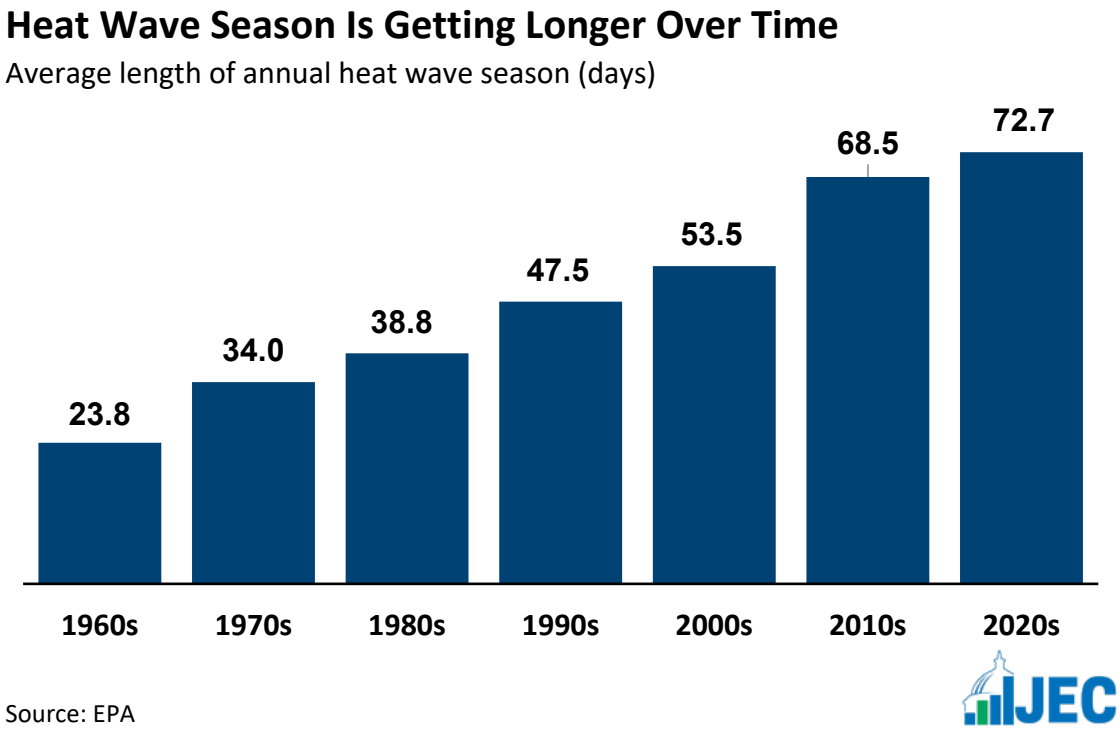
The Mounting Costs of Extreme Heat

Record-breaking high temperatures have made headlines across the globe this summer, drawing attention to one of the most salient and alarming effects of climate change. As global average temperatures rise, extreme high temperatures are expected to increase at an even more rapid rate. The week of July 3rd 2023 contained two of the hottest days in recorded history, with millions of Americans exposed to dangerously high temperatures representing a dramatic threat to human health and the economy.



The frequency, length, and severity of heat waves have all increased significantly in recent years. Globally, the number of days above 95 degrees Fahrenheit is expected to increase more than threefold by 2100 in the absence of major greenhouse gas emissions reductions. Even under the most optimistic climate projections, the trend of increasing extreme high temperatures is expected to continue, with potentially devastating consequences for human health and wellbeing, particularly among the most vulnerable populations. The scope of this crisis requires both additional actions to address the climate crisis and policies to mitigate the effects of heat.

Heat waves are a growing threat to public health.

Extreme heat directly harms public health, which makes the increasing severity and frequency of extreme heat days all the more concerning. Extreme heat is already the leading cause of weather-related deaths in the United States. Between 2004 and 2018, over 10,000 Americans died of heat-related causes. The true number of heat-related deaths is likely significantly higher, as heat often plays a role in deaths that are officially attributed to other causes.

Health care costs associated with rising temperatures are also considerable and likely to increase over time. A Center for American Progress study based on insurance claims data from 2016 to 2020 estimated that heat-related health care costs in the United States amount to as much as $1 billion each summer.

