/100 m<sup>2</sup> in the baseline case to 0.53 %income/100 m<sup>2</sup> in the maximum. In the highest burden locations, the energy burden range from 8.7 %income/100 m<sup>2</sup> to under 5.5 %income/100 m<sup>2</sup>. Running a linear regression with the results of the sensitivity study, we find that on average energy burden decreases by

0.002 %income/100 m<sup>2</sup> per unit increase in albedo, and 0.06 per unit increase in set point, with both trends being statistically significant ( $p < 0.001$ ).

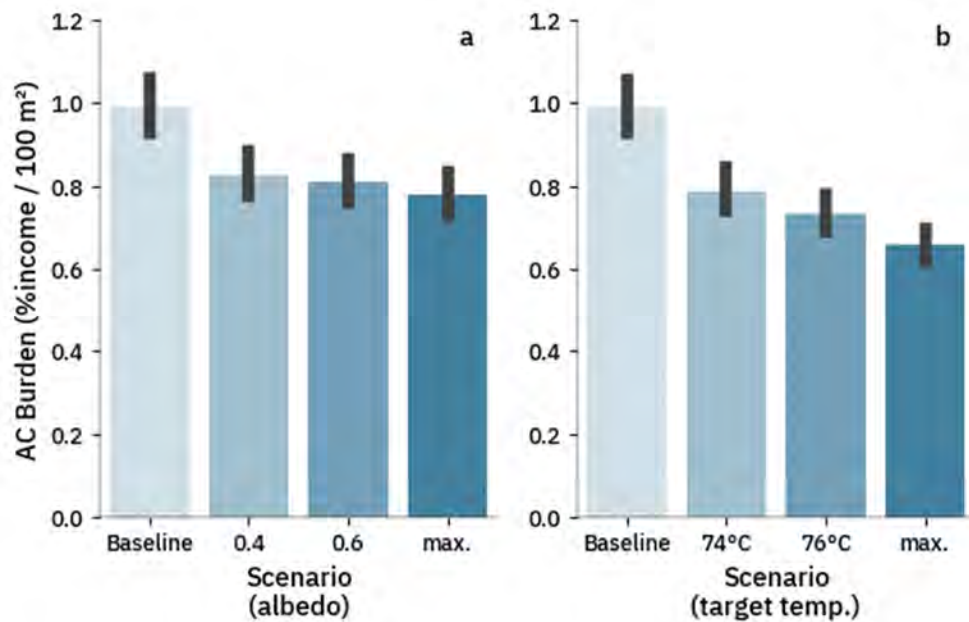


Figure 10: Sensitivity of AC energy burden for (a) increases in rooftop albedo and (b) increases in AC set point temperature. Black bars represent a bootstrapped 95% confidence interval using 1000 bootstrap iterations

Results from our two adaptation strategy simulations show that adaptation strategies can have significant impacts on the cooling energy burden at the household level (Figure 11). Increasing the AC temperature and humidity set points have the largest impacts throughout the domain, with the burden in the South Bronx region decreasing by 0.33 % income per 100 m<sup>2</sup> on average, a reduction of nearly 21%. We find the burden in East Brooklyn area decreased, on average, by 0.24 % income per 100 m<sup>2</sup>, or 20% of their future burden. In some grid cells, percent reduction in burden reaches close to 0.50 % income per 100 m<sup>2</sup> or up to 22% of the total future burden within both boundaries.

Results from the reflective roof simulations show relatively modest reductions in energy burden compared to raising AC set points. For instance, reductions in cooling energy burden averaged in the

South Bronx 0.13 and reaches up to 0.21 % income per 100 m<sup>2</sup>, representing decreases of 8% and 10%, respectively. Meanwhile in the East Brooklyn area, reductions averaged 0.8 % income per 100 m<sup>2</sup> and up to 0.15 % income per 100 m<sup>2</sup>, representing decreases of 6% to 13% of their total.

These results are consistent with recent work in by Mughal et al (2020), which found larger reductions in cooling energy demand from increasing set points from 21°C to 25°C than from reflective roof coatings. They found, however, that cool roof coatings decrease outdoor temperatures in low-rise areas more than set-point increases do, which might provide benefits beyond the building envelope.

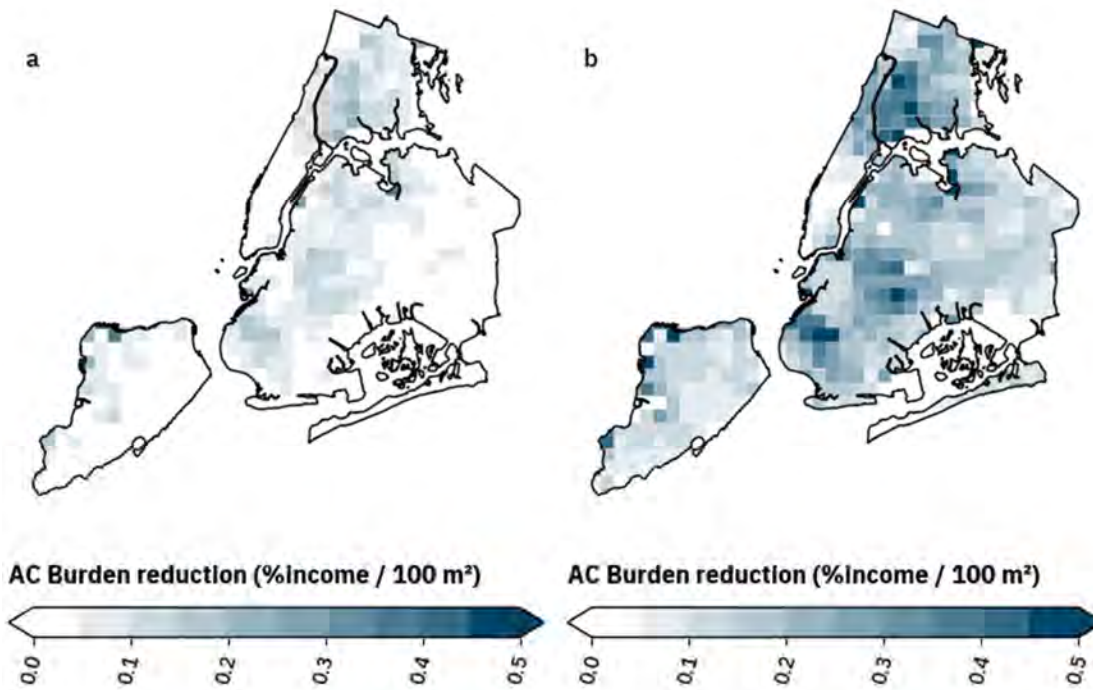


Figure 11: AC Burden reduction resulting from (a) full adoption of reflective roof coatings, and (b) higher set points.

#### 4. Conclusion

Through a series of coupled building energy-weather simulations combined with census and utility data, we present an estimation of the burden of indoor cooling relative to household incomes in NYC. To the authors' knowledge, this is one of the first studies that contextualizes dynamically modeled energy use with spatially explicit household income data at the city scale. By modeling the physical processes between buildings and the atmosphere, our work accounts for the feedbacks inherent to the urban climate system that impact the thermal loading of buildings, which in turn has an important role in cooling costs.

We compare these costs by using hours exposed to hazardous heat as an indicator of heat-related health risks. In addition, we present potential climate-driven impacts of warming summers to this cost. Our results show that locations with lower income households have the highest estimated energy burden from AC use. In locations with the highest burden, under present climate conditions, a 100 m<sup>2</sup> household would spend 6.1% of their total income on cooling during a fairly typical summer. Meanwhile, during an equivalent end of century summer in a high emissions scenario, this cost could increase to 8% of total income. These locations coincide with neighborhoods recorded to currently have the lowest AC adoption rates and highest heat mortality rates (Ito et al. 2018). Work by Madrigano et al (2015a) also found that these neighborhoods have high rates of vulnerable populations (elderly, low income) (Madrigano et al. 2015a). Their work found that mortality rates increases during a heat wave were higher for low income, non-white, and elderly populations in NYC compared to other groups. This uneven exposure across vulnerable populations was compounded by less accessible green space and higher neighborhood surface temperatures, a trend that has recently been found across many US cities as recently found by Hsu et al. (2021).

Meanwhile, energy burden in higher income neighborhoods range from nearly negligible ( $< 0.01\%$  of total income per  $100 \text{ m}^2$ ) to  $0.5\%$  of total income  $100 \text{ m}^2$ , with current AC adoption rates close to  $100\%$ . We also show that changes in the energy burden are higher in low-income areas in spite of lower relative increase of internal heat load compared to higher income neighborhoods.

Simulated exposure to indoor heat and AC energy burdens are driven by indoor parameters like occupancy, building infrastructure and meteorological processes. NYC summer temperatures are often characterized by an afternoon sea breeze from the south east which significantly cools areas in proximity to the coastline while essentially moving the core of the daytime UHI northwest and into parts of New Jersey, which contributes to the indoor temperature gradient reproduced by our simulations. Previous studies also show vertical variation in indoor temperatures, with top floors, even in tall buildings, can have significantly higher temperatures than ground floor dwellings, which is not considered in our analysis (Quinn et al. 2017).

High costs of air conditioning operation may also serve as a driver of passive, less energy intensive forms of building envelope cooling. Studies have shown that cool roofs (e.g., white roofs and green roofs) and even photovoltaic panels can decrease cooling loads significantly (Jaffal et al. 2012; Skelhorn et al. 2016; Salamanca et al. 2016) during the warm season. Rooftop technologies might be particularly useful in the high-burden neighborhoods with the largest indoor heat exposure as their shorter, less slender can deflect a more significant portion of incoming solar radiation via roofs (Ortiz et al. 2016), with estimated reductions of  $10\text{-}16\%$ . Our work presented here, however, highlights how these technologies may benefit low-income communities, with potential reductions of up to  $20\%$  in an idealized adoption scenario. In addition, urban planning and use of urban gardens and other vegetation have been shown to reduce not only outdoor temperatures (Dimoudi et al. 2014; Farhadi et al. 2019) but also reduce energy poverty (Tsilini et al. 2015).

#### *4.1. Limitations and uncertainty*

One of the largest sources of uncertainty in our work is the consideration of static social indicators (e.g., population, median income). Although results show increase in indoor heat exposure hours under no AC use, we do not account for changes in populations, income, or building infrastructure throughout the 21<sup>st</sup> century. Therefore, results should be interpreted as potential impacts on current NYC conditions. These uncertainties are partly constrained by the recently reported slowdown of population increase in NYC (U. S. Census Bureau 2019). In addition, as income and population data from the American Community Survey 5-year estimate are derived from somewhat limited samples, as opposed to the comprehensive decennial census, they carry margins of error. In our analysis, each grid point is assigned the median value to estimate economic burden, whereas income might vary drastically between households within a single neighborhood or even city block. Occupant behavior, which is not accounted for in this study, can also significantly impact both energy use and hazardous heat exposure, as people may move to outdoor activities as a function of outdoor weather conditions or typical day-to-day activity. In addition, model evaluation as performed here is limited by a lack of spatially explicit building electric load data and the method used to compute the non-weather sensitive of NYISO bulk supply-side data.

Another limitation of the study relates to the use of electric rates from a single summer. Utility rates vary year-to-year due for various reasons, including taxes on generation and transmission, repair and maintenance of infrastructure, and projected electric demand. Based on Consolidated Edison approved rate increases, NYC residents will be seeing cost per kWh to grow by nearly 4% per year until 2022 (Consolidated Edison 2021a). Nevertheless, rate hikes may change at different dates due to changes in energy supply and new investments in energy infrastructure. Further, there has been increased focus from utilities to offer “Time of use” (TOU) pricing, where energy use is more

expensive during peak demand times. These TOU pricing schemes usually charge less than current averages during off-peak hours, but may charge significantly more during peak or so called “super-peak” hours (Consolidated Edison 2021b). These increased rates during peak hours may further burden residents during extreme heat events, when indoor cooling may be most needed.

Finally, we note that our study considers a single year (2018) compared to an analog taken from a single year from a GCM end of century 30-year output. Although our analysis shows geospatial disparities in the cooling energy burden, actual values will vary depending on how cool or warm a particular summer might be. For example, as the energy burden is a function of household income, significantly warmer summers would increase low-income households’ burden at higher rates than their higher income counterparts. In addition, limitations related to model resolution could be addressed with increased computing power and finer scale AC adoption rates data, which might improve the representation of spatial characteristics of energy burden.

Nevertheless, our study highlights the disparities spatial distribution of the impacts of current heat exposure across current socioeconomic groups. Our results show that, all things remaining equal, future conditions have the potential to disproportionately affect groups that have fewer means to adapt to these changes. These neighborhoods also stand to experience the highest increases in indoor heat exposure due to a combination of indoor thermal conditions (e.g., occupancy) and outdoor conditions, and our results show increasing risk of heat-related illness and mortality when no adaptations are used. Moreover, by quantifying potential future impacts of future climate on current populations, current policy can focus on strategies to mitigate or avoid them altogether. We also show that, although there are state and local programs to mitigate some of the cost of AC technology (e.g., HEAP), operational costs may pose a significant barrier for their and operation, which might exacerbate negative impacts related to heat exposure under changing climate conditions. Similar studies on the role of

socioeconomic factors on exposure and vulnerability to extreme heat (either outdoor or indoor) have been reported across the US in cities like Portland (Voelkel et al. 2018), Chicago (Klinenberg 1999; Wilson and Chakraborty 2019), and San Juan (Méndez-Lázaro et al. 2018), and studies like this might prove useful to reveal what disparities, if any, exist in cooling energy burdens.

## 5. Acknowledgments

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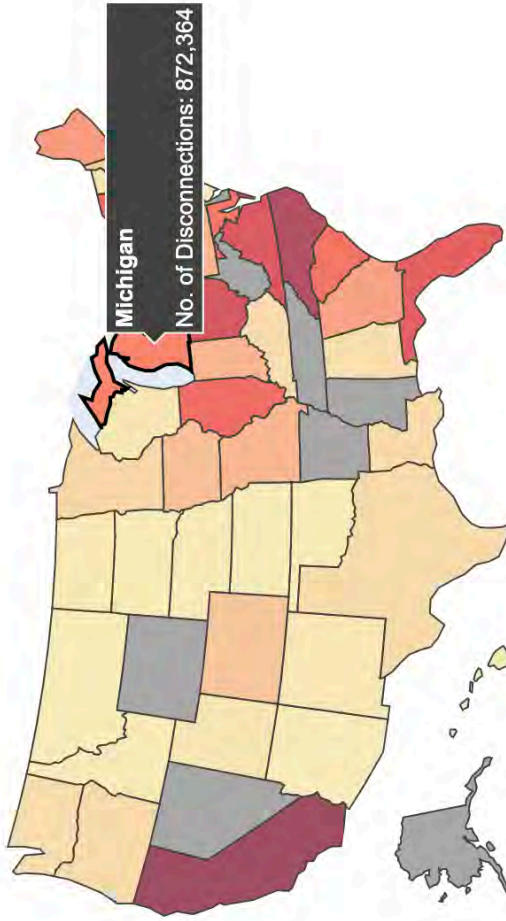
All

Month

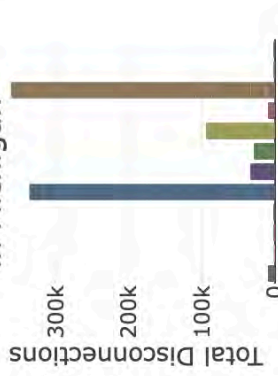
- May
- June
- July
- August
- September
- October

Indicator

Total Disconnections



Disconnections by Utility in Michigan



- Holland Boa
- City of Bay
- Upper Michi
- Northern St
- Consumers
- Semco Ener
- Indiana Mic
- Lansing Boz
- Michigan Gz
- DTE Energy

Michigan instituted a disconnections reporting requirement in response to the COVID-19 pandemic, and utilities provided reports on customer shutoffs, disconnections, and reconnection efforts. The Energy Justice Lab obtained disconnections information from the Lansing Board of Water and Light (2010-2022), Holland Board of Public Works (2018-2022), and the City of Bay City (2020-2022) through open records requests.

