Extreme heat in disadvantaged communities

New climate projections show rising exposure to extreme heat in disadvantaged communities.

ICF CLIMATE center

By Judsen Bruzgul, Mason Fried, Durban Keeler, Adam Parris, and Raquel Silva, ICF

Executive summary

Extreme heat is one of the deadliest and most widespread climate change risks. It's particularly dangerous for disadvantaged communities, which are least able to prepare for, withstand, and recover from the impacts of extreme heat.

Fortunately, the Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA) include record amounts of funding to address climate change and its impacts. In addition, the federal government's Justice40 Initiative[1] set a goal that 40% of the overall benefits of federal funding for climate change flow to disadvantaged communities that are marginalized by underinvestment and overburdened by pollution.

In this report, the ICF Climate Center leverages the latest climate projections with ICF's market-leading climate risk analytics platform, ClimateSight®, to understand how people living in "communities that are marginalized and overburdened by pollution and underinvestment," as defined by the Justice40 Initiative, could potentially be exposed to extreme heat in the coming decades. Because the risks of extreme heat are acute for human health and energy reliability, the analysis focuses on potential exposure to extreme heat levels that have impacts on those two areas.

It compares historical extreme heat exposure to projected exposure in moderate and high greenhouse gas emissions scenarios. The scenarios reveal how a failure to control emissions could lead to a more challenging future for many.

In the future, far more Americans living in Justice40 communities will face exacerbated consequences from extreme heat on their health, and hardships from reduced energy reliability as shown in Figure 1 and Figure 2. The number of additional people in Justice40 communities potentially exposed to health-threatening heat waves each year could rise by 25 million by 2050 under a moderate emissions scenario.

Similarly, about 8 million people in Justice40 communities are currently potentially exposed to a high level of extreme heat waves that could impact energy systems. That number could rise to more than 34 million by 2050 under a moderate emissions scenario.

This is a critical moment for disadvantaged communities: BIL and IRA funding offers a once-in-a-generation opportunity to address the needs of Justice40 communities to start adapting to a much hotter future.

[1] Justice40 Initiative

Figure 1: U.S. population exposed to 48+ health-threatening heat days

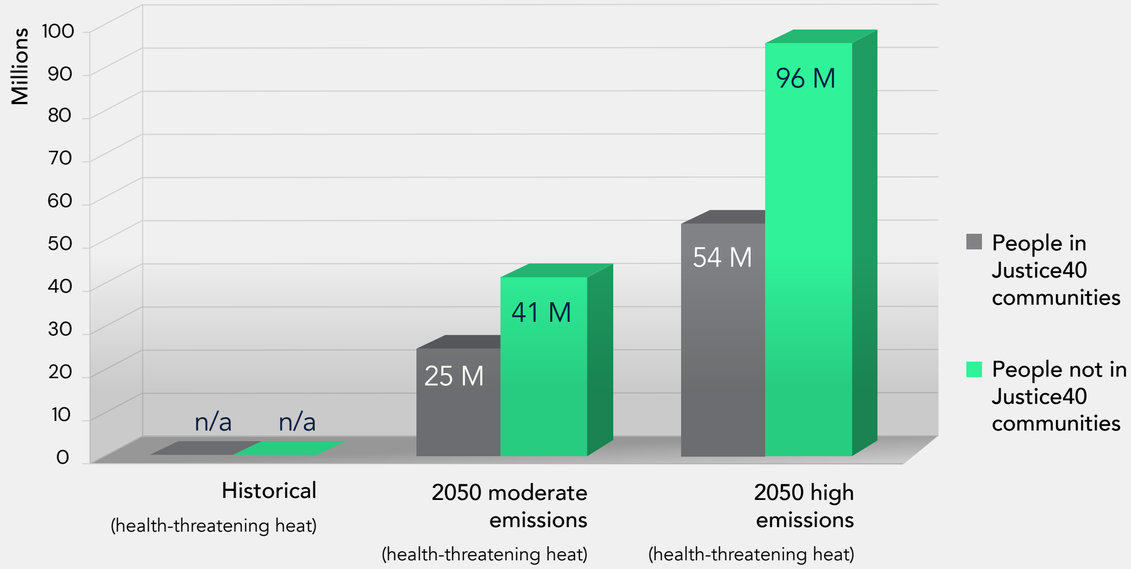
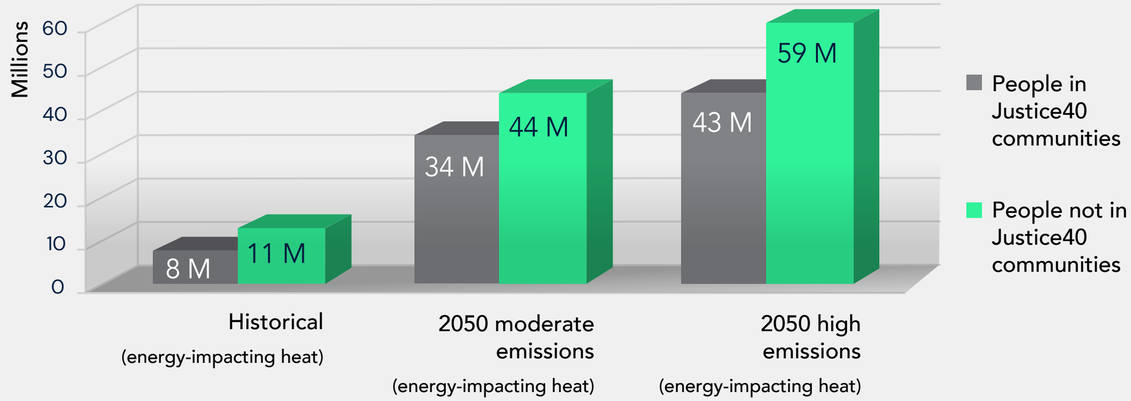