High temperatures are dangerous to everyone, but infants, children, the elderly, pregnant women, outdoor workers, homeless individuals, and those with preexisting conditions are all especially vulnerable to heat-related illness and death. Prolonged exposure to high temperatures places immense and potentially fatal strain on vital organs and can exacerbate the health impacts of allergens and air pollution. Heat and the resultant dehydration can impair balance and cognition, which may explain why workers tend to have more occupational injuries when temperatures rise.

Elevated nighttime temperatures during a heat wave are especially dangerous because they do not allow for a break from the heat. Even life-saving adaptations to high temperatures can come at a cost, as retreating indoors reduces participation in health-promoting outdoor activities.

Rising temperatures are taking a toll on workers in sectors like food production, transportation, and manufacturing, which will harm the economy now and in the future.

Extreme heat is already having a significant impact on the U.S. economy, particularly in heat-exposed industries like agriculture, mining, construction, manufacturing, and transportation. Crop workers die of heat-related illnesses at 20 times the rate of other civilian workers in the United States. Between 1992 and 2016, 285 construction workers died from heat exposure—accounting for more than 30% of heat-related occupational deaths during that period.

Heat is also significantly impacting the working conditions of mail and shipping delivery workers. Demands for heat mitigation technologies (air conditioning, fans, heat shields) were front and center in the recent contentious contract negotiations between UPS and its 340,000 Teamsters union members.

Together, the loss of productivity caused by heat is emerging as one of the biggest economic costs of climate change. A recent study on the effect of temperature on productivity found that, while extreme heat harms agriculture, the impact on productivity in manufacturing and other sectors is larger – in part because they are more labor-intensive. Heat increases absenteeism and reduces work hours and these effects are expected to grow as the world warms. In 2021,

data showed that more than 2.5 billion hours of labor in the U.S. agriculture, construction, manufacturing, and service sectors were lost to heat exposure. Another report found that, in 2020, loss of productivity from heat exposure cost the economy $100 billion with annual costs expected to grow to $500 billion by 2050. A recent study showed that as temperatures reach 90 degrees Fahrenheit productivity drops by about 25%, and it falls by 70% as temperatures reach 100 degrees Fahrenheit.

Heat waves and higher average temperatures are also increasingly damaging to crops and livestock, with potentially devastating consequences on our food system. Since 2001, heat-related crop losses have led to over $1.3 billion in federally-subsidized crop insurance payouts to farmers in six states in the Southwest—New Mexico, Arizona, California, Nevada, Colorado, and Utah. Heat waves have resulted in lost livestock, more expensive cooking oil, and shortages of staple grains like wheat. In the long term, increases in average temperatures may benefit some farmers by extending growing seasons and opening new growing regions; however, in the short term, they can result in significant losses and price volatility as producers struggle to drastically adapt their operations.

The future economic costs associated with extreme heat depend largely on the extent and pace of emissions reductions. Global average temperatures are currently on track to rise by 2.7 degrees by 2100. Even if more than 70% of nations were to meet their proposed net zero targets, warming is still expected to reach at least 1.8 degrees—well above the 1.5 degree target established by the Paris Agreement. The United States is projected to lose an average of 14 labor hours per weather-exposed worker per year if the global temperature rise is contained to 2 degrees Celsius. If there is an increase of 4 degrees, lost productivity is expected to more than double. In areas of the Southeast, Southern Great Plains, and Southwest, the direct effects on productivity are likely to be substantially above the national average.

The relative importance of vulnerable sectors to local and state economies can amplify the direct economic impacts of heat. As the table below shows, workers in the most heat-exposed industries comprise a significant share of the workforce across the country. **In Wisconsin and Indiana, nearly 1/3 of workers are employed in heat-exposed industries.** Relatively small changes to working hours due to heat will have outsized economic impacts in states where more people work in heat-exposed industries. The following table includes the total number of employees in heat-exposed industries in each state and their share of each state's total workforce.