Available data range: January 2010 - December 2024.

# POWERLESS IN THE UNITED STATES

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## How Utilities Drive Shutoffs and Energy Injustice

An ongoing project tracking utility service disconnections and corporate profiteering

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**Center for Biological Diversity** | Selah Goodson Bell and Jean Su  
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### Design

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*Photo credit: Reverend Michael Malcom*

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## INTRODUCTION

The epidemic of utilities shutting off people’s electric and gas service for nonpayment has continued unabated in the months since our earlier Powerless in the Pandemic publications, which tracked utility disconnections and corporate profits since COVID-19 began.<sup>1</sup> Utilities shut off power to households an estimated 4.2 million times in the first 10 months of 2022.\* The harm is real and self-evident, as are the solutions. Yet utility companies are still depriving U.S. households of power and heat millions of times a year while returning billions to their shareholders and executives.

The seriousness of the problem was made plain by the late December superstorm that battered the United States. Frozen gas lines and downed power infrastructure led to at least 60 fatalities and left millions of people unsafe, without power and heat – a situation that distributed renewable power generation and storage, along with a grid that moves clean electricity more efficiently, could have alleviated.

**Access to electricity is a basic human right. Without it, people struggle to maintain employment and stay alive.**

Access to electricity is a basic human right. People rely on electricity for water, physical safety, food security, medical care and telecommunications. When these essentials are taken away, the harm spreads like ripples across a pond. Disconnections foster instability: Without power, people struggle to maintain employment, keep their kids in school, and even stay alive. This is doubly true for the largely poor communities of color that are most vulnerable to inadequate housing and climate-driven weather extremes.

The preventable practice of disconnections keeps millions of Americans in poverty and narrows their avenues of escape. By giving utility companies the power to penalize poverty, we license them to perpetuate it.

Shutoffs allow corporate utilities to punish customers’ economic precarity while guaranteeing record profits and massive payouts for themselves and their investors.

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\* The data cover states disconnections up until their latest month of reporting in 2022. See Methodology ([Annex 3](#)).

As this report shows, the companies most responsible for utility disconnections tend to be less profitable than their peers but spend more of their cash on executive pay – about \$5.9 million per executive per year – and Wall Street dividends. It shows how a broken utility industry causes energy insecurity and hurts American people, and it outlines what federal and state lawmakers and regulators can do to fix that.

For the first time, we provide data on fossil fuel-price volatility and gas-utility disconnections, in addition to electricity shutoffs. What emerges is a vicious cycle in which shortsighted overinvestment in fossil infrastructure by utilities helps drive that price volatility and fuels the shutoff crisis. Excessive profit-taking also is a key driver of skyrocketing inflation that adds to people's economic woes.

Our work is limited by lack of data transparency. Only 60% of states require utilities to report the egregious practice of shutting off power for nonpayment. As long as utilities can hide behind industry-friendly regulators and politicians, refusing to provide clear data on their anti-consumer policies, we will never know the true scope of damage caused when companies sever service.

## EXECUTIVE SUMMARY

-  **UTILITIES CUT OFF POWER TO HOUSEHOLDS MORE THAN 1.5 MILLION TIMES** from January through October 2022 in the 30 states and Washington, D.C., where data was available. Extrapolating the rate of customers disconnected across all 50 states, we estimate **4.2 MILLION HOUSEHOLD DISCONNECTIONS OCCURRED ACROSS THE COUNTRY** in the first 10 months of 2022.
-  **THE SHUTOFFS CRISIS IS GROWING.** We found a **29% INCREASE IN POWER DISCONNECTIONS AND A 76% INCREASE IN GAS DISCONNECTIONS** in the first 10 months of 2022 compared to the same period in 2021, among power utilities and a subset of gas utilities providing data.
-  **A DOZEN COMPANIES PERPETRATED 86% OF THE SHUTOFFS** documented from 2020 through October 2022. **JUST 1% OF THEIR SPENDING ON DIVIDENDS FOR SHAREHOLDERS COULD HAVE PREVENTED ALL THEIR DOCUMENTED POWER SHUTOFFS** over that period. Those same companies spent \$2.8 billion paying about 70 top executives in the three years beginning in 2019 – about \$5.9 million per executive per year.
-  **BY CONTINUING TO INVEST IN FOSSIL GAS AND INFRASTRUCTURE, IGNORING PRICE VOLATILITY, UTILITIES ARE DRIVING ENERGY INSECURITY AND SHUTOFFS, PARTICULARLY FOR HOUSEHOLDS OF COLOR.** Electricity prices are up about 12% since 2021, driven by the Russian war in Ukraine, utilities' reliance on fossil gas for power generation, and their ability to pass rising fuel costs directly on to customers. This economic precarity hit particularly hurts people of color; 1 in 3 families couldn't afford at least one energy bill last year.
-  **THE SCALE OF THE SHUTOFFS PROBLEM IS MASKED BY A WIDESPREAD FAILURE OF TRANSPARENCY, WITH STATE REGULATORS IN NEARLY 40% OF STATES FAILING TO REQUIRE ANY DISCLOSURES.** Most notably, Florida stopped providing data in late 2021, leading to an apparent (but misleading) decrease in the number of shutoffs documented in 2022. Florida Power & Light imposed the most shutoffs – nearly 1 million – from 2020 through 2021.
-  **THERE ARE MANY STEPS FEDERAL AND STATE LAWMAKERS AND REGULATORS CAN TAKE TO TACKLE THE CHRONIC DISCONNECTIONS PROBLEM.** We provide the most comprehensive policy blueprint to date of what they can do – from banning utility shutoffs to transforming the unaccountable, dirty utility system. ([See Annex 1.](#))

# FINDINGS

## Electricity Disconnections Are Increasing

Utility shutoffs are spiraling out of control. Electric companies cut off power to households more than 1.5 million times from January through October of 2022 in the 30 states and Washington, D.C. where data were available. The seven worst offending utilities' disconnections equaled about 3% of their total customers. If this rate prevailed across the United States, it would suggest a total of 4.2 million household disconnections in the first 10 months of 2022.<sup>2</sup>

Ten states accounted for nearly 84% of the shutoffs we documented. (See Table 1.) Utilities in Illinois, Pennsylvania, Georgia, Michigan, Ohio and Missouri committed more than two-thirds of the 2022 shutoffs. Had Florida continued reporting data past October 2021 it likely would have remained at or near the top of the list.

Combining this new dataset with findings from our earlier reports, we can document a staggering 5.7 million electricity shutoffs against U.S. households from January 2020 through October 2022.

**TABLE 1**  
**STATE**  
**DISCONNECT**  
**DATA**

Top 10 states

State (latest month of reporting in 2022)*	Disconnects in 2021*	Disconnects in 2022*	Change in Disconnects from 2021 to 2022	% Change in Disconnects from 2021 to 2022
Illinois (October)	225,504	284,720	59,216	26
Pennsylvania (October)	180,219	198,627	18,408	10
Georgia (October)	189,649	198,463	8,814	5
Michigan (June)	142,904	166,284	23,380	16
Ohio (May)	106,378	107,271	893	1
Missouri (September)	68,534	84,754	16,220	24
Maryland (October)	41,416	74,345	32,929	80
Connecticut (October)	153	58,945	58,792	38,426
Kentucky (June)	16,029	52,609	36,580	228
New York (October)	0	41,235	41,235	N/A
<b>Total</b>	<b>970,786</b>	<b>1,267,253</b>	<b>296,467</b>	<b>31</b>

\*The data cover states' disconnections up until their latest month of reporting in 2022. See the Year-Over-Year Comparison section in Methodology ([Annex 3](#)) for a full explanation.

In areas served by utilities that provided data in 2021 and 2022, the country saw a 29% increase in disconnections in the first 10 months of 2022, year-over-year. Among the 10 states with the most disconnections, the percentage increase from 2021 to 2022 was 31%.<sup>3</sup> (See Table 1.)

Many states with notable increases in disconnections also saw average utility bills increase sharply;<sup>4</sup> Missouri (shutoffs up 24%, electric bills up 24%); Kentucky (shutoffs up 228%, electric bills up 17%); and Arizona (shutoffs up 20%, electric bills up 6%).

Many pandemic-induced bans on shutoffs expired in 2021, which helped drive up disconnections. At the start of the pandemic in March 2020, 32 states and Washington, D.C., imposed a patchwork of moratoriums that barred utilities from shutting off power to people struggling with COVID-related economic disruptions. Most of the moratoriums ended in 2021, resulting in tens of thousands more disconnections in 2022 in states including Connecticut, New York and Massachusetts.

New York's COVID-related shutoffs moratorium, among the country's most ambitious, ended in December 2021.<sup>5</sup> In the first 10 months of 2022 New York utilities disconnected households more than 41,000 times.

## Seven Utilities Perpetrated Most Shutoffs

Seven utility parent companies, operating in nine states and D.C., perpetrated nearly 70% of the shutoffs documented in 2022. They increased disconnections collectively by more than 22% over the same period in 2021: Exelon Corp. (31% increase), Southern Company (5% increase), DTE Energy (16% increase), Ameren Corp (10% increase), First Energy Corp. (20% increase), PPL Corp. (139% increase), and American Electric Power Co Inc (7% increase). (See Table 2.)

**TABLE 2**  
**UTILITIES WITH**  
**MORE THAN**  
**70,000**  
**SHUTOFFS**  
*January-October 2022*

Parent Company (states of operation) <sup>6</sup>	Disconnects 2021*	Disconnects 2022*	Change in Disconnects from 2021 to 2022	% Change in Disconnects 2021 to 2022
Exelon Corp <sup>7</sup> (IL, MD, PA, DC)	280,303	368,579	88,276	31
The Southern Co. <sup>8</sup> (GA)	189,649	198,463	8,814	5
DTE Energy (MI)	102,206	118,699	16,493	16
Ameren Corp (IL, MO)	100,539	110,688	10,149	10
FirstEnergy Corp <sup>9</sup> (MD, PA, OH)	81,744	98,467	16,723	20
PPL Corp <sup>10</sup> (PA, KY)	33,904	81,058	47,154	139
American Electric Power Co Inc <sup>11</sup> (OH, KY, MI, IN)	67,900	72,881	4,981	7
<b>Total</b>	<b>856,245</b>	<b>1,048,835</b>	<b>192,590</b>	<b>22</b>

\*The data cover each state's disconnections up until their latest month of reporting in 2022. See the Year-Over-Year Comparison section in the Methodology ([Annex 3](#)) for a full explanation.



## ILLINOIS TOPS SHUTOFFS CHART, EXEMPLIFIES UTILITY CORRUPTION

Illinois leads the nation in electric shutoffs for nonpayment in the first 10 months of 2022 thanks to two major investor-owned utilities: Exelon's Commonwealth Edison (ComEd) and Ameren. The companies reported 225,827 and 57,588 disconnections in Illinois, respectively. Illinois' gas utilities also reported a combined 82,496 shutoffs for nonpayment last year.

Illinois is one of many states where shutoffs resumed in 2021 after the expiration of COVID-related moratoriums. In March 2021 families urged the state utility regulatory body, the Illinois Commerce Commission, to extend the moratorium:

*“I am opposed to allowing Ameren and other utilities to resume shutting off services to customers during the pandemic. This is cruel and is a danger to all citizens of Illinois.”*

AMEREN CUSTOMER, MARCH 2021

ComEd's customers are paying more on multiple fronts. In October 2021 ComEd imposed a 26% higher supply price for electricity.<sup>12</sup> In addition, to pay for delivery costs including utility-owned infrastructure, ComEd sought permission from regulators to hike rates by \$199 million, which it received in November 2022.<sup>13</sup> It pursued the case while disconnecting households' power tens of thousands of times last year.

*“The moratorium on utility shutoffs is set to expire, and it is simply easier to allow that to happen. But it needs to be understood that this would cause a great deal of instability in this community. Not just for all the reasons that every other person has mentioned and will mention, but because all of those things compound and multiply one another.”*

AMEREN CUSTOMER, MARCH 2021<sup>14</sup>

The latest rate hike request was approved three months after the Illinois Commerce Commission ordered ComEd to refund \$38 million to customers for using ratepayer funds as part of a bribery scheme detailed in ComEd's July 2020 deferred criminal prosecution agreement with the U.S. Department of Justice. The utility also agreed to pay \$200 million to resolve the investigation.<sup>15</sup> The bribery scheme involved ComEd securing the passage of 2011 legislation implementing a “formula rate” system. This formula rate system exposed ComEd customers to “hundreds of millions of dollars in rate hikes over the last decade.”<sup>16</sup> An Illinois PIRG report explained ComEd earned more than \$4.7 billion than it would have without the alleged criminal scheme.<sup>17</sup>



## GEORGIA POWER SHUTOFFS, PROFITS RISING

Widespread power shutoffs by Georgia Power, a subsidiary of Southern Company, lifted Georgia to third place among states with the most shutoffs. The utility perpetrated 198,463 shutoffs by October 2022, on pace to exceed its 2021 total. The increase tracks rising rates charged to Georgia Power customers, a trend set to continue.

The Georgia Public Service Commission recently approved Georgia Power's request to charge customers \$1.8 billion for coal-ash cleanup, rising fuel costs, and the expansion of a nuclear power plant.<sup>18</sup> While customers contend with bills rising nearly 12% over three years, Georgia Power insiders are giving executives and shareholders a raise. Utility regulators increased Georgia Power's allowed profit margin to the maximum 11.9%, 2% above the national average for similar utilities, according to Gina Webber, interim director of the Sierra Club Georgia chapter.<sup>19</sup>

Southern Company returned \$2.8 billion to shareholders as dividends in 2021, exceeding the company's \$2.4 billion in profits for the year. The company also awarded seven top executives compensation totaling \$52.5 million in 2021, an average of \$7.5 million each – the second-highest figure among our Hall of Shame after NextEra.

The latest rate increase is just one of four Georgia Power will rely on to cover accumulated costs from rising fuel prices – what utilities call an “under recovered fuel balance.”<sup>20</sup> If regulators approve all four, the average residential customer's bill could soar by \$55 to \$60 a month over the next three years.<sup>21</sup> Georgia Power is exacerbating the problem by deepening its dependence on gas, securing power purchase agreements for 2 gigawatts of natural gas in the coming years.<sup>22</sup>

“Don't raise my rates. Enough. ... I can't survive like that, my businesses won't survive. I won't survive. My kids won't see generational wealth.”

GEORGIA POWER CUSTOMER<sup>23</sup>

With rising fossil gas prices from Russia's war in Ukraine driving rate increases, regulators have an opening to broaden generation options and support customers as they adjust to higher fuel costs. Instead, in Georgia Power's latest rate case, the Georgia PSC decided against expanding Georgia Power's popular rooftop solar net metering program.<sup>24</sup>

### **NextEra, Duke Energy Among Worst Actors Amid Skewed, Hidden Data**

Both NextEra and Duke Energy topped the list in 2020 and 2021 as the worst disconnection offenders among utilities that reported data. In 2022 these two utilities remained among the worst actors, even though their data was missing or skewed.

Florida utility customers were disconnected a staggering 1.48 million times between January 2020 and September 2021, making Florida the worst state for shutoffs during that period. In October 2021, however, Florida stopped requiring utilities to disclose disconnection data.<sup>25</sup>

Power shutoffs we were able to document (in states where transparency prevailed) declined a cumulative 42% in the first 10 months of 2022 compared to 2021. Florida's transparency failure contributed heavily to the shrinking number of confirmable shutoffs.