Figure 2: U.S. population exposed to energy-impacting heat



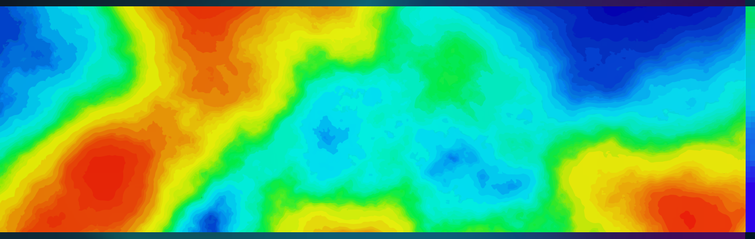
Source: ICF/ClimateSight®

Extreme heat and disadvantaged communities

The most severe harms from climate change, including extreme heat, fall disproportionately upon Justice40 communities. There are three primary reasons these communities are most vulnerable to extreme heat.

1

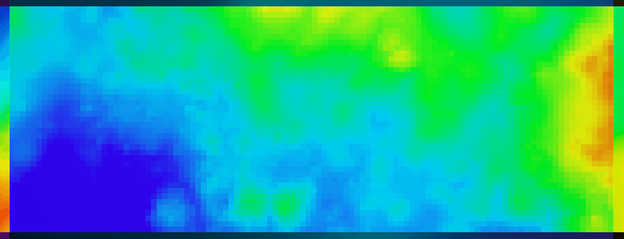
Higher exposure to extreme heat.



People in Justice40 communities are, on average, more exposed to extreme heat than people who are not part of these communities.

2

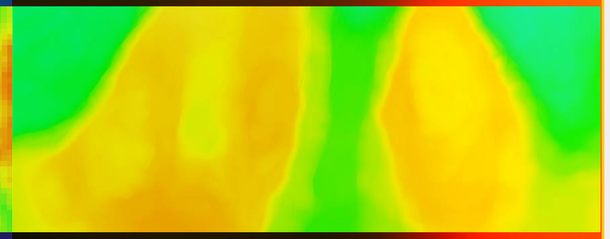
Higher sensitivity to extreme heat.