Employment in the Sectors Most Vulnerable to Extreme Heat Varies by State		
State	Number of Workers in Heat-Exposed Industries	Employment in Heat-Exposed Industries as a % of Total
Alabama	610,000	28%
Alaska	80,000	25%
Arizona	740,000	22%
Arkansas	380,000	29%
California	4,400,000	24%
Colorado	660,000	22%
Connecticut	400,000	22%
Delaware	90,000	20%
Florida	2,000,000	21%
Georgia	1,300,000	25%
Hawaii	110,000	18%
Idaho	260,000	29%
Illinois	1,500,000	25%
Indiana	1,100,000	32%
Iowa	500,000	31%
Kansas	390,000	27%
Kentucky	580,000	29%
Louisiana	470,000	24%
Maine	160,000	24%
Maryland	550,000	18%
Massachusetts	700,000	20%
Michigan	1,400,000	30%
Minnesota	790,000	27%
Mississippi	360,000	29%
Missouri	750,000	26%
Montana	130,000	25%

Nebraska	280,000	28%
Nevada	300,000	21%
New Hampshire	180,000	24%
New Jersey	960,000	21%
New Mexico	180,000	20%
New York	1,600,000	18%
North Carolina	1,300,000	26%
North Dakota	110,000	28%
Ohio	1,600,000	28%
Oklahoma	450,000	26%
Oregon	500,000	25%
Pennsylvania	1,500,000	25%
Puerto Rico	230,000	21%
Rhode Island	120,000	22%
South Carolina	630,000	27%
South Dakota	130,000	28%
Tennessee	900,000	28%
Texas	3,600,000	26%
Utah	420,000	26%
Vermont	80,000	25%
Virginia	810,000	19%
Washington	930,000	25%
West Virginia	170,000	23%
Wisconsin	950,000	32%
Wyoming	80,000	28%

Source: 2021 American Community Survey.

Note: Heat-exposed sectors include transportation and warehousing, utilities, manufacturing, agriculture, mining, and construction. The number of workers is rounded to the nearest thousand or ten thousand for figures under and above 1 million, respectively.

Critical U.S. infrastructure may be ill-equipped to handle the effects of extreme heat.

High temperatures place additional stress on the water, energy, and transportation infrastructure that forms the bedrock of the U.S. economy and society. Much of the existing critical infrastructure was not designed to operate in extreme heat and may require significant adaptations or replacement to avoid costly and dangerous disruptions to essential services.

In recent years, utilities across the country have become increasingly concerned about the potentially destabilizing effects of summer heat waves on the electric grid, forcing them to take drastic measures. Extreme heat places immense stress on the electric grid, as it both directly impacts the capacity of transmission lines to transmit electricity and increases demand for energy-intensive air conditioning. Heat-driven grid strain has forced California utilities to implement rolling blackouts for the first time in 20 years and led the Texas power authority to request that residents voluntarily reduce their consumption to avoid similar blackouts.

Recent heat waves have also highlighted the many heat-related vulnerabilities within our transportation infrastructure. One study estimates that the additional road maintenance and replacement costs associated with rising temperatures could reach $19-26.3 billion nationwide by 2040, as many roadways in the U.S. were constructed with asphalt grades ill-suited to higher temperatures. Texas, California, Illinois, and Florida are expected to see the greatest impacts. Additionally, Portland, Oregon was forced to suspend streetcar service during a heat wave in 2021, as record high temperatures warped a critical power cable.

In recent years, heat-related disruptions to air travel have also increased significantly. Higher temperatures reduce air density, which renders takeoffs more difficult and can outright prohibit certain flights from taking place. Airlines have been forced to adapt to high temperatures by restricting airplane weights (limiting passengers and cargo), providing cooling facilities for employees, and cancelling flights altogether. Southwest Airlines recently identified rising temperatures and heat waves as two of the most significant physical risks to their operations in the mid and long terms. A 2015 study projected that the number of weight-restriction days at Denver, LaGuardia, DCA, and Phoenix airports will increase by as much as 200% by 2050-2070.

The impacts of extreme heat are unevenly distributed and disproportionately impact disadvantaged communities.

The effects of heat amplify and reflect preexisting inequalities in health, housing, income, and occupational safety—as these disparities impact access to life-saving health care and air conditioning. Many workers in agriculture, construction, and other heat-exposed sectors earn well below the median wage and may be unable to afford to miss work and seek medical attention during heat events. Low-income households also face higher rates of energy insecurity, which can result in disconnection from life-saving mitigation measures such as air conditioning and medical devices during heat waves.