NextEra — owner of Florida Power & Light (FPL), the state's biggest utility — disconnected power more than 738,000 times in 2021, more than a quarter of the national total and a 67% increase over 2020. If that increase continued, NextEra would have shut off power 1.2 million times in 2022 — more than the combined total shutoffs of 2022's seven worst-offending utility companies.

**NextEra's disconnections increased 67% from 2020 to 2021. If that continued, the company would have shut off power 1.2 million times in 2022.**

Electricity rates have continued to climb because of a series of FPL rate hikes.<sup>26</sup> These higher bills can be traced directly to the rising cost of fossil gas. FPL, along with the other utilities in the state, have spent billions of dollars on fossil gas infrastructure, and fossil gas accounted for a hefty 73% of FPL's fuel mix at the end of 2020.<sup>27</sup> The price of gas that it pays for to run those plants has increased by 67%.<sup>28</sup>

Despite relatively poor financial performance (given its large market capitalization), NextEra is an outlier in spending lavishly on executives and shareholders. It paid \$78.6 million to five top executives in 2021, or \$15.7 million per executive, on average — by far the highest among its peers. It also spent \$3 billion on dividends for shareholders that year and another \$22.2 million on share buybacks that directly benefit shareholders.

In early December 2022, Florida regulators approved fuel rider increases for FPL along with multiple other Florida utilities to help them keep buying more gas amid spiking fossil gas prices. FPL customers will likely see a \$5 bump in their bill. That's on top of 2021 rate increases amounting to an extra \$6.82 per 1,000 kilowatt hours<sup>29</sup> and a four-year rate settlement allowing FPL to hike bills by at least \$12 a month for many customers.<sup>30</sup> This enables FPL to increase its gas capacity at several power plants, along with many other operations and management expenses.<sup>31</sup>

Duke Energy decreased disconnections in 2022, largely because shutoffs were suspended in North Carolina after it implemented a new billing system.<sup>32</sup> Households continued to accrue arrearages during this temporary suspension.<sup>33</sup>

At mid-year, as Duke Energy resumed shutoffs in North Carolina, the utility reported roughly 9,600 disconnections in June 2022 alone – more than double the number in June 2021. South Carolina saw an even bigger increase, with 5,257 shutoffs reported in June 2022, almost three times the June 2021 figure.

### Gas Prices, Disconnections Climb

A separate data set of gas utility shutoffs, including data from 42 gas utilities across 27 states and D.C., shows households were disconnected from gas nearly 384,000 times from January to October 2022, a staggering 76% increase from 2021. The top states of concern were Illinois, Pennsylvania, Missouri, Michigan and Connecticut.

These findings highlight the role rising gas prices play in compounding the struggles of energy-poor households.

**TABLE 3**  
**STATES WITH**  
**MOST FOSSIL**  
**GAS SHUTOFFS**

January-October 2022

State (latest month of reporting in 2022)*	Disconnects in 2021*	Disconnects in 2022*	Change in Disconnects from 2021 to 2022	% Change in Disconnects from 2021 to 2022
Illinois (October)	31,190	82,496	51,306	164
Pennsylvania (October)	74,709	71,224	-3,485	-5
Missouri (September)	37,336	41,166	3,830	10
Michigan (June)	21,423	30,385	8,962	42
Connecticut (October)	97	28,347	28,250	29,124
<b>Total</b>	<b>164,755</b>	<b>253,618</b>	<b>88,863</b>	<b>54</b>

\*The data cover states disconnections up until their latest month of reporting in 2022. See the Year-Over-Year Comparison section in the Methodology ([Annex 3](#)) for a full explanation.

**TABLE 4**  
**UTILITIES WITH**  
**MORE THAN**  
**30,000 FOSSIL**  
**GAS SHUTOFFS**  
 2022

Parent Company (state)	Disconnects in 2021*	Disconnects in 2022*	Change in Disconnects from 2021 to 2022	% Change in Disconnects from 2021 to 2022
Ameren Corp (MO, IL)	1,003	42,736	41,733	4,161
Spire Inc (MO)	30,655	33,735	3,080	10
Southern Company <sup>34</sup> (IL, GA)	25,488	31,370	5,882	23
<b>Total</b>	<b>57,146</b>	<b>107,841</b>	<b>50,695</b>	<b>89</b>

\*The data cover each state's disconnections up until their latest month of reporting in 2022. See the Year-Over-Year Comparison section in the Methodology ([Annex 3](#)) for a full explanation.

### Disconnections Data Blackout Worsens

This report's data set is incomplete because there's no national requirement for utilities to publicly release information about how they disconnect households from power. In 2022 only 30 states and Washington, D.C., required utilities to publicly disclose disconnection data, leaving 40% of states unaccounted for.

The number of states requiring public disclosure decreased from 33 jurisdictions to 31 between 2021 and 2022.<sup>35</sup> As discussed above, the absence of information from Florida, in particular, skews the data because Florida reported the most disconnections (1.5 million) from 2020 through 2021,<sup>36</sup> then halted data collection in November 2021 after a pandemic-related mandate expired.

The difference in the quality of reporting requirements also muddies transparency. Only 13 states and D.C. require private utilities promptly to disclose monthly information on power shutoffs. Another 17 states have occasional or delayed disclosure, such as annual, quarterly, or time-lagged monthly reporting. This limits the ability of lawmakers, regulators and the public to understand the scale of the shutoffs problem.



dollars away from customers and toward executives and Wall Street investors. Given the companies' focus on paying insiders and investors, it is not surprising that those most focused on self-enrichment tend to be harshest toward customers who fall behind. With profits at the core of their mission, these companies have no incentive to mitigate the harm caused by service shutoffs.

The companies in this group are: NextEra Energy Inc., Duke Energy Corp., Exelon Corp., The Southern Co., American Electric Power, DTE Energy Co., AES Corp., Ameren Corp., CMS Energy Corp., Emera Inc., FirstEnergy Corp., and PPL Corp. Among the states where they operate: Florida, Georgia, Illinois, Indiana, Kentucky, Maryland, Missouri, Michigan, New Mexico, North Carolina, Ohio, Pennsylvania, South Carolina and Washington, D.C.

## SOME KEY FINDINGS

-  **DISCONNECTIONS ARE INCREASING.** The companies increased their disconnections by 1.3 million from 2020 to 2021. By October 2022 most were on track to finish the year with more disconnections than 2021.
-  **LESS PROFITABLE.** From 2019 through 2021, these 12 companies generated only about half the net income of their peers, on average — \$4.9 billion, versus \$9.9 billion across all 45 utility parent corporations.
-  **HIGHER DIVIDENDS.** Hall of Shame companies each spent \$4 billion paying dividends to shareholders from 2019-2021, on average — about 140% of the average dividend spending by the broader utility industry in the same period.
-  **PLENTY OF CASH TO PREVENT SHUTOFFS.** These 12 companies could have forgiven all 4.9 million documented shutoffs 90 times over using their dividends from 2020 through the third quarter of 2022 — **TOTALING TO JUST 1% OF THE AMOUNT OF THEIR DIVIDENDS.**<sup>40</sup>
-  **MASSIVE EXECUTIVE PAYOUTS.** The 12 companies collectively paid roughly 70 top executives<sup>41</sup> \$1.2 billion in the three-year period examined, or about \$5.9 million per year to each named executive. That's 15% more than the average across peer companies.<sup>42</sup>
-  **NEXTERA A STANDOUT.** Among utility-only parent corporations,<sup>43</sup> NextEra reported the highest average pay per executive (\$11.2 million) and second-highest spending on dividends (\$8.1 billion, after Duke Energy's \$8.6 billion).

**TABLE 5**  
**HALL OF SHAME**  
**UTILITIES**

Parent Company (state)	Total Cumulative Disconnects (2020 through October 2022)	Cost to Prevent Disconnects	Dividends (2020 through Q3 2022)	Dividends/ Cost to Prevent Disconnections
Exelon Corp <sup>44</sup> (IL, MD, PA, DC)	743,040	\$78,762,240	\$3,988,000,000	51x
The Southern Co. <sup>45</sup> (GA)	538,841	\$57,117,146	\$7,628,000,000	134x
DTE Energy (MI)	377,492	\$40,014,152	\$2,065,000,000	52x
Ameren Corp (IL, MO)	293,719	\$31,134,214	\$3,401,400,000	109x
FirstEnergy Corp <sup>46</sup> (MD, PA, OH)	239,527	\$25,389,862	\$2,361,000,000	93x
PPL Corp <sup>47</sup> (PA, KY)	195,555	\$20,728,830	\$3,174,000,000	153x
American Electric Power Co Inc <sup>48</sup> (OH, KY, MI, IN)	373,065	\$39,544,890	\$4,156,900,000	105x
Duke Energy Corp (FL, IN, KY, NC, SC, OH)	602,068	\$63,819,208	\$8,315,000,000	130x
NextEra Energy Inc <sup>49</sup> (FL)	1,180,212	\$125,102,472	\$8,274,000,000	66x
AES Corp <sup>50</sup> (IN, OH)	152,756	\$16,192,136	\$1,098,000,000	68x
CMS Energy Corp <sup>51</sup> (MI)	148,708	\$15,763,048	\$1,386,000,000	88x
Emera Inc <sup>52</sup> (FL)	85,163	\$9,027,278	\$1,346,000,000	149x
<b>TOTAL</b>	<b>4,930,146</b>	<b>\$522,595,476</b>	<b>\$47,193,300,000</b>	<b>Average 90x</b>

## Utility Industry Profits During COVID Pandemic

The pandemic years were massively lucrative for corporate owners of private utilities. The 45 companies examined raked in \$184.8 billion in profits in 2021, a 71% increase from 2020. Even in 2020, the toughest of the three years analyzed, all but four were profitable.

From 2019 through 2021, the companies posted total profits of \$447.8 billion. They spent \$3.8 billion paying top executives and \$239.5 billion on buybacks and dividends – returning 54% of their profits to insiders and shareholders. By contrast, the Hall of Shame companies spent 83% of their profits on executive pay, dividends and buybacks during the same period.

The \$76.5 billion (71%) year-over-year profit increase in 2021 amounts to more than \$28,000 for each of the 1.25 million shutoffs committed in 2021. These increasing profits are a root cause of inflation, accounting for a rising portion of price growth, according to a recent study by the Economic Policy Institute.<sup>53</sup>

When executives offer shareholders aggressive profit-sharing, shareholders are less prone to rebel against weak financial performance and excessive executive pay. After overinvestment in gas infrastructure led to ballooning fuel costs, the solution was to charge customers more, not to distribute funds away from the executives who made those calamitous decisions.

## MASSIVE PAY AT NEXTERA

**Florida Power & Light parent corporation NextEra is an outlier in its harsh anti-consumer shutoff policies** as well as its rapacious spending to enrich insiders and investors.

In 2021 the company spent a staggering \$78.6 million paying five executives, up 59% from 2020. Then-CEO James L. Robo made \$25.3 million, and two others received pay packages each totaling more than \$15 million. NextEra spent an additional \$291,398 in 2021 on perks for the five executives, including home security, company cars, and a \$25,000 “perquisite allowance” to CFO Rebecca J. Kujawa. About \$30,000 went to current CEO John W. Ketchum’s personal use of company aircraft.

NextEra’s spending on executive compensation alone in 2021 amounted to \$67 for each time they cut off people’s power.



# FACTORS DRIVING SHUTOFFS EPIDEMIC

## Energy Burdens and a Racist Energy System

When utility bills go unpaid, it is because people are making difficult choices about where to put their limited money. The less income a family has, the higher the percentage that goes to fixed bills like energy, housing and internet. As energy prices rise, energy bills consume an even greater share of families' earnings — known as energy burden.<sup>54</sup>

Crippling energy burdens are not a new phenomenon, but they are worsening, particularly for families of color. Last year more than 20% of families couldn't afford to pay at least one energy bill. The rate was 50% higher (31%) for households of color.<sup>55</sup> COVID-19 turned this crisis into a fatal catastrophe. A national moratorium on utility shutoffs would have reduced COVID-19 deaths by 15%, Duke University researchers found.<sup>56</sup>

**Communities of color bear the brunt of energy insecurity. Decades of discrimination have left communities of color in structurally deficient housing that costs more to heat and cool.**

Communities of color bear the brunt of energy insecurity.<sup>57</sup> The median energy burden of Black households is 43% higher than that of white households. For Native American households it's 45% higher, and for Latino households it's 20% higher.<sup>58</sup>

The legacy of racist redlining — official and unofficial collusion to concentrate racial groups in certain neighborhoods — compounds the risks. Decades of discrimination have left communities of color in structurally deficient housing that costs more to heat and cool.<sup>59</sup> Formerly redlined neighborhoods are today on average 5 degrees Fahrenheit hotter in summer than areas once favored for housing loans. The climate emergency is worsening these conditions.

Though shutoffs are the most severe form of punishing the poor, struggling individuals and families also suffer the impacts of utility debt accumulation — the step before disconnection. Arrearages limit purchasing power and hurt credit scores, preventing people from obtaining home loans and good jobs. Utility companies burden people with unsustainable obligations that relegate them to perpetual poverty. Total U.S. arrearages for electricity and heating bills were estimated at \$16 billion in August 2022.<sup>60</sup>



## MICHIGAN'S DTE ENERGY: PREDATORY COLLECTION PRACTICES

DTE Energy provides electricity and gas to customers in Michigan through its subsidiaries DTE Electric and DTE Gas. It reported 128,806 electric and gas disconnections in 2022. In a comment urging Michigan's utility regulators to deny DTE Energy's latest rate hike request, one customer decried the company's "shameful conduct."<sup>61</sup>

Whether it's the "middle of winter, heat of summer, DTE doesn't care. No thought or respect to consumers; shameful conduct generally."

**DTE CUSTOMER WHO WAS DISCONNECTED THREE TIMES FOR OWING LESS THAN \$200** <sup>62</sup>

As rising fossil gas prices drive rate increases for DTE customers,<sup>63</sup> the company has distinguished itself with a particularly predatory, anti-consumer practice: selling customers' debt to litigious collections agencies.

DTE Energy quietly sold the debt of 290,000 residential customers and nearly 14,000 commercial accounts in 2017, according to an investigation by Outlier Media and ProPublica.<sup>64</sup> DTE is the only utility in the Great Lakes states of Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin to sell customers' debt, the report found. And DTE sold the debt for cheap, receiving just \$4.8 million from debt collectors now entitled to collect more than \$282 million.

DTE customers have had their wages garnished and tax refunds seized by debt collectors. In response to the investigation, a spokesperson for the Michigan Public Service Commission said state law prohibits regulators from making utility management decisions more pro-consumer.<sup>65</sup>

## Fossil Fuel Price Volatility and the Broken Utility Business Model

Household disconnections are trending higher because of rising methane gas energy prices and inflation. Electricity prices jumped 12% in the past year.<sup>66</sup>

Fossil gas has been a hotspot of price volatility. As of September 2022, the Henry Hub spot price of methane gas had risen 310% over two years.<sup>67</sup> The wholesale price of U.S. fossil gas tripled from the summer of 2020 to the summer of 2021 alone.<sup>68</sup> The Energy Information Administration expects the price to increase even more this winter, resulting in high electricity and heating gas prices driven by rising methane gas prices.<sup>69</sup>

**As utilities continue investing in fossil fuel infrastructure, they guarantee price volatility will burden consumers while shareholders keep profiting.**

This price spike is driven by a familiar boom-and-bust cycle in fossil fuel commodity markets. As the pandemic eased and businesses reopened, demand for fuel rebounded sharply. Oil and gas producers, meanwhile, were slow to respond with increased supply that would have lowered prices and profits.<sup>70</sup> Instead they focused on pleasing investors and avoiding risky capital investment, with price-gouging and hefty dividends ensuring massive profits and satisfied shareholders.<sup>71</sup>

Fossil gas markets lurched in early 2022 as Russia's war on Ukraine led to reduced Russian gas exports to Europe, resulting in a bidding war for limited global supplies of liquified natural gas (LNG). Overseas buyers snapped up a growing share of the LNG produced by newly commissioned U.S. export facilities. The result: The United States is exporting more than one-fifth of all the gas it produces, the most ever.<sup>72</sup>

America's surge in lucrative fossil gas exports is incentivizing a dramatic, years-long expansion of dangerous fossil fuel infrastructure beyond what is required to thwart Europe's immediate energy crisis.<sup>73</sup> The expansion locks in methane emissions and air pollution for decades to come, endangering communities and ecosystems at the sites of fossil gas extraction, pipelines and exports.