Extreme heat can have a greater impact on people who are more sensitive to it. Due to the variables used to identify Justice40 communities, such as the population's average age and levels of preexisting health conditions, these communities by definition have higher sensitivity.

3

Lower adaptive capacity to extreme heat.



People in Justice40 communities have fewer means to adapt to extreme conditions. Low average income and high energy cost as a percentage of income are two variables used to define these communities that contribute to it being more difficult for residents to cool themselves during an extreme heat event.

For people who live in marginalized communities, heat is already a challenge, but it will get worse as more heat wave days increase stress on people in these locations.

What are Justice40 communities?

Justice40 communities are defined by the federal government as **"disadvantaged communities that are marginalized and overburdened by pollution and underinvestment."** Using the Climate and Economic Justice Screening Tool (CEJST)[2], more than 27,000 U.S. census tracts met the Justice40 community threshold due to their low average income levels and high levels of burden related to eight categories:

- Climate change
- Energy
- Health
- Housing
- Legacy pollution
- Transportation
- Water and wastewater
- Workforce development

[2] Climate and Economic Justice Screening Tool

Extreme heat and health in disadvantaged communities

Extreme heat increases human health risks for all people, resulting in increased emergency room visits, hospital admissions, and deaths.

Many regions of the United States experienced record-breaking high temperatures in 2023, with populations potentially exposed to extremely high temperatures for prolonged periods. A recent U.S. Centers for Disease Control and Prevention report found that rates of emergency department visits for heat-related illness substantially increased across several U.S. regions in 2023 compared with previous years.[3]

Heat exhaustion, heat stroke, and dehydration are well-known direct health risks of potential heat exposure. Comorbidities such as asthma, diabetes, and heart disease can also increase risks during periods of extreme heat. Due to increased risks from exposure, greater sensitivities, and lower ability to adapt, people living in Justice40 communities are more likely to face detrimental health effects of extreme heat.

Historically, very few Americans in Justice40 communities experience 48 or more days per year in which heat is considered a threat to human health[4]. However, by 2050, even in a moderate greenhouse gas emissions scenario, more than 25 million Americans in these communities are expected to face at least 48 health-threatening heat days per year. In a high emissions scenario, the number grows to 54 million people by 2050, more than half of the overburdened community population.

[3]Heat-Related Emergency Department Visits — United States, May–September 2023

[4] The U.S. Environmental Protection Agency defines a heat wave as two or more consecutive days when the daily minimum temperature exceeds the 85th percentile of historical July and August temperatures. Potential heat wave exposure is expressed as the total number of "health-threatening heat days" in a year. The 48-day threshold represents the upper end (top 25%) of the historical and future projected health-threatening heat days experienced by Justice40 communities in the United States.

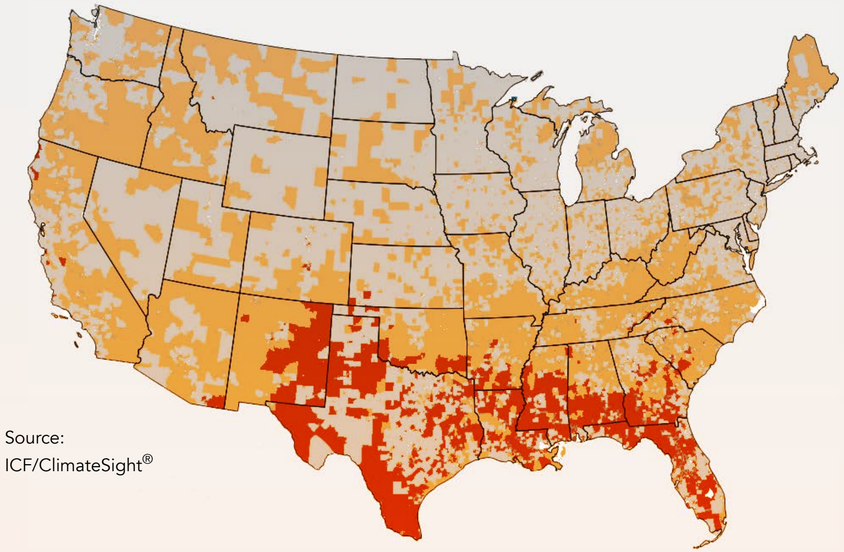
Climate projections in this analysis are powered by ClimateSight, ICF's proprietary climate risk analytics platform. Coupled with ICF's expert consulting, ClimateSight leverages the most advanced climate science, powerful datasets, and Amazon Web Services cloud infrastructure to quickly identify key climate hazard scenarios and actionable insights across industries.