Insecure immigration status and language barriers of agricultural workers can also increase vulnerability to dangerous heat exposure. Over 40% of agricultural workers are estimated to lack legal status, and 71% report limited English language proficiency, which may limit their ability to advocate for better working conditions and life-saving adaptations.

While agriculture workers are disproportionately exposed to heat based on the nature of their work, studies have found that many employers in the agricultural sector also fail to adopt mitigation measures that could significantly reduce related health risks. A study of farmworker housing in North Carolina found that nighttime summer temperatures were dangerously high in over 80% of rooms surveyed and that more than half of the dwellings lacked air conditioning.

Black and Native American communities in the United States suffer significantly higher rates of heat-related death than other ethnic groups. This likely reflects wealth and income gaps, disproportionately high rates of preexisting conditions, and reduced health care access.

Disparate access to housing quality also plays an important role. Many low-income rural residents in Southwestern states experiencing extreme heat like Arizona live in manufactured homes (AKA mobile homes) designed pre-HUD standards. These homes have little insulation, were not designed to accommodate modern air conditioning, and can even fall apart in the heat. Approximately 17% of households on reservations in the United States live in manufactured homes, a significant proportion of which may be substandard.

The legacies of past institutionalized housing discrimination against Black communities, such as redlining, may also increase their exposure to heat in urban environments. Although urban areas generally experience higher ambient temperatures than surrounding areas due to the heat island effect, Black and Hispanic urban residents are more likely to live in those neighborhoods most exposed to high temperatures. Studies have found that previously redlined communities are far hotter than non-redlined neighborhoods and have lower tree cover. In certain U.S. cities, neighborhoods with higher proportions of white and wealthy residents have been found to be anywhere from 5 to 20 degrees cooler in the summer than those with more low-income and minority residents.

Local, state, and federal efforts addressing the impacts of extreme heat

In recent years, governments have begun to invest additional resources to better understand and combat the many negative effects of extreme heat. They are increasingly recognizing the need to address the impacts of heat—but much remains to be done. Below are examples of how local, state, and federal policies and proposals are starting to address the impacts of heat.

Tracking and studying the impacts of extreme heat

In 2021, the Biden administration announced the launch of an interagency effort to address the growing impacts of extreme heat. More than 10 federal agencies worked in collaboration to create the National Integrated Heat Health Information System (NIHHIS) and its associated web portal, Heat.gov, which brings together resources and data to help decision-makers at all levels

understand and address the impacts of extreme heat. In the midst of substantial heatwaves in July 2023, Biden also announced substantial investments in weather forecasting and clean water initiatives.

A bill introduced by Senators Markey, Padilla, and Sinema—the Preventing Health Emergencies And Temperature-related (HEAT) Illness and Deaths Act—would provide NIHHIS with statutory authority and funding to and expand its efforts to better coordinate federal agencies' efforts to address the impacts of extreme heat. The bill also requires NIHHIS to conduct a study in contract with the National Academies of Science, Engineering, and Medicine to result in recommendations on policy, communications, research and data collection and standardization to improve resilience to extreme heat across the country.

Keeping workers safe on the job

California, Colorado, Washington, Minnesota, and Oregon have established heat-specific labor standards to protect workers. However, there is currently no federal standard specifying the protections that employers must provide under conditions of extreme heat.

OSHA instigated a heat-related rulemaking in 2021, which is still in process. The Asuncion Valdivia Heat Illness and Fatality Prevention Act, introduced by Sen. Brown in the 117th Congress and reintroduced in both chambers in the 118th by Rep. Chu and Sen. Brown, directs the OSHA to quickly develop and implement a federal standard for heat exposure, requires covered employees and supervisors to receive training on the mitigation of heat-risks and related employee rights, and establishes protections for whistleblowers.

A bill introduced by Rep. Sylvia Garcia, H.R. 785, would require employers to provide 15-minute breaks to construction workers. Importantly, these bills would overrule a law recently passed in Texas, which strips related protections from workers in municipalities with stricter labor regulations than the state by setting a high federal standard. 112 Democrats in the House and Senate signed onto a July 24th letter to the Secretary of Labor, which calls for OSHA to quickly implement a heat standard modeled on the Valdivia bill and specifically cites the lack of protections for outdoor workers in Texas as a cause for concern in the context of extreme heat.