Unfortunately, it's consumers who are paying for the volatility of dirty energy prices. Utilities purchasing fossil gas for electricity and gas heating pass higher fuel costs onto consumers in the form of fuel riders. This practice of shifting rising costs onto customers results in higher bills for households.<sup>74</sup> Fuel riders were a popular tool among the utilities with the highest disconnections in 2022.<sup>75</sup> They allow utilities to rely more heavily on gas plants, because customers pay for the fuel regardless of the cost.

In a self-reinforcing downward spiral, rising fossil fuel prices were a major driver in record inflation,<sup>76</sup> which skyrocketed from 1% in January 2021 to 8% in August 2022.<sup>77</sup> Rising inflation without equally rising pay has meant that a household's dollar is stretched even thinner. The resulting higher heating and electric bills are a major contributor to the epidemic of service disconnections discussed here.

This winter, consumers — especially low-income families reliant on fossil gas — are bearing the brunt of this volatility. Heating a house with fossil gas this winter is expected to cost 66% more than it did two years ago. Electricity prices have also risen approximately 12% compared to 2020.<sup>78</sup> The average family could pay more than \$1,200 to heat their home this winter — \$175 more than last winter and \$300 more than the 2020 winter.<sup>79</sup>

As utilities continue to invest in methane gas infrastructure, they are guaranteeing that gas price volatility will continue to burden consumers while shareholders continue to profit.

**TABLE 6**  
**ESTIMATED**  
**WINTER**  
**HEATING**  
**COSTS**

2020-21 to 2022-23

Winter Heating Season	Natural Gas	Electricity	Heating Oil	Propane	All Fuels
2020-21	\$573	\$1,191	\$1,212	\$1,158	\$888
2021-22	\$709	\$1,242	\$1,876	\$1,587	\$1,025
2022-23	\$952	\$1,328	\$2,115	\$1,828	\$1,202
% Difference, 22-23 vs. 21-22	34%	7%	13%	15%	17%
% Difference, 22-23 vs. 20-21	66%	12%	75%	58%	35%

Assumes same consumption in 2022-23 as 2021-22

Data Source: National Energy Assistance Directors' Association, September 2022, available at <https://neada.org/wp-content/uploads/2022/09/winter2022-23PR.pdf>

## Climate Emergency Increases Energy Fragility

Heat waves, freezes and floods in 2022 spotlighted how climate-driven extreme weather boosts demand for electricity and heat, exacerbating the threat of utility disconnections. It also showed the brittleness of a centralized fossil fuel system.

More than half the U.S. was under an extreme heat watch or warning during the summer months.<sup>80</sup> Energy demand for cooling increased as a result.<sup>81</sup> Although 41 states limit utility shutoffs during extreme cold weather events, only 18 do so during heat waves.<sup>82</sup> January 2022's deadly climate-driven superstorm — which put half the country on deep freeze alerts and led to freezing of gas supplies and rolling power outages — also drove up demand and prices for fossil gas.<sup>83</sup>

The climate emergency also reinforces energy insecurity among poor households and communities of color, which are “less able to prepare for, respond to, and recover from disaster events.”<sup>84</sup> Rebuilding can lead to insurmountable costs, making it even more difficult to keep up when utility bills return.

## The climate emergency reinforces energy insecurity among poor households and communities of color, which are less able to prepare for, respond to, and recover from disaster events.

Kentucky and Missouri exemplify this pattern. Both states experienced severe flash floods in 2022 and have above-average-to-high poverty rates of 16% and 12%, respectively.<sup>85</sup> Disconnections in both states increased significantly in 2022 over 2021.

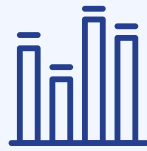
The recent 2022 winter superstorm, like all climate disasters, spotlights the racial inequity of climate impacts and recovery efforts. Blacks suffered disproportionate fatalities, accounting for half of the deaths reported in Buffalo in late December, and appeared to receive slower restoration of power and roads than their white counterparts.<sup>86</sup>

When power shutoffs have been at the utility's discretion in response to climate-fueled disasters, communities of color have been disproportionately targeted. For example, during the 2021 winter storm in Texas, “areas with a high share of minority population were more than four times as likely to suffer a blackout than predominantly white areas.”<sup>87</sup>

This pattern of recovery inequity is consistent with federal relief efforts, where the Federal Emergency Management Agency has disproportionately denied assistance to poor communities of color.<sup>88</sup> Inequitable recovery means that households denied assistance take longer to return to economic security and pay bills on time.

## ANNEX 1: POLICY RECOMMENDATIONS

Lawmakers and regulators must finally address the multiple and complex roots of the utility disconnections crisis. Here are some key policy avenues to begin improving the electric utility sector and ending the racist fossil energy system driving this chronic problem.



### Require Utilities to Disclose Disconnections, Other Key Data.

To understand the full scale of the shutoffs pandemic, all public and private utilities<sup>89</sup> should be required to publicly report data on disconnections at least monthly. Disclosure should be paired with data showing which communities are impacted and how, including but not limited to: dollar amount of arrearages and late fees collected; number of customers participating in deferred payment programs, and the success and failure of these programs; reconnections and reconnection fees; duration of disconnections; ZIP code and demographic data of disconnected households; and energy burdens of disconnected households.



**Federal pathways:** The U.S. Energy Information Administration has the authority to establish a federal reporting database on household disconnections and other relevant data.<sup>90</sup> Congress can also mandate the creation of a federal database and charge an agency to act.



**State pathways:** State utility commissions,<sup>91</sup> legislators<sup>92</sup> and governors have broad authority to collect data on disconnections and other key data.




### Ban Utility Shutoffs, Other Punitive Measures Against the Poor.

The utility industry's custom of shutting off power punishes people for being poor. This barbaric practice — and related punitive measures, like resale of debt to predatory private companies — must end.



**Federal pathways: Congress** should enact a nationwide ban on utility shutoffs and other punitive collection practices for unpaid household utility bills for households meeting poverty criteria,<sup>93</sup> expanding upon a nationwide moratorium on shutoffs passed under the House's HEROES Act and proposed Senate legislation during COVID-19.<sup>94</sup> In September 2022 Reps. Cori Bush, Rashida Tlaib and Jamaal Bowman introduced a resolution recognizing the human right to electric, water and broadband utilities.<sup>95</sup> There is international precedent for broad shutoff bans and for treating electricity as a human right.<sup>96</sup>

 **State pathways:** If Congress does not act, **governors, state legislators and/or state utility commissions** should impose permanent state moratoriums on utility shutoffs for nonpayment for consumers who meet established poverty criteria and who cannot pay their bills. At a minimum they should enact temporary moratoriums for climate-driven extreme weather conditions like heat waves, which drive up energy demand, as well as reconnection criteria that prioritize low-income communities when climate disasters drive power outages. States should also establish shutoffs protections for vulnerable populations, including households with elders, infants, and seriously ill persons.



### **Debt Relief, Federal Assistance, Equity Reforms.**

While stopping the immediate harms of debt and shutoffs, policymakers should advance ideas that lower energy burdens.



**Federal pathways: Congress** should vastly increase funding for the Low-Income Home Energy Assistance Program (LIHEAP), which provides energy bill assistance, and the Weatherization Assistance Program (WAP), which helps people afford energy efficiency upgrades, a more durable solution.<sup>97</sup> Administering agencies such as the **Health and Human Services Department, Department of Energy,** and **Department of Housing and Urban Development** should also improve methods of funding deployment to efficiently and effectively reach eligible households.<sup>98</sup>

**Congress** should also address mounting arrearages – which, according to NEADA, have doubled from 2019 to an estimated \$20 billion<sup>99</sup> – and design debt-elimination programs for all affected customers, or for a qualifying class of low-income households, using student loan cancellation as a model. Congress should tax utility profits to pay off the debt.



**State pathways: State legislators** should work with Congress to design debt relief programs, either retiring balances on a one-time basis or gradually reducing payments.<sup>100</sup> New York recently enacted major debt forgiveness for utility debt accumulated during the COVID pandemic.<sup>101</sup> States should also tax utility profits to pay off the debt.

**State utility commissions** should make bills more affordable by, among other things,<sup>102</sup> establishing payment plans based on percentage of income and providing ways to decrease past-due balances, effectively capping families' monthly liabilities. These steps would protect them against fuel riders and unexpected energy price hikes due to climate-driven weather extremes and fossil fuel price volatility.<sup>103</sup> Regulators should also consider factoring in energy

burdens, energy insecurity, energy poverty and other environmental justice factors when deciding whether utility rates are “just and reasonable.”<sup>104</sup>

**State utility commissions** should halt ineffective and unjust prepayment plans. These plans, where a customer pays for electricity or gas in advance, generally allow the utility to disconnect customers who do not refresh their prepayments, sometimes without reporting the disconnection.<sup>105</sup>

**State utility commissions** should routinely examine safeguards on alternative energy suppliers.<sup>106</sup> Several states with high disconnections allow alternative retail suppliers, which consumer advocates have found leads to higher prices.<sup>107</sup>



### **Ditch Fossil Fuels for a Clean, Just, Accountable Energy System**

The country must address the underlying conditions that brought us to this point: profit-seeking companies whose business models favor fossil fuel buildout; poor regulation and regulatory capture; and high dollar influence-peddling. Fighting the climate emergency presents a tremendous opportunity to build new energy systems that are nonpolluting, distributed, climate-resilient, affordable and politically accountable. Distributed energy resources (DERs) – including rooftop and community solar paired with energy storage, demand-side management, and energy efficiency technologies – can deliver on multiple fronts to redress chronic energy injustice if deployed equitably.

As a foundation for state-level reform, public utility commissions need fundamental transformation to be held accountable to the public, as detailed by the Chisholm Legacy Project.<sup>108</sup>

In passing the 2022 Inflation Reduction Act, Congress provided necessary clean energy tax incentives, but lawmakers at both state and federal levels must hold utilities accountable and stop their obstruction of clean energy, energy efficiency, and other alternatives that will power a just energy future.




**Federal Pathways:** The **Biden administration** should phase out the country’s reliance on fossil fuels, including halting new fossil fuel production and infrastructure using existing executive powers.<sup>109</sup>

The **Federal Trade Commission** should heed public calls for an industry-wide investigation of the electric industry’s abusive practices that stifle renewable energy competition and undermine consumer protection.<sup>110</sup> The **Federal Energy Regulatory Commission** should block utilities from spending ratepayers’ funds on anti-environmental political lobbying.<sup>111</sup>

**Congress** should enact measures prioritizing the development of distributed and community-owned solar and storage in environmental justice communities; it should support alternative models of accountable public power.<sup>112</sup> **The Biden administration** should implement distributed energy measures to meet its Justice40 initiative goals, which commit to deliver 40% of federal investments “in climate and clean energy to disadvantaged communities.”<sup>113</sup>

**Congress** should pass laws to curtail disastrous ongoing subsidies that keep the fossil fuel industry afloat and tax the industry’s windfall profits, including the Big Oil Windfall Profits Tax Act.<sup>114</sup>

 **State Pathways: State utility commissions** should adopt strong utility accountability mechanisms, including performance-based ratemaking that rewards utilities for their performance rather than for building new infrastructure.<sup>115</sup> This should include making utilities bear the cost of fossil fuel price volatility instead of passing it on to ratepayers.<sup>116</sup>

**State utility commissions** should oppose utility efforts to impose fixed charges and related measures, such as gutting net energy metering, and making it harder for rooftop solar, community solar and other decentralized energy solutions to thrive.<sup>117</sup> **State legislators** should establish distributed rooftop and community solar programs and energy efficiency programs that prioritize environmental justice communities with direct grants and financial assistance.<sup>118</sup> Those who suffer the brunt of the racist fossil energy system should be the first to receive access to clean, affordable, resilient energy.

**State and local governments** can explore alternative systems of accountable public and community-owned power, as in New York<sup>119</sup> and Maine.<sup>120</sup>

## ANNEX 2

The full utilities data table can be found [here](#).

**TABLE 7**  
**HALL OF SHAME**  
*Cumulative Disconnects,  
January 2020-October 2022*

Parent Company (electric)	Utility	Total Disconnects 2020	Total Disconnects 2021	Total Disconnects 2022 (through Oct)	Cumulative Total Disconnects 2020 to Oct 2022
Exelon Corp (IL, MD, PA, DC)	Commonwealth Edison	50,380	177,887	225,827	454,094
	PECO Energy Co	59	76,487	67,359	143,905
	Baltimore Gas and Electric Company	7,902	27,846	60,659	96,407
	Pepco Holdings Inc	6,700	18,058	8,849	33,607
	Potomac Electric Power Company	3,238	0	3,810	7,048
	Delmarva Power	1,344	4,560	2,075	7,979
<b>Exelon Corp Total</b>		<b>69,623</b>	<b>304,838</b>	<b>368,579</b>	<b>743,040</b>
The Southern Co. (GA)	Georgia Power	103,330	237,048	198,463	538,841
<b>The Southern Company Total</b>		<b>103,330</b>	<b>237,048</b>	<b>198,463</b>	<b>538,841</b>
DTE Energy (MI)	DTE Energy	80,606	178,187	118,699	377,492
<b>DTE Energy Total</b>		<b>80,606</b>	<b>178,187</b>	<b>118,699</b>	<b>377,492</b>
Ameren Corp (IL, MO)	Ameren Illinois	22,830	55,960	57,588	136,378
	Ameren Missouri	36,515	67,726	53,100	157,341
<b>Ameren Corp Total</b>		<b>59,345</b>	<b>123,686</b>	<b>110,688</b>	<b>293,719</b>
FirstEnergy Corp (MD, PA, OH)	Metropolitan Edison Company	71	26,941	27,289	54,301
	West Penn Power Company	22	16,147	20,164	36,333
	Pennsylvania Electric Company	4	20,354	19,573	39,931
	Ohio Edison Company	5,799	34,505	13,054	53,358

Parent Company (electric)	Utility	Total Disconnects 2020	Total Disconnects 2021	Total Disconnects 2022 (through Oct)	Cumulative Total Disconnects 2020 to Oct 2022
	The Cleveland Electric Illuminating Company	1,403	12,831	8,240	22,474
	The Toledo Edison Company	2,205	18,069	6,886	27,160
	Pennsylvania Power Company	0	2,416	3,083	5,499
	Potomac Edison	67	226	178	471
<b>FirstEnergy Corp Total</b>		<b>9,571</b>	<b>131,489</b>	<b>98,467</b>	<b>239,527</b>
PPL Corp (PA, KY)	PPL Electric Utilities Corporation	0	30,843	32,720	63,563
	Kentucky Utilities Company	15,025	30,043	27,572	72,640
	Louisville Gas and Electric	15,031	23,555	20,766	59,352
<b>PPL Corp Total</b>		<b>30,056</b>	<b>84,441</b>	<b>81,058</b>	<b>195,555</b>
American Electric Power Co Inc (OH, KY, MI, IN)	Ohio Power Company	65,568	162,644	59,694	287,906
	Indiana Michigan Power Company	27,519	34,347	10,057	71,923
	Kentucky Power Company	1,970	8,136		13,236
<b>American Electric Power Co Inc Total</b>		<b>95,057</b>	<b>205,127</b>	<b>72,881</b>	<b>373,065</b>
Duke Energy Corp (FL, IN, KY, NC, SC, OH)	Duke Energy Carolinas, LLC	50,107	34,764	30,029	114,900
	Duke Energy Progress, LLC	49,757	61,377	14,086	125,220
	Duke Energy Ohio	12,566	40,526	6,436	59,528
	Duke Energy Indiana, LLC	25,233	45,426	6,346	77,005
	Duke Energy Kentucky Inc	2,307	7,657	1,141	11,105
	Duke Energy	78,396	135,914	0	214,310