Looking ahead to 2050 in Figure 3, the overburdened communities potentially exposed to this high number of health-threatening heat days expand across Texas and much of the lower Southeast. Under a high emissions scenario, overburdened communities across Texas, Louisiana, Oklahoma, Arizona, California, Florida, and even patches of the Northwest could all expect to regularly experience health-threatening heat waves.

Figure 3: 2050 Justice40 communities potentially exposed to 48+ health-threatening heat days in 2050

Moderate emissions scenario

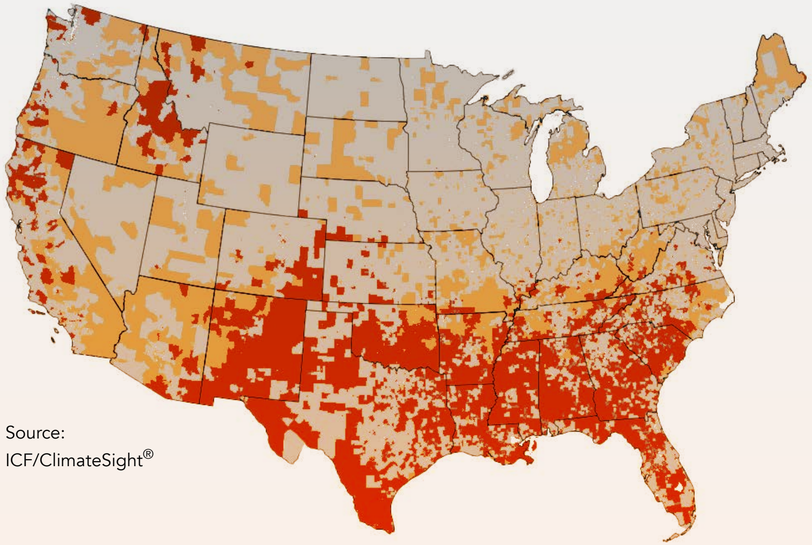
(SSP2–4.5)



Source:
ICF/ClimateSight®

High emissions scenario

(SSP5–8.5)



Source:
ICF/ClimateSight®

Not Justice40 communities

Justice40 communities not exposed

Justice40 communities exposed

Of course, extreme heat conditions are not limited to the geographic areas identified in Figure 3. “Heat dome” events that elevate heat conditions to dangerous levels for several days at a time have already taken place in locations such as Northern California and the Pacific Northwest, where temperate conditions are the norm. The focus of Figure 3 is instead on those Justice40 communities projected to experience a high number of health-threatening heat days.

Heat and human health at the local level

The implications of this analysis can also be viewed at a local level, where actions to reduce the impacts of extreme heat are often implemented. For example, the Jacksonville, Florida, metropolitan area is projected to potentially be exposed to a high number of health-threatening heat days in both moderate and high emissions scenarios. As such, the area serves as an apt case study for how people in Justice40 communities could potentially be exposed to increased extreme heat in the future.

Of the 1.36 million people in the Jacksonville area, 24% live in Justice40 communities.

Historically, residents in the Jacksonville area experience relatively few health-threatening heat days each year. However, by 2050 most marginalized communities in the area should expect to see 60 to 70 health-threatening heat days per year in a moderate emissions scenario, which rises to 70-plus days for most of the region in a high emissions scenario.

On the following page, Figure 5 illustrates the breakdown of health-threatening heat day exposure for Jacksonville's Justice40 communities. More than 288,000 people living in those areas will face at least 48 health-threatening heat wave days per year by 2050 in the moderate emissions scenario. That means about 9 out of 10 people in the area's overburdened communities are expected to face at least 48 heat wave days by 2050, compared to 8 out of 10 of the total population facing that level of health-threatening heat days. This is but one example of how extreme heat driven by climate change exacerbates existing inequities.