Mitigating heat island effects

There are several adaptations that can be made to significantly reduce the heat island effect in urban environments, such as increasing tree coverage and installing more light-reflecting roofs and pavements. In recent years, a number of cities have recognized the inequitable risks posed by heat island effects and started initiatives to mitigate them.

The Inflation Reduction Act (IRA) made historic investments in the Forest Service's Urban and Community Forestry Program, which supports communities' efforts to combat heat stress. In April, the U.S. Department of Agriculture announced $1 billion in grant funding to local and state governments, tribes, nonprofits, and others to "increase equitable access to trees and green spaces in urban and community forests", with a significant proportion of this funding going to disadvantaged communities. The Preventing Health Emergencies And Temperature-related

(HEAT) Illness and Deaths Act would create a $100 million financial assistance program to support community projects and research that promotes resilience to extreme heat, particularly in disadvantaged communities.

Ensuring homeowners and renters have access to affordable cooling

Funding made available by the IRA is also helping to close the air conditioning gap among homeowners. Households are now eligible to claim up to thousands of dollars in annual tax credits for a variety of energy efficiency upgrades, including the purchase and installation of an air source heat pump, which efficiently provides both heating and cooling while lowering energy costs. These provisions of the IRA were based on JEC Chairman Heinrich's 2021 Zero-Emissions Homes Act.

The Weatherization Assistance Program (WAP) and Low Income Home Energy Assistance Program (LIHEAP) are also important tools in this effort. They provide funding to states to provide low-income renters and homeowners with direct assistance with energy costs and energy efficiency upgrades. While President Biden's FY24 budget request included $1.8 billion for these and other programs that increase households' energy security and efficiency, Republicans on the House Appropriations Committee recently voted to claw back funding allocated to energy efficiency programs by the IRA.

While it is vital to ensure that homes and apartments across the country have energy-efficient cooling systems in place, it is also important to ensure that households do not lose access to cooling during a heat wave. During the pandemic, collaboration by local, state, and federal governments—alongside nonprofit and private partners—helped prevent utility disconnections. The 2021 Consolidated Appropriations Act provided $25 billion in utility and rental assistance to state and local governments, allowing them to provide direct cash support to households struggling to pay their bills. The American Rescue Plan more than doubled funding to LIHEAP. States used these and other funds to provide unprecedented support to households. The administrative infrastructure created to disburse and spread awareness of these funds can serve as a model for future efforts to prevent potentially deadly utility connections during heat waves.

Preparing for future heat-related public health emergencies

A study which examined the outcomes of recent fatal heat waves in Washington state found that investments in infrastructure such as air conditioning alone would not be sufficient to protect vulnerable populations from extreme heat, and concluded that successful strategies would require significant planning and implementation coordination among stakeholders at all levels.

While governments are increasingly taking action to address the effects of extreme heat, more could be done to integrate extreme heat events into disaster and hazard planning. A 2023 study of states' FEMA-approved hazard mitigation plans found that only 25 states included a section specifically on extreme heat and only 12 states had related mitigation plans. Of those 12 states, a few had plans that did not "expand beyond basic emergency preparedness" or target the

populations most vulnerable to extreme heat. This is especially troubling as several states without comprehensive mitigation plans —New Mexico, Texas, Washington, and Nevada— are currently experiencing dangerously high temperatures. The Navajo Nation declared a state of emergency due to the extreme heat on July 25, 2023 – extreme heat is particularly devastating on the Navajo Nation as at least 15,000 families lack the electricity needed to run air conditioning.

Formally recognizing heat waves as a major disaster may be one way to ensure they are treated accordingly; however, the United States does not currently have legal authority to do so. Proposed legislation (H.R. 3965) introduced by Rep. Gallego would add extreme heat to the definition of a major disaster—enabling states to ask for FEMA assistance and seek reimbursement for emergency measures like cooling stations and welfare checks.

Extreme heat is one of the deadliest and most economically catastrophic effects of climate change. Strong policy action is needed to address the climate crisis now and to give people tools to adapt to and weather these increasing temperatures.