Parent Company (electric)	Utility	Total Disconnects 2020	Total Disconnects 2021	Total Disconnects 2022 (through Oct)	Cumulative Total Disconnects 2020 to Oct 2022
<b>Duke Energy Corp Total</b>		<b>218,366</b>	<b>325,664</b>	<b>58,038</b>	<b>602,068</b>
NextEra Energy (FL)	Gulf Power	4,308	44,170	0	48,478
	Florida Power & Light Company	437,385	694,349	0	1,131,734
<b>NextEra Energy Total</b>		<b>441,693</b>	<b>738,519</b>	<b>0</b>	<b>1,180,212</b>
AES Corp (IN, OH)	Dayton Power and Light Company	7,249	20,943	6,912	35,104
	Indianapolis Power & Light Company	37,103	75,769	4,780	117,652
<b>AES Corp Total</b>		<b>44,352</b>	<b>96,712</b>	<b>11,692</b>	<b>152,756</b>
CMS Energy Co (MI)	Consumers Energy	24,511	80,849	43,348	148,708
<b>CMS Energy Co Total</b>		<b>24,511</b>	<b>80,849</b>	<b>43,348</b>	<b>148,708</b>
Emera Inc (FL)	Tampa Electric Company	44,464	40,699	0	85,163
<b>Emera Inc Total</b>		<b>44,464</b>	<b>40,699</b>	<b>0</b>	<b>85,163</b>

## ANNEX 3: METHODOLOGY

To compile the data for this report, the authors reviewed available disconnection data for all 50 states, Washington, D.C., and Puerto Rico from January 2022 through October 2022. Disconnection data was retrieved by reviewing state and territory utility dockets and calling state commissions where the data was not identifiable online or where public information requests were necessary.

### **Dataset**

The resulting data set includes shutoff data from 30 states and the District of Columbia, where they were made available. Of these, only 13 states and D.C. require utilities to disclose monthly information on power shutoffs. Another 17 states require occasional or delayed disclosure (e.g. annual, quarterly, or time-lagged monthly reporting).

States began reporting data at various times. In many cases the reporting started in early 2020 because of state requirements to disclose disconnection data in response to COVID-19. In a handful of states, these measures have expired – most notably Florida, which reported the most shutoffs in 2021.

Regulators in 20 states and Puerto Rico do not require their utilities to track and publicize the number of times they shutoff households' power every year.

Cumulative data were compiled by combining 2022 findings with data from our earlier reports in this series.

### **Adjustment to Exclude Rapid Reconnections**

Reconnection data for all 50 states, Washington, D.C., and Puerto Rico were reviewed. Reconnection reporting requirements varied by state. Some states did not require any reconnection reporting, while others did not indicate the time from disconnection to reconnection. Where we could prove power was reconnected within 24 hours of disconnection, we excluded these cases from utilities' disconnect totals in those months.

We deemed reconnections within 24 hours to mitigate the impact of a disconnect but considered longer periods without service too harmful to be excluded. Being without electricity for more than 24 hours can render homes uninhabitable and prove life-threatening due to inoperability of lifesaving medical equipment, temperature extremes, and similar outcomes. Reconnections with no specified time frame were recorded and not subtracted from disconnection totals.

## Utility Service Type

The disconnection data set delineates gas and electric utilities under the column titled *Service Type*. However, while several utilities separate electric and gas disconnections in their docket compliance filings, others do not. Those that do not are listed as “gas/electric” in our dataset and their shutoffs are treated as electric disconnections.

## Customer Class

Although our data is focused on tracking residential utility disconnections, several states and utilities do not distinguish between residential and commercial customer classes in their filings. Since most of these utilities’ customers are residential, we erred on the side of over-inclusion and used values that may include some nonresidential disconnections.

## Year-Over-Year Comparisons

For this report we collected data from January through October 2022. For earlier iterations of this report, we had full-year data sets (covering January through December 2020 and 2021). To ensure accurate apples-to-apples comparisons of year-over-year data, we compared datasets during the same time periods across years.

Moreover, as states with disconnection data differed in their latest month of reporting, year-on-year comparisons were state-specific and compared data made available in 2022 against the same period in 2021. For example, for states that disclosed data from January through October 2022, data from January through October 2021 was used as a comparison, as opposed to all of 2021. For states that only had data through March, like Arizona and South Dakota, January through March 2021 was used as a comparison for January through March 2022. The aggregated totals for 2022 thus represent all the available data, but for Tables 1-4 the data for 2021 only includes disconnections from each respective state’s reporting period.

## Extrapolation

In our findings section, we extrapolated disconnection and residential customer data from our top seven utilities to estimate how many times utilities disconnected customers across the country, including in states where there is no reporting. Specifically, we took an average of the top utilities’ disconnection rates and applied it to the total number of utility customers in the country (139,780,608).<sup>121</sup> This approximation comes with a few caveats, including that households can be disconnected multiple times. That limits the precision of a result based on multiplying disconnection rates by the total number of U.S. households. Specifically, total disconnects may account for a smaller percentage of a utility’s base of

customers if some households are experiencing chronic energy insecurity and experience frequent shutoffs throughout the reporting period.

### **Financial Data**

As a proxy for the average cost to cover a customer's unpaid bill, we used the average U.S. monthly residential electric utility payment of \$106, as determined by Vote Solar.<sup>122</sup> The utility industry standard is to initiate shutoff procedures after one month of nonpayment.<sup>123</sup> Utility parent corporations were reviewed in Bloomberg to determine if they were publicly traded or privately held entities. Corporate financial data for the publicly traded corporations, including profits, dividends, share buybacks, and executive compensation, were pulled from publicly available 10-K and DEF 14A filings retrieved from the SEC's EDGAR database.

Corporate share buyback data for publicly traded companies listed in the United States is reported as a dollar value of shares repurchased per quarter. Foreign companies are not subject to the same reporting requirements, do not report repurchased shares, or only report the number of shares, not the value of those shares. Buybacks reported as a number of shares were excluded from the report due to the inaccuracies that would arise from assuming an average trade price.

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and detail compensation to certain executive officers. The number of officers can vary due to personnel changes and differing corporate structure. Average compensation to individual executives within the Hall of Shame is calculated based on the number of officers disclosed in a given year. For this broad comparison of all disclosed pay to Named Executives Officers, however, the number of officers is considered only in the aggregate.

- 40 This calculation assumes an average amount needed to cure an arrearage of \$106. For more details please see Methodology ([Annex 3](#)).
- 41 Payments were to 72 executives in 2019, 66 in 2020, and 68 in 2021.
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- 43 E.g. excluding financial conglomerates like JPMorgan Chase & Co and Berkshire Hathaway Co. that are included in the list because their own utilities reporting shutoffs.
- 44 Exelon Corp.'s subsidiaries: Commonwealth Edison (IL), Baltimore Gas and Electric Company (MD), Delmarva Power (MD), and Pepco Holdings Inc. (MD), Pennsylvania [PECO Energy Co. (PA), Potomac Electric Power Company (DC)
- 45 The Southern Co.'s subsidiary: Georgia Power (GA)
- 46 FirstEnergy Corp's subsidiaries: Potomac Edison (MD), Pennsylvania Metropolitan Edison Company (PA), Pennsylvania Electric Company (PA), Pennsylvania Power Company (PA), and West Penn Power Company (PA), The Cleveland Electric Illuminating Company (OH), Ohio Edison Company (OH), and The Toledo Edison Company (OH)
- 47 PPL Corp's subsidiaries: LG&E (KY) and KU Energy LLC (KY)
- 48 American Electric Power's subsidiaries: Ohio Power Company (OH), Kentucky Power Company (KY), Indiana Michigan Power Company (MI) (IN)
- 49 NextEra Energy's subsidiaries: Gulf Power (FL) and Florida Power & Light Company (FL)
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# Bridging the Gap between National Weather Service Heat Terminology and Public Understanding

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## KEYWORDS:

Social Science;  
Communications/  
decision making;  
Decision making

**ABSTRACT:** Clearly communicating heat warning information to the public is an important way to reduce heat mortality and morbidity. However, heat communication interventions from the National Weather Service commonly include technical and scientific terms, otherwise known as jargon. These terms, such as heat advisory or heat index, may not be understood by the public. Given the importance of message understanding in protective action decision-making, the purpose of this study is to assess how the public understands National Weather Service heat information. Specifically, we asked 195 participants recruited via Amazon MTurk what the terms excessive heat watch, excessive heat warning, heat advisory, and heat index mean to them. This approach allows us to (i) evaluate how these terms are understood by examining how people give them meaning and (ii) determine if they are jargon by comparing the meanings between the National Weather Service and the public. Our results show that these terms mean something different to the public than to the National Weather Service. Almost half of the participants reported that heat index was synonymous with air temperature, with less than 10% of participants indicating that heat index includes humidity. Furthermore, the timing of heat watches, warnings, and advisories was inconsistent with National Weather Service definitions. To address these differences in understanding, we suggest that researchers and practitioners explore plain language messaging alternatives to improve future heat communication from the National Weather Service and the weather enterprise more broadly.

**SIGNIFICANCE STATEMENT:** In this study, we find that the terms heat index, excessive heat watch, excessive heat warning, and heat advisory are jargon. This means they carry different connotations for the public than for the National Weather Service. Including these terms in public messaging can negatively impact message understanding and protective action decision-making. Therefore, we recommend the use of plain language messaging and additional research on messaging alternatives.

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## 1. Introduction

National Weather Service (NWS) forecasters are tasked with communicating complex weather risks, such as heat and humidity, to various groups. This frequently includes translating the scientific and technical aspects of heat and heat forecasting into accessible language for different populations. However, technical language is commonly found in NWS heat communication (Li et al. 2018), potentially making heat information difficult to understand. For example, Olson et al. (2023) examined 250 NWS social media messages sent during periods of excessive heat. They found that the NWS commonly alerts the public to heat risks via “signal words”—or words used to “attract attention to the warning and indicate the level of hazard present” (Wogalter et al. 2002, p. 221). Currently, these include terms like excessive heat warning, excessive heat watch, and heat advisory—referred to as heat “products” by the NWS (Hawkins et al. 2017). Heat products are one way for people to become aware of current or upcoming heat risks (Benmarhnia et al. 2019). The NWS also uses the term heat index to describe heat. Olson et al. (2023) argue that heat index and language contained in heat products could be jargon.

Jargon is specialized language used by experts to communicate with one another (Bullock et al. 2019; Sharon and Baram-Tsabari 2014; Shulman et al. 2021). It consists of technical terms with accepted definitions that facilitate quick and precise communication among experts who have similar training and skills. Yet jargon is not self-explanatory, familiar, or accessible to those outside of an expert group (Krieger and Gallois 2017; Rice and Giles 2017; Sharon and Baram-Tsabari 2014). Although jargon is most common in fields like law, finance, and medicine, it is also prevalent in scientific communication, including weather and climate messaging (Bruine de Bruin et al. 2021; Sivle and Aamodt 2019; Soden et al. 2022; Venhuizen et al. 2019).

Messages that contain jargon are difficult for nonexperts to process and understand (Bruine de Bruin et al. 2021; Riggs et al. 2022; Shulman et al. 2021). Jargon is especially problematic in messages intended to promote protective action, as understanding is the first step in decision-making. Before individuals assess their risk and decide to act, they first must understand the information a message contains (Mileti and Sorensen 1990). This includes the threat, potential impacts, and actions they can take to protect themselves from those impacts. Indeed, not understanding the threat and its dangers may result in an inaccurate perception of the risk and expose one to danger. For example, heat index is a measure of temperature plus humidity; lacking knowledge of the effects of humidity on one’s ability to cool off can result in decisions that can be life threatening if one overexerts themselves. Thus, it is crucial for experts to translate and adjust their communication in a way that is accessible and understandable for all message recipients (Andersen and Spitzberg 2020; Wong-Parodi and Bruine de Bruin 2017).

Given the importance of message understanding for protective action decision-making, in this study, we assess how people understand NWS heat risk information and if terms, such as excessive heat warning and heat index, are jargon. Unlike prior research, however, we do not measure understanding objectively, which relies on individuals accurately defining technical

terms (e.g., Balluz et al. 2000; Chaney et al. 2013; Jauernic and Van Den Broeke 2016; Mason and Senkbeil 2015; Mitchem 2003; Nunley and Sherman-Morris 2020; Powell and O’Hair 2008). One measure of objective understanding, for example, might include assessing if people provide (or accurately select from a list) the definition of a term that corresponds to an expert’s definition. If these definitions match, they are thought to have a high degree of understanding. Studies that use such measures have inherent limitations in accuracy, especially if one can correctly guess corresponding definitions. Furthermore, using objective understanding measures can, in certain cases, lead to a knowledge deficit approach to risk communication (Grant 2023). This model assumes that if someone does not understand messages or accept message recommendations, it is simply because they lack knowledge on a topic; by educating about the definition of a technical term, the knowledge gap will be closed, and behavior change will ultimately occur.

We observe that heat risk communication interventions often use a knowledge deficit approach, which commonly assumes that providing people information about heat risks, such as communicating heat index values, will lead to behavior change (Mayrhuber et al. 2018). However, this places the burden on message receiver’s ability to interpret and understand expert’s specialized language. This approach also ignores the social, cultural, and political factors that influence how people approach and process new information, such as one’s personal values or previous interactions with the message source (Howes and Kemp 2017; National Academies of Sciences 2017; Sivle and Aamodt 2019).

With this in mind, we define understanding as one’s attachment of meaning to information (Mileti and Sorensen 1990), rather than one’s ability to correctly define expert’s terms. Research on both sensemaking and mental models demonstrates how people make sense of, and thus understand, new scientific and risk information (see Doyle et al. 2022; Lynch et al. 2024). Both approaches argue that when encountering unfamiliar risk information, people use their prior experiences, influential memories, and preexisting beliefs to contextualize and reach conclusions about new dangers (Bruine de Bruin et al. 2021). Therefore, we focus on discovering how people understand risk information by determining what NWS heat information means to them. Instead of “quizzing” participants or asking them to match definitions to terms, we ask them to draw from their knowledge and experience to offer their own definitions of the most common terms in NWS public heat communication (Olson et al. 2023). Thus, we ask the following research questions:

RQ1: What does heat index mean to the public?

RQ2: What does an excessive heat watch mean to the public?

RQ3: What does a heat advisory mean to the public?

RQ4: What does an excessive heat warning mean to the public?

## 2. Method

**a. Materials.** We used qualitative, open-ended questions to obtain a nuanced description of how the public defines and interprets heat information. Open-ended questions reduce a source of priming by *not* providing participants a discrete set of options to select from. This approach also allows for greater conceptualization of participants’ insights and thoughts (Jauernic and Van Den Broeke 2016). Using our research questions as a guide, we asked participants the following questions:

- In your own words, what does it mean if a heat advisory/excessive heat watch/excessive heat warning is in effect for your area?
- In your own words, what does heat index measure?