Figure 4: 2050 Justice40 communities potentially exposed to 48+ health-threatening heat days in Jacksonville, Florida

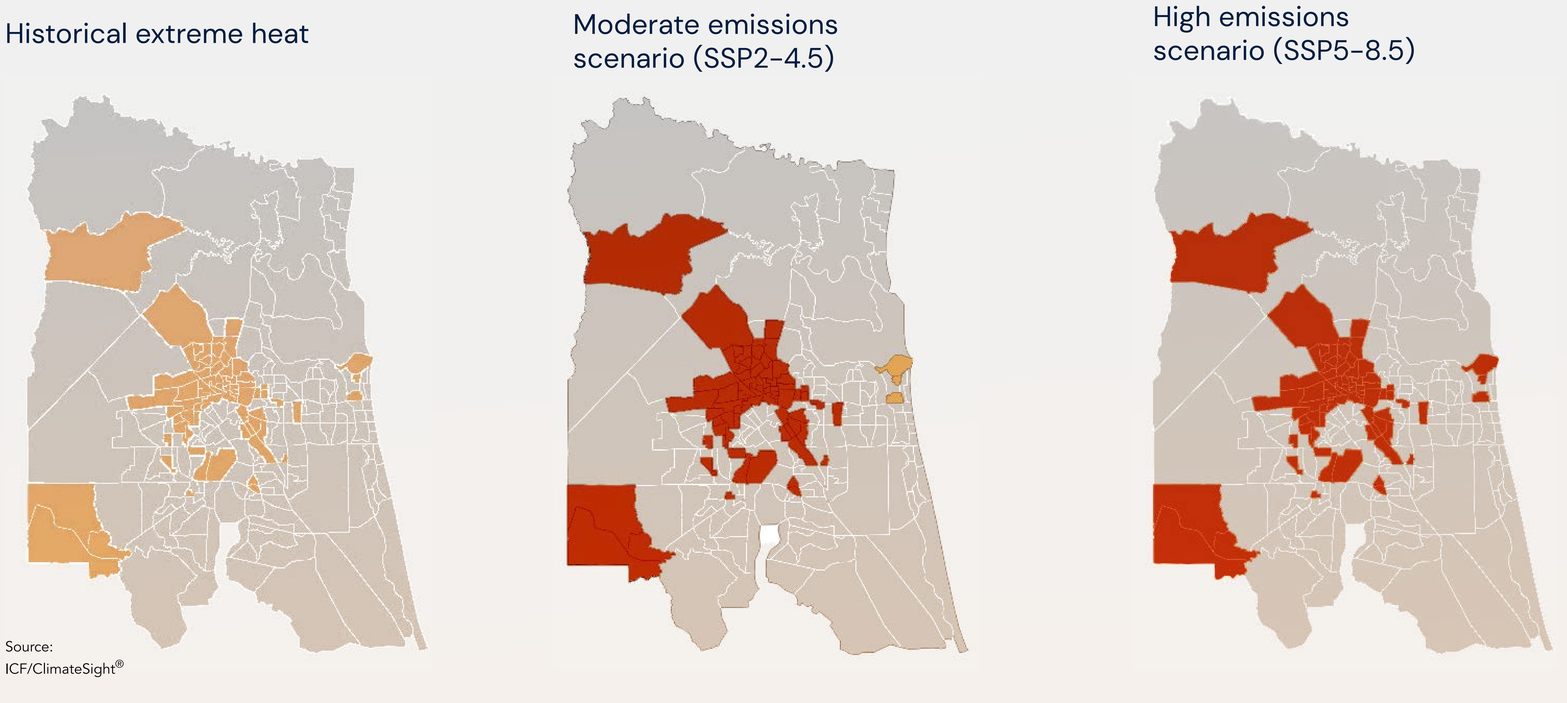