Participants were randomly assigned to answer what an excessive heat watch, an excessive heat warning, or a heat advisory means to them. Random assignment was used to reduce the likelihood that interpretations about one heat product affected the interpretation of the other products. All participants answered the question about heat index after providing their responses about their assigned heat product. We use the term “in effect” based on our previous analyses of public heat communication on social media, which found that this phrase was a common way to introduce heat products (see Olson et al. 2023).

The general NWS definitions of heat watches, warnings, and advisories can be found in Table 1. Note that watches, warnings, and advisories are issued based on predetermined heat index values for a particular location, although each NWS Weather Forecast Office is encouraged to establish their own criteria (Hawkins et al. 2017). Heat index is the combination of the air temperature and relative humidity, which provides an estimate as to how hot it “feels like” outside (NWS 2024d).

At the end of the survey, we asked participants about their age, income, gender, race/ethnicity, education, state they reside in, and prior experiences with heat (see Esplin et al. 2019; Hass and Ellis 2019; Williams 2018).

**b. Sample.** Participants were recruited via Amazon MTurk, which is an online crowdsourcing platform that offers organizations the ability to solicit “workers” for various tasks, including participating in research studies (Gerlich et al. 2018). Before agreeing to participate, potential participants were told they would be completing a 10–15-min academic survey about extreme heat information.

MTurk provides a more generalizable and representative sample of the general population than convenience sampling of college students, for example. MTurk is generally accepted among researchers as a viable and acceptable data collection mechanism (Berinsky et al. 2012; Levay et al. 2016; Zhang and Gearhart 2020). However, like other online data collection platforms, data quality issues have been observed. These issues are discussed in the limitations section.

Table 2 presents the demographic characteristics of our 195 participants who chose to answer our demographic questions, which were optional. In addition, participants reported that they most frequently resided in North Carolina ( $n = 16$ ), Indiana ( $n = 14$ ), Florida ( $n = 13$ ), Texas ( $n = 11$ ), and California ( $n = 10$ ), with less than 10 participants living in the remainder of the states. Finally, most participants reported having some prior experience with heat (Esplin et al. 2019). The most common experiences were decreased productivity at work (69.8%;  $n = 118$ ) and personal discomfort (e.g., inability to sleep; 88.6%;  $n = 150$ ).

**TABLE 1. NWS Definitions for Excessive Heat Watch, Excessive Heat Warning, and Heat Advisories.** From <https://www.weather.gov/safety/heat-ww>. Accessed November 2023.

Product	Definition
Excessive heat warning	An excessive heat warning is issued within 12 h of the onset of extremely dangerous heat conditions. The general rule of thumb for this warning is when the maximum heat index temperature is expected to be 105° or higher for at least 2 days and nighttime air temperatures will not drop below 75°; however, these criteria vary across the country, especially for areas not used to extreme heat conditions. If you do not take precautions immediately when conditions are extreme, you may become seriously ill or even die.
Excessive heat watches	Heat watches are issued when conditions are favorable for an excessive heat event in the next 24–72 h. A watch is used when the risk of a heat wave has increased but its occurrence and timing are still uncertain.
Heat advisory	A heat advisory is issued within 12 h of the onset of extremely dangerous heat conditions. The general rule of thumb for this advisory is when the maximum heat index temperature is expected to be 100° or higher for at least 2 days, and nighttime air temperatures will not drop below 75°; however, these criteria vary across the country, especially for areas that are not used to dangerous heat conditions. Take precautions to avoid heat illness. If you do not take precautions, you may become seriously ill or even die.

**c. Data collection.** The initial survey was pretested with 10 participants for a \$2.50 Amazon MTurk incentive. These participants were not retained for analysis, as they were found to be copying and pasting from external sources, such as NWS websites. This was determined by the lead author searching for the identical text via Google. If a participant's answer matched that of an external source precisely (i.e., word for word), their response was not retained for analysis. After pretesting the survey, we solicited 250 participants via MTurk. The survey was updated to advise participants not to copy from external sources to receive their MTurk incentive. After data collection was complete, the lead author went through each participant's responses to approve their incentives. Overall, 55 participants were rejected because their responses copied information from external sources (as identified using an identical procedure as the pretest survey), included duplicate responses, or exhibited other data quality issues (e.g., one word, yes/no responses, nonsensical and/or generic answers). As Griffin et al. (2022) note, using these qualitative data-specific cleaning procedures also helps us identify and remove responses from possible bots. These respondents were also ineligible to receive their incentive. The final number of participants retained for analysis is 195.

TABLE 2. Sample demographic characteristics.

Characteristic	<i>n</i>
Gender ( <i>N</i> = 170)	
Male	111
Female	58
Prefer not to say	1
Race/ethnicity ( <i>N</i> = 170)	
White/Caucasian	126
Asian/Asian American	24
Black/African American	11
Other/multiple categories	9
Age ( <i>N</i> = 169)	
18–24 years old	7
25–34 years old	76
35–44 years old	48
45–54 years old	22
55–64 years old	13
65+ years old	3
Household income ( <i>N</i> = 169)	
Less than \$25,000	14
\$25,000–\$49,999	53
\$50,000–\$99,999	75
\$100,000–\$199,999	25
I do not know/prefer not to say	2
Education ( <i>N</i> = 169)	
Less than high school degree	2
High school degree or equivalent (e.g., GED)	17
Some college but no degree	24
Associate degree	14
Bachelor's degree	96
Master's, doctoral, or professional degree	16

**d. Data analysis.** The analysis began with the first author conducting iterative readings of the data to become familiar with its content. During this stage, initial codes were generated to describe key ideas, concepts, and patterns that emerged. These codes were derived inductively, meaning they were grounded in the data itself rather than being predetermined, while also being informed by the guiding research questions. The codes were also not mutually exclusive, which allowed for more complex and overlapping ideas to be captured.

This initial coding phase involved documenting key ideas, words, and phrases from participant responses via Microsoft Excel spreadsheets, along with reflective notes about potential connections between codes. The second author reviewed the developing codes, provided feedback on recurring ideas, and identified areas of overlap or ambiguity. Together, the authors refined the codes, which resulted in a final codebook that articulated clear definitions and applications for each code.

Then, the first author systematically applied the codebook to the dataset. Once the data were fully coded, the authors worked collaboratively to group similar codes into topic summaries. These summaries were defined and reviewed to ensure they accurately reflected participants' responses. As Braun and Clarke (2021) note, topic summaries capture the explicit

ideas emerging from the data and provide a structured way to organize and categorize coded content. Specifically, this process allowed us to identify overarching patterns and connections within the data, which we discuss next.

### 3. Results

**a. Heat index.** Although most participants knew that heat index measures heat in some capacity, almost half of the 195 participants thought heat index is akin to temperature. This belief was the prevailing interpretation of heat index. Specifically, participants commonly mentioned that heat index measures the temperature and/or heat for an area, meaning they specified “temperature” or how hot it is absent of additional factors. For example, participants indicated “it measures the temperature to determine how hot it is outside” or “it tells you how hot it will be today.” Others mentioned that heat index means the temperature is measured on some type of scale or includes a range for different levels of heat. For example, one participant said, “heat index measures the temperature [in] degrees like 102°–109°F,” while another mentioned that heat index is “how hot it is on a scale of 1–10.”

Many participants mentioned that heat index measures what it feels like outside. This means they used the word “feels like” absent humidity. For example, participants stated that heat index is “how hot it actually feels instead of just the objective temperature” or that it means what “the temperature will actually feel like. It usually means it will be warmer than the actual temperature.” However, a few participants were unsure if this is correct (e.g., “I am not sure, but I think the heat index means how hot it actually feels outside as opposed to the actual temperature”).

Importantly, heat index is the combination of air temperature and relative humidity for an area. However, few participants mentioned humidity *and* temperature in their responses. For example, one participant said heat index is a “measure [of] the level of hotness along with humidity factor and natural air temperature.” Other participants seemed unsure of their answer by using question marks or hedging language (e.g., “I think it measures how hot it feels by taking into account both humidity and temperature?”).

Participants also mentioned additional factors that may impact the heat index, such as the sun, air quality, air pressure, and cloud coverage. For example, one participant said heat index is “maybe a point of how uncomfortable it will feel when you combine the temperature with the humidity and air quality.” Another participant stated “heat index measures the temperature of the air, humidity, UV ray index, dry conditions, etc.”

Although less frequent, a few participants provided insights into how they thought the heat index is calculated. For example, several participants thought that heat index is a comparison with the average, “usual,” or historical temperatures for an area, with one participant stating that heat index is “the total amount of heat and humidity as compared to the usual temperature.” Another participant said, “I never learned what it means, but I expect that it measures the heat level now in relation to the average heat level for the same time of year.” One participant focused on the word “index” by stating “if something is being indexed, it is being measured against other data. Therefore, I would infer that a heat index compares present heat measurements with [the] past.” However, participants were unsure that they were correct in how heat index is calculated by stating “does it measure the heat relative to what it's been in a region in past years?” or it is “the average? not sure.”

Finally, a smaller subset of participants stated that heat index measures the severity of a heat event and the consequences that might ensue. For example, one participant stated that heat index is “how hot the temperature is in terms of lethality.” Again, others were unsure. One participant stated, “I'm not too sure about the heat index, but I assume that it's a measurement of how severe the heat is and whether it would be a danger to people and/or

animals,” while another said heat index is “the level of heat based on UV radiation levels? Higher index = higher UV and sunburn most likely to occur?” Two participants indicated they “don’t know” what heat index means to them.

**b. Excessive heat watch, heat advisory, and excessive heat warning.** Although similar themes emerged for heat watches, warnings, and advisories, we describe our results by signal word (i.e., product) in order to provide a more nuanced understanding of how people interpret each type of information they may receive.

**1) EXCESSIVE HEAT WATCH.** An excessive heat watch is a type of signal word meant to prepare the public for a possible heat event in their area (NWS 2024a). This means that forecast conditions suggest elevated heat/heat index values are expected within the next 24–72 h based on a Weather Forecast Office’s locally established criteria. Therefore, elevated heat conditions are not currently happening.

First, many participants had some timing elements emerge in their responses. Here, many participants used present-tense verbs like “is” or “are” when describing an excessive heat watch. For example, participants said that “it means that heat levels are dangerous.” Those who described a watch as being hot in the future used words like “going to be” or “will” (e.g., “I guess that means it is going to be very hot”). It is possible that the inclusion of timing relative to heat events was meaningful to participants (i.e., whether heat is current, ongoing, or in the future). However, it is also possible that this finding is influenced by factors such as what time of day a participant took the survey.

Next, participants frequently mentioned the negative impacts of heat in their responses, which were primarily related to one’s health. For example, one participant stated, “it means that there is a health risk from being outside for very long at a time.” These impacts also included death.

Interestingly, participants also discussed if they and/or others should change their behavior in response to a heat watch, as well as the location where this should occur. Here, more participants indicated that an excessive heat watch means they now need to protect themselves versus needing to “be aware” of unsafe conditions that may occur later. The outdoors was also commonly included in these responses. For example, participants stated they “need to be extremely careful going outside” or “it means to be careful [to] do anything outside because it’s so hot that your health could be in danger.” No one mentioned the need to protect themselves or be aware while indoors.

Who is vulnerable to heat was another theme that emerged, with several participants discussing who is at risk in their responses. Participants more commonly mentioned that only certain groups are vulnerable to heat impacts under an excessive heat watch. The most frequent group mentioned was the “elderly” or “older people” (e.g., “it means that it’s so hot it might be dangerous for people like the elderly or people with breathing problems”). Fewer participants mentioned that everyone is potentially at risk for heat impacts.

Finally, the factors that make it hot and/or dangerous were also discussed. To some, an excessive heat watch means it will be “hotter than normal” and/or they are experiencing high temperatures in their area. Humidity and heat index were rarely mentioned, with no one mentioning the “real feel” or “feels like” temperature.

**2) HEAT ADVISORY.** A heat advisory is “issued within 12 h of the onset of extremely dangerous heat conditions . . . [and] take precautions to avoid heat illness” (NWS 2024a, para. 3). An advisory is like a warning in terms of timing and protective action but is issued for lower heat index thresholds based on local criteria (Hawkins et al. 2017).

First, unlike an excessive heat watch, more participants used future-tense verbs (e.g., “going to be” or “will”) to describe a heat advisory, indicating it *will be* hot compared to currently hot outside. Participants also believed that advisories include hotter than normal conditions and/or high temperatures. However, humidity and feels like were rarely mentioned, with no one mentioning the heat index.

Similar to excessive heat watches, participants mentioned the consequences of a heat advisory, which again were primarily related to one’s health. Furthermore, these participants mentioned that heat advisories can be fatal. Many also mentioned how they and/or others should respond to a heat advisory, with more participants stating that heat advisory information means protect yourself (e.g., “stay where it is cool” or “don’t go outside”). In contrast, fewer participants believed that under heat advisories, one should be aware (e.g., “be mindful of . . . the heat”). Finally, participants also discussed who is vulnerable. Here, more participants indicated that only some groups are at risk for severe heat impacts under heat advisories, whereas only a few participants specified that everyone is potentially at risk to experience heat impacts.

**3) EXCESSIVE HEAT WARNING.** According to the NWS (2024a), an “Excessive Heat Warning is issued within 12 h of the onset of extremely dangerous heat conditions . . . if you don’t take precautions immediately when conditions are extreme, you may become seriously ill or even die” (para. 2). Thus, a warning is more imminent than a watch.

First, more participants used future-tense verbs like “going to be” or “will” to describe an excessive heat warning. This finding is similar to heat advisories but dissimilar to excessive heat watches. As with other heat products, no one mentioned humidity, heat index, real feel, or feels like temperatures in their responses.

The consequences of heat were mentioned, but unlike watches and advisories, no one mentioned death or fatalities. Participants also commonly discussed populations that are especially vulnerable to heat in their responses, with more participants indicating that everyone was vulnerable to heat impacts compared to those who expressed that only certain groups of people are vulnerable. Finally, participants discussed behaviors, with more participants indicating that an excessive heat warning means they and/or others need to protect themselves versus be aware of future heat threats.

#### 4. Discussion

When examining what the three levels of NWS heat alerts and heat index mean to the public, our results show that the public expresses different meanings of these terms compared to the NWS. When this occurs, experts often assume they should educate the public about how a term is defined, which adopts a knowledge deficit approach to risk communication. Instead, we propose that experts can better bridge this “gap” by meeting the public where they are in terms of their understanding and adjusting their communication accordingly.

First, we find that almost half of the participants thought that heat index was similar to air temperature, with far fewer participants indicating that heat index involves humidity. However, it is possible that humidity is included in participant’s mental representations of “heat” or “high temperature” without being explicitly mentioned in their responses. Furthermore, about a quarter of participants indicated that heat index is the “feels like” temperature. But these participants did not indicate why it feels a certain way (i.e., they did not mention humidity). Participants also revealed how they thought heat index was calculated, with most believing heat index is a comparison with previous or “normal” temperatures for their area or that it includes factors such as air quality or ultraviolet rays. These findings suggest that humidity needs to be mentioned as a contributor to what it feels like outside, rather than using the term “heat index” in isolation.

Next, similar themes emerged from the data for watches, warnings, and advisories. Although the exact frequencies vary, these terms appear similar in the eyes of the public. First, in many parts of the country, watches, warnings, and advisories are issued based on heat index values (Hawkins et al. 2017). Yet heat index, humidity, real feel, or feels like temperatures were seldom mentioned or absent in participant's responses. This shows that people may be unaware of one of the primary impacts that necessitated the NWS issuing a particular product: humidity. People will not automatically assume that because a watch, warning, or advisory is in effect, this may include humidity or know what conditions will feel like. If humidity is important for people to consider when a watch, warning, or advisory is in effect, they are not making that connection inherently. Thus, our findings suggest the need to highlight the importance of humidity in public messaging during watches, warnings, and advisories if applicable.

Specifically, due to climate change, humidity will continue to increase in certain regions, making previous places that were "just hot" especially dangerous for populations (Yuan et al. 2020). Messages should address our changing environment by specifying when humidity will be a factor and why it is dangerous. Indeed, humidity is important for people to consider because it negatively affects the body's ability to cool off via sweat evaporation. This information is especially important for populations who already have lower thermoregulation abilities, such as older adults, who must be increasingly careful in humid versus dry conditions (Klompaker et al. 2023). However, less humid areas of the country will need to adopt a different messaging approach based on their local criteria. How other tools used to make watch, warning, and advisory decisions (e.g., the new NWS HeatRisk) should be incorporated into public messaging needs to be considered (Olson et al. 2024).

Furthermore, the time in which one can expect impacts was not clear. For example, many participants used future-tense verbs to describe advisories and warnings and present-tense verbs to describe watches. Provided that the verb tense used is a meaningful indicator of how participants were thinking about the timing of heat products, these results suggest that people may not be able to intuit when they are or will be at risk from these terms alone. We know from previous research on warning message design that timing information is an essential element in complete messages that help people protect themselves (Mileti and Sorensen 1990). However, explicit and easily understandable timing information is often missing from NWS public heat communication, such as when hot conditions are expected to start (Olson et al. 2023). To include additional timing information, messages could indicate when impacts will occur (e.g., the hottest parts of the day) and when people need to take protective action (e.g., the time in which they should get to a cooling shelter).

With these findings in mind, we recommend that researchers and practitioners explore plain language messaging alternatives to the terms heat index, excessive heat watch/warning, and heat advisory when communicating to nonmeteorologist groups. Although these terms may be important "shorthand" to NWS partners and other high-end users, more research in this area is needed to determine exactly what types of alternative messaging should be used with the public. We recommend eliminating jargon based on prior research, which has found that providing definitions does not mitigate or eliminate its negative effects (see Shulman et al. 2020). Thus, plain, everyday language should be used to increase the likelihood that people will attend to, understand, and recall information, as well as see themselves at risk and follow message recommendations (Bruine de Bruin et al. 2021; Riggs et al. 2022; Shulman et al. 2020; Williams and Ogden 2004).

The Plain Writing Act of 2010 defines plain language as "writing that is clear, concise, [and] well-organized," which can be achieved by using simple, straightforward words to express an idea. For heat products, plain language can include breaking down technical words into their ensuing parts. For example, this could include replacing an "excessive heat warning"

with the expected temperatures and the time in which they will occur. Furthermore, some situations may allow for the replacement of jargon with telling message recipients it will feel like a certain temperature due to the humidity, instead of using the term heat index. Plain language also applies to other components of the message, including timing, impacts, and protective action(s).

Yet we recognize that experts are often hesitant to remove jargon and adopt a plain language messaging approach because they feel they will lose scientific accuracy or do not want to be seen as “talking down” or “dumbing things down” to their audiences (Krieger and Gallois 2017; Sharon and Baram-Tsabari 2014; Wong-Parodi and Bruine de Bruin 2017). But when people speak to one another using a shared language, we are adhering to the communication norms and inherent rules we have for our conversation partners—that we should comprehend and understand the intent of one another’s messages (Grice 1975). We have identified that the terms heat advisory, excessive heat watch, excessive heat warning, and heat index are jargon, and thus should be avoided when possible and practical. Although we provide recommendations above, addressing what messages should specifically say is an open question for future research, which we discuss next.

**Limitations and future research.** We used qualitative methods as the first step in assessing understanding and jargon (Bruine de Bruin and Bostrom 2013). Specifically, we used open-ended questions distributed via a survey to help us identify a problem: NWS heat terms have different meanings to the public. However, this approach restricts our ability to ask follow-up questions to participants. Furthermore, we do not measure how or whether differences in understanding lead to behavior change. As our next step, we will assess understanding via focus groups by asking about people’s mental models, that is, their interpretation of “how things work.” In this case, we may ask participants what causes heat and what it does to a person’s body. These qualitative findings will then inform a large-scale survey with a representative sample of the United States to determine the extent to which heat beliefs are present and how they may vary, including examining regional differences. For example, more humid areas of the country may have a better understanding of heat index, and regions that have more heat products may be more familiar with their definitions.

Future research could also ask about heat terms that represent more ordinary or colloquial concepts (e.g., extreme heat, heat wave), but whose meanings likely vary between experts and the public (Castro et al. 2007; Venhuizen et al. 2019). Research could also include how people interpret heat impacts (e.g., heat illness) or protective action information (VanderMolen et al. 2022). Additionally, as Pitt and Hendrickson (2020) argue, the ways in which information is presented can also disrupt message processing; thus, stylistic choices, such as the use of acronyms, could also be assessed as a form of jargon. Furthermore, the NWS Hazard Simplification Program indicates that heat advisories will be replaced with “plain language” headlines that “more clearly describe weather and water hazards” (NWS 2024c, paragraph 1). The word “excessive” in watches and warnings is also being replaced with “extreme” (NWS 2024b), which could also be assessed to see if this word resonates more with the public. Future research should also expand the types of participants included by recruiting more diverse participants in a more systematic manner. This includes prioritizing vulnerable groups to see if they comprehend heat information differently (e.g., Lazrus et al. 2020).

Finally, it is important to note potential issues with data quality for online surveys. Although MTurk can match the data quality of more expensive panel participant providers (Snowberg and Yariv 2021), the effects of bots have been noted even on platforms with built-in protections (see Griffin et al. 2022). Furthermore, all researchers using asynchronous qualitative methods will have to be aware of the rise of applications like ChatGPT that participants may

use to generate their responses. Thus, screening for data quality becomes even more important as data collection methods move increasingly online.

## **5. Conclusions**

Because experts are deeply immersed in their field and accustomed to its specialized language, they may find it challenging to identify jargon. We demonstrate that excessive heat watches, excessive heat warnings, heat advisories, and heat index are jargon, as they mean something different to the public.

Jargon is a barrier to effective scientific and risk communication because it inhibits message understanding and protective action decision-making. Therefore, we recommend that these terms be avoided when possible and practical, or defined using plain language messaging.

**Data availability statement.** Data may be made available upon request.

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## Understanding Heat Alerts

[Weather.gov](#) > [Safety](#) > Understanding Heat Alerts

**Safety**  
National Program

- Heat Safety
- Watches and Warnings
- Heat Forecast Tools
- During a Heat Wave
- Heat Related Illnesses



## Understanding Heat Alerts

### EXTREME HEAT WATCH

An Extreme Heat Watch is issued when **dangerous heat is possible**.

Reschedule outdoor activities in the coming days. Make sure that children, the elderly, and pets have a place to cool off during the heat.

Be Prepared.

### EXTREME HEAT WARNING

An Extreme Heat Warning is issued when **dangerous heat is happening or about to happen**.

Avoid heavy activity & direct sunlight. Stay hydrated, find a cool indoor place, and check on children, elderly & pets.

Take Action!

- ### Heat Safety Resources
- Heat.gov
  - Children, Pets and Vehicles
  - Seasonal Safety Campaign
  - Ultraviolet (UV) Safety
  - Games and Activities for Kids
  - Survivor Stories
  - Education and Outreach
  - Links and Partners

Each National Weather Service Forecast Office issues some or all of the following heat-related products as conditions warrant. NWS local offices often collaborate with local partners to determine when an alert should be issued for a local area. For instance, residents of Florida are much more prepared for 90°F+ weather than residents in Alaska.

- **Extreme Heat Warning—Take Action!** An Extreme Heat Warning is issued when extremely dangerous heat conditions are expected or occurring. Avoid outdoor activities, especially during the heat of the day. If you must be outside, be sure to drink plenty of water and take frequent breaks in the shade. Stay indoors in an air-conditioned space as much as possible, including overnight. Check on family and neighbors.
- **Extreme Heat Watch—Be Prepared!** An Extreme Heat Watch is issued when conditions are favorable for an extreme heat event but its occurrence and timing is still uncertain. Plan to suspend all major outdoor activities if a warning is issued. If you do not have air conditioning, locate the nearest cooling shelter or discuss staying with nearby family or friends who have air conditioning.
- **Heat Advisory—Take Action!** A Heat Advisory is issued for dangerous heat conditions that are not expected to reach warning criteria. Consider postponing or rescheduling outdoor activities, especially during the heat of the day. If you must be outside, be sure to drink plenty of water and take frequent breaks in the shade. Stay in a cool place, especially during the heat of the day and evening.

September 18, 2025

Executive Secretary  
Michigan Public Service Commission  
P.O. Box 3022  
Lansing, Michigan 48909.

Dear Public Service Commissioners,

We applaud the Commission's return to the 2018 docket U-20140, which required all regulated energy utilities to propose limits to disconnections during periods of extreme heat and extreme cold. Renewing these considerations adds to recommendations to amend disconnection protections for customers with medical and chronic health conditions, as proposed by the Critical Care Committee (CCC) of MPSC's Energy Assistance and Affordability Collaborative (EAAC) in case no. U-20757.

In its August 7 order in case no. U-20140, the Commission requested input on eleven questions regarding weather-based disconnection protections, in addition to the array of questions taken up by the CCC. Our comments respond to each request individually, but first we offer broader context and strongly urge the Commission to consider universal protection from disconnections under all circumstances, i.e., a disconnection moratorium. Universal protection would obviate the time-consuming need for ongoing policy assessment and amendments, be future-proof to increasing climate impacts including extreme heat and wildfire smoke and responsive to unforeseen crises, like the next pandemic. Universal protections would ensure no customer slips through a gap and suffers or dies without power during an extreme heat wave or cold snap. As the full toll of impacts from disconnections are becoming even clearer, we believe protections from heat and cold will only go so far to protect vulnerable customers. Disconnection protections are fundamentally about foresight. These protections recognize potential but preventable harms and require utilities to take reasonable actions to protect the welfare—and survival—of their customers.

Universal, year-round protections are also a much more logical solution to the root causes of disconnections for non-payment. The first root cause of disconnections for non-payment is unaffordable rates. The 2022 residential energy burden in Michigan was higher than all but 13 other states, eating up 4.04% of the average household's income.<sup>1</sup>

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<sup>1</sup> Citizens Utility Board of Michigan 2024 Utility Performance Report, p.32. cubofmichigan.org.

Secondary root causes include ineffective identification and engagement of customers eligible for protections, and inadequate availability of funds to provide energy and EWR assistance to all eligible customers. We note, for example, that a central reason Consumers Energy gave for recommending against continuation of its Percentage-of-Income-Payment pilot was that the 6% energy burden target (defined by most as a high energy burden) increased assistance costs too much. It is flatly inconsistent to hold that an energy burden above 6% is unreasonable and yet hold customers accountable to pay those unreasonable bills by disconnecting them when they cannot. While we do not absolve residential customers of all responsibility to use energy efficiently and make reasonable efforts to pay their bills, until utilities and governments more comprehensively address the root causes of arrearages and disconnections, we cannot countenance policies that hold struggling residential customers primarily responsible for these failings. To do so would be like blaming passengers on the Titanic for failing to avoid the iceberg and then for failing to fit into the plainly inadequate lifeboats available to them. Utility customers may have more agency in their situation than passengers on the Titanic did, but the point holds that they are not the root cause of the predicament they find themselves in and should not be the ones who suffer the direst consequences.

Nationally, disconnection protections have been established for no fewer than eight broad categories (see table below), including three sets of protections for external conditions and five for customer characteristics (i.e., demographics). The MPSC has considered and adopted some form of protection in seven of these categories. That said, the current call to revisit protections from heat and cold indicates to us that even with revisions and greater clarity, the Commission is concerned these protections are insufficient to address the dangers some customers will continue to encounter.

EXTERNAL CONDITIONS	CUSTOMER CHARACTERISTICS
Cold – based on i) Date, ii) Temperature, iii) Weather service alert	Age – i) Seniors, ii) Young children
Heat – based on i) Date, ii) Temperature, iii) Heat index, iv) Weather service alert	Health – i) Chronic condition or disability, ii) Acute medical emergency, iii) Pregnancy
Crisis – Covid protections, ad hoc protections during local affordability crises or gaps in the safety net	Military service – i) Deployed or active-duty service members, ii) Spouse or children of deployed or active-duty service members
	Safety net alignment – Enrollment in energy bill assistance, efficiency, or weatherization programs
	Income – i) Poverty level or AMI, ii) Enrollment in other assistance programs

In recent dockets, we have revealed the extent of harms from disconnections and how they disproportionately impact certain customers, particularly in Michigan's majority

Black, Indigenous and other People of Color (BIPOC) communities such as Detroit, Hamtramck, Highland Park, and Pontiac. The legacies of historic discrimination, such as through redlining, have further exacerbated disconnection disparities by resulting in less efficient housing and urban heat islands (higher cooling costs), lower access to energy waste reduction products and services, and an increase in predatory lending and penalties. Even the best temperature-based protections will be unable to mitigate the disproportionate disconnection risks these communities face. The only sure-fire way to protect public health and ensure continuous access to energy--a universal basic need--is through universal protection from disconnection under all circumstances. Universal protection has already proven to be technically feasible, as protections were adopted during the early months of the COVID-19 crisis. Whether universal protections are politically feasible and how such protections could be designed to minimize ratepayer or public costs are important, but in our view secondary questions. We believe considering universal protections through U-20140 or a new dedicated disconnections docket, following the model of Hawai'i's 2025-02848, is a more promising direction.

To illustrate why short-term, weather-based disconnection protections fail adequately to protect customers from harm, we turn to data reported by DTE in the U-20757 (COVID) and U-18120 (quarterly report) dockets. The data clearly reveal that the number of customers protected by weather-based shutoff moratoria is dwarfed by the number of customers whose services were previously shut off and not yet restored and thus remain unprotected during extreme weather events. We focus on DTE because we have not compiled statewide data from the U-18120 quarterly reports to compare with the U-20757 COVID docket data that the MPSC compiles and charts on its website. We are not aware that DTE's data is exceptional in any way, other than it being the biggest utility reporting.

DTE's U-20757 report dated 12/31/2024 shows a total of 13,743 electric, gas and combination residential premises remained without service at the end of the month owing to nonpayment. This is the number of premises that would not be protected by a weather-based, short-term shutoff moratorium, because they already lost service. While that number may have varied to some extent throughout the month of December 2024, we can assume for the sake of illustration that at least that many premises would have already been without service on the eve of any shutoff moratorium declared during that month, because the November numbers had been higher.

DTE's quarterly report (U-18120 docket) for December 2024 shows that 7,167 premises were newly disconnected for non-payment during the, an average of 231 new disconnections per day.

Therefore a DTE shutoff moratorium lasting two days will delay 462 disconnections on average but do nothing for the 13,743 customers whose service was already disconnected. The moratorium in this scenario protects a paltry 3.25% of the customers who would go without service during the weather event were it not enacted.

Having noted our firm belief that universal protections are needed and are superior to a patchwork of fleeting protections for cold, heat, and vulnerable health, we respond to the Commission's questions below.

*(1) The existing extreme weather condition policies vary by utility, with some suspending disconnections at a temperature threshold and others using National Weather Service (NWS) heat and cold advisory warnings. Are each utility's extreme weather condition policies appropriate for setting shutoff and customer protections? If not, what other thresholds should be considered? What is the most appropriate threshold for utilities in Michigan?*

A1. Existing extreme weather condition policies do not adequately protect customers because the weather-based threshold approach is fundamentally flawed.

Episodic shutoff moratoria based on weather conditions may be inaccurate and fail to protect many people.

Weather forecasts may inaccurately predict the onset, severity, duration, and impacted areas. Weather-based criteria also assume that all residential premises have the same ability to withstand severe weather conditions. Yet we know that many premises are poorly weatherized, and premises in cities are exposed to urban heat island effects that raise ambient temperatures as much as 5 degrees F compared to nearby suburbs.

Episodic moratoria may fail to protect many customers. As noted above, they fail to protect comparatively enormous numbers of customers whose services have already been shut off.

Further, it is very difficult to monitor how utilities implement weather-based shutoff moratoria, given how dynamic and unpredictable extreme weather conditions can be in time and space and how effectively utilities identify and protect vulnerable or other protected customers.

If the Commission is not prepared to bar all shutoffs for nonpayment, it ought to consider less-comprehensive modifications that would help substantially.

First, if the Commission is not prepared to bar shutoffs at all times, it should bar them during the times of year that extreme weather is most common, namely the summer and winter months. We recommend adoption of calendar-based thresholds for the peak winter heating season and the peak summer cooling season, which could vary based on the typical onset of extreme weather conditions in each utility service territory. This approach virtually eliminates weather forecasting inaccuracies and virtually eliminates incomplete protection caused by difficulties identifying customers who need protection based on specified characteristics. Seasonal shutoff moratoria would not protect residents of premises where service has already been shut off at the beginning of the season, but this problem could be addressed through an effort to identify any such premises that are still occupied and to reconnect them at the beginning of each moratorium season. A modification of this approach would be to specify an arrearage threshold below which nobody would be, or remain, disconnected during the summer and winter seasons.

One reason we do not prefer seasonal shutoff moratoria is that, for most of the state, the summer and winter seasons would likely comprise more than half of the calendar year. If extreme weather conditions may occur in a majority of months of the year, it may not be worth the administrative, communication and regulatory effort to frequently cycle in and out of moratorium periods.

Second, if the Commission is not prepared to extend shutoff protections year-round to all customers, it could extend them to some customers year-round. This approach would extend the current winter shutoff protections to more people and over the full year. Again, this approach is hampered by difficulties identifying customers based on eligibility characteristics. We know that many senior, critical medical and low-income customers are not identified despite utility education and engagement efforts.

*(2) Should the extreme weather condition policies be consistent across utilities or continue to vary by utility?*

A2. First, we reiterate our central recommendation that shutoff protections should be in effect year-round and not subject to weather conditions at all.

If the Commission adopts our less-preferred alternative of seasonal shutoff moratoria, then we do not recommend that every utility should adopt the same

summer and winter moratorium calendars. Extreme weather periods begin at different times around the state: winter starts earlier in the UP and lasts longer, and summer starts early in the southern lower peninsula and lasts longer. The Commission should identify specific temperature and humidity thresholds that should be consistent across the state then require each utility to propose when those conditions commence and end, in an average year, across their service territories.

Utilities with large service territories, such as Consumers and DTE, should propose multiple zones within their service territories. The zones should be defined by climate differences across large utility territories and urban heat island effects.

If the Commission allows utilities to continue using weather-based thresholds, then the criteria should be the same across the state. A 95-degree day has the same impact on somebody in the UP as in Detroit: it's just less common. In addition, two other criteria in addition to ambient temperature should be considered. First, humidity should be taken into account, presumably using wet-bulb temperature. Second, air quality indices should be considered. High and low temperatures and atmospheric conditions can exacerbate air pollution problems, including but not limited to ozone, carbon monoxide, ambient pollutants, and wildfire smoke. During air quality alerts, residences need to be able to operate their indoor air filters to clean the air, and to run air conditioning so they do not have to open windows and admit potentially unhealthful pollutants.

*(3) How long should protections be in place after an extreme weather event? For example, should utilities be prohibited from instituting shutoffs for 72 hours after the event if the high/low temperature threshold or NWS heat/cold advisory warning is forecasted for any time in the 48 hours following the event?*

A3. Again, we stress that our primary recommendation is that protections should always be in place.

With a seasonal shutoff moratorium, protections should remain in place until the end of the defined extreme weather season.

If weather-based thresholds remain in effect, then shutoffs should not be permitted within 72 hours of the predicted onset or resumption of extreme weather conditions. Both Consumers and DTE report that most customers disconnected for nonpayment get their service restored within 72 hours. This indicates that a disconnection that takes place more than 72 hours before an extreme weather event provides the customer with a reasonable amount of time to do whatever is

necessary to get their service restored before the extreme weather sets in. While more lead time might be preferable, forecasts much further in advance would likely introduce inaccuracies that might unnecessarily impact many more customers than ultimately proved necessary for protective purposes.

Barriers to service restoration should also be lowered when shutoff moratoria go into effect. Service restoration typically requires that a customer pay down some amount of their arrearage and agree on a payment plan to resolve the remaining balance. Above, we recommended that no customer be disconnected if their arrears balance is below a certain number regardless of ageing. Similarly, we recommend here that any customer be able to get their service restored when a shutoff moratorium goes into effect if they are able to reduce their balance below that threshold or they agree to a payment plan.

*(4) What protections do other states with similar climates have in place during extreme weather that the Commission should consider? How effective are they? What extreme weather thresholds are used?*

A4. We defer on this response to comments and third-party research that the University of Chicago - Abrams Law Clinic plans to provide in this docket.

*(5) What process improvements might be considered for extreme weather condition policies?*

A5. If longer shutoff moratoria are adopted that protect more customers, then utilities and the Commission will need to develop processes and resources to prevent customers building up insurmountable arrearages that often lead to shutoff when the moratorium ends. This topic has received significant attention in other proceedings.

*(6) Should utilities provide more data or file reports on a regular basis related to extreme weather condition policies? If so, how often and what should be included? What purpose would the reports serve?*

A6. Utilities should provide data that help the Commission evaluate whether the policies provide effective customer protections and management of accumulation of arrearages. Suggested data:

(1) If seasonal moratoria are instituted.

- a. How many premises were protected from shutoff each month – need both the total in protected status at end of month and number of new shutoffs averted each month.

- b. Report on arrearages owed by vulnerable customers: seniors, critical care, low-income, families with small children.

(2) If weather-based thresholds are retained, For each moratorium period, report:

- a. Time and date that moratorium advance period began. Report separately by county or other geographic area if timing differs.
- b. Time and date that actual weather conditions first satisfied moratorium trigger criteria.
- c. Time and date the moratorium was ended and actual weather conditions at that time.
- d. Number of premises protected from shutoff during the moratorium.
- e. Number of premises whose service was not restored before the moratorium commenced, by service type.
- f. Number of premises whose service was restored in the 72 hours before the extreme weather conditions began.

*(7) Should the extreme weather condition policies be updated or evaluated on a specific timeline, to ensure they remain effective and responsive to changing weather patterns and emerging challenges? Or should another trigger (other than time) be used for the update or reevaluation?*

A7. Extreme weather condition rules should be evaluated as part of periodic review of the Billing Rules.

*(8) If applicable, what public engagement process should utilities utilize to update their respective extreme weather condition policies?*

A8. Utilities should seek public input on their policies at least every five years, or whenever changes are made to their policies, whichever comes first.

Public engagement should include :

- Notification of customers via bill insert;
- Consultation with energy assistance providers;
- Consultation with local and regional governments;
- Consultation with MDHHS and other state agencies.

*(9) Should utilities be required to notify the Commission when their extreme weather protections are triggered?*

A9. Such reporting would not be useful if year-round universal shutoff protections were implemented. This information would also not be useful with the seasonal protections that we recommend as an alternative.

If the Commission continues to allow temperature-based protections, utilities should report the data recommended above at the end of the winter heating and summer cooling seasons. The Commission may wish to consider merging extreme weather reporting with the quarterly reports filed in docket no. U-18120.

*(10) What assistance measures are utilities providing to customers during extreme weather (e.g., information on cooling/heating centers and resilience hubs, pallets of water bottles, etc.)? How is this assistance communicated to customers? What other entities are utilities coordinating with? Are there additional assistance measures that should be considered?*

A10. We defer to utilities to answer most of this question.

In addition, however, we recommend strengthened coordination and communication between utilities and local service providers including local governments. Local providers have little way to know who in their community has lost utility service and may need help during an emergency unless those customers reach out and identify themselves. When power is out, however, customers may lose mobile phone or other communications access; may be too busy struggling to survive to reach out; and may not know who can help. We respect utilities' responsibility to protect customer privacy but submit that helping people survive a crisis ought to justify some relaxation of those privacy standards by providing information to responsible local parties.

*(11) What else should utilities and the Commission consider when reviewing and updating the extreme weather condition policies?*

A11. We have nothing further to add.

Thank you again for inviting these comments. We look forward to assisting the Commission in its continuing deliberations.

Sincerely,

Amy Bandyk, Citizens Utility Board of Michigan

Shimekia Nichols, Soulardarity

Mark Templeton, Abrams Environmental Law Clinic at the University of Chicago Law School

Sergio Cira-Reyes, Urban Core Collective

Gloria Lowe, We Want Green Too

Boratha Tan, Vote Solar

Justin Schott, Energy Equity Project, University of Michigan School for Environment & Sustainability

Rick Bunch, Michigan Municipal Association for Utility Issues



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**Bulletin 14 of 2024  
Inflation Rate Multiplier  
October 22, 2024**

**TO:** Assessors and Equalization Directors

**FROM:** Michigan State Tax Commission

**SUBJECT:** Inflation Rate Multiplier for use in the 2025 capped value formula and the "Headlee" Millage Reduction Fraction (MRF) formula

The calculation of the Inflation Rate Multiplier is set in statute in MCL 211.34d:

(l) "Inflation rate" means the ratio of the general price level for the state fiscal year ending in the calendar year immediately preceding the current year divided by the general price level for the state fiscal year ending in the calendar year before the year immediately preceding the current year.

(f) "General price level" means the annual average of the 12 monthly values for the United States consumer price index for all urban consumers as defined and officially reported by the United States Department of Labor, Bureau of Labor Statistics.

### **Calculation of 2025 Inflation Rate Multiplier**

Based on the statutory requirements in MCL 211.34d, the calculation of the inflation rate multiplier for 2025 is as follows:

1. The 12 monthly values for October 2022 through September 2023 are averaged.
2. The 12 monthly values for October 2023 through September 2024 are averaged.
3. The ratio is calculated by dividing the average of column 2 by the average of column 1.

The specific numbers from the US Department of Labor, Bureau of Labor Statistics are as follows:

**CPI data used to calculate Inflation Rate Ratio for 2024 property taxes****2024 Calculations**

<u>FY 2022 - 2023</u>		<u>FY 2023 - 2024</u>	
Oct-22	298.012	Oct-23	307.671
Nov-22	297.711	Nov-23	307.051
Dec-22	296.797	Dec-23	306.746
Jan-23	299.170	Jan-24	308.417
Feb-23	300.840	Feb-24	310.326
Mar-23	301.836	Mar-24	312.332
Apr-23	303.363	Apr-24	313.548
May-23	304.127	May-24	314.069
Jun-23	305.109	Jun-24	314.175
Jul-23	305.691	Jul-24	314.540
Aug-23	307.026	Aug-24	314.796
Sep-23	<u>307.789</u>	Sep-24	<u>315.301</u>
<b>Average</b>	<b>302.289</b>	<b>Average</b>	<b>311.581</b>

Ratio	<b>1.031</b>
% Change	<b>3.1%</b>

**Important:** Local units **cannot** develop or adopt or use an inflation rate multiplier other than 1.031 in 2025. It is not acceptable for local units or assessors to indicate to taxpayers that they do not know how the multiplier is developed.

**Inflation Rate Multiplier (IRM) Used in the 2025 Capped Value Formula**

The inflation rate, expressed as a multiplier, to be used in the 2025 Capped Value Formula is 1.031.

$$\text{2025 CAPPED VALUE} = (\text{2024 Taxable Value} - \text{LOSSES}) \times 1.031 + \text{ADDITIONS}$$

- The formula above does not include 1.05 because the inflation rate multiplier of 1.031 is lower than 1.05.

**Inflation Rate Multiplier Used in 2025 “Headlee” Calculations**

The inflation rate multiplier of 1.031 shall ALSO be used in the calculation of the 2025 “Headlee” Millage Reduction Fraction required by Michigan Compiled Law (MCL) 211.34d.

The formula for calculating the 2025 “Headlee” Millage Reduction Fraction (MRF) is:

$$\mathbf{2025\ MRF = \frac{(2024\ Taxable\ Value - LOSSES) \times 1.031}{2025\ Taxable\ Value - ADDITIONS}}$$

### Historical Inflation Rate Multipliers

The following is a listing of the inflation rate multipliers used in the Capped Value and "Headlee" calculations since the start of Proposal A.

YEAR	IRM		YEAR	IRM
1995	1.026		2012	1.027
1996	1.028		2013	1.024
1997	1.028		2014	1.016
1998	1.027		2015	1.016
1999	1.016		2016	1.003
2000	1.019		2017	1.009
2001	1.032		2018	1.021
2002	1.032		2019	1.024
2003	1.015		2020	1.019
2004	1.023		2021	1.014
2005	1.023		2022	1.033
2006	1.033		2023	1.050 (Capped Value)
2007	1.037			1.079 (Headlee)
2008	1.023		2024	1.050 (Capped Value)
2009	1.044			1.051 (Headlee)
2010	0.997		2025	1.031
2011	1.017			



<b>2024 Utility Outages</b>		
<b><u>Start Date of Event</u></b>	<b><u>Utility</u></b>	<b><u>Cumulative Outages</u></b>
8/27/2024	DTE	378,232
8/27/2024	CE	217,820
8/27/2024	I&M	7,650
7/15/2024	I&M	11,000
7/9/2024	CE	44,968
6/25/2024	CE	185,497
6/19/2024	DTE	125,128
6/16/2024	CE	87,334
6/5/2024	DTE	71,603
5/20/2024	CE	34,988
4/12/2024	CE	93,060
2/28/2024	CE	45,704
1/12/2024	DTE	190,235
1/9/2024	CE	293,020
*Initial Report - Will Be Updated With Final Numbers		

STATE OF MICHIGAN  
BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the Application of **CONSUMERS ENERGY COMPANY** for authority to increase its rates for generation and distribution of electricity and for other relief.

Case No. U-21870

ALJ Jonathan F. Thoits

**PROOF OF SERVICE**

I, Mark N. Templeton, certify that an electronic copy of the Official Exhibits of Sergio Cira-Reyes on Behalf of Urban Core Collective, UCC-27 to UCC-37 (Part 3 of 6), was served on the following on November 13, 2025.

Name/Party	E-mail Address
<b>Administrative Law Judge</b> Jonathan F. Thoits	<a href="mailto:thoitsj@michigan.gov">thoitsj@michigan.gov</a>
<b>Consumers Energy Company</b> Gary A. Gensch Jr. Anne M. Uitvlugt Evan B. Keimach Mark R. Ruskiewicz Spencer A. Sattler Bret A. Totoraitis Kelly Hall	<a href="mailto:mpsc.filings@cmsenergy.com">mpsc.filings@cmsenergy.com</a> <a href="mailto:gary.genschjr@cmsenergy.com">gary.genschjr@cmsenergy.com</a> <a href="mailto:anne.uitvlugt@cmsenergy.com">anne.uitvlugt@cmsenergy.com</a> <a href="mailto:evan.keimach@cmsenergy.com">evan.keimach@cmsenergy.com</a> <a href="mailto:mark.ruskiewicz@cmsenergy.com">mark.ruskiewicz@cmsenergy.com</a> <a href="mailto:spencer.sattler@cmsenergy.com">spencer.sattler@cmsenergy.com</a> <a href="mailto:bret.totoraitis@cmsenergy.com">bret.totoraitis@cmsenergy.com</a> <a href="mailto:kelly.hall@cmsenergy.com">kelly.hall@cmsenergy.com</a>
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The statements above are true to the best of my knowledge, information, and belief.

Date: November 13, 2025

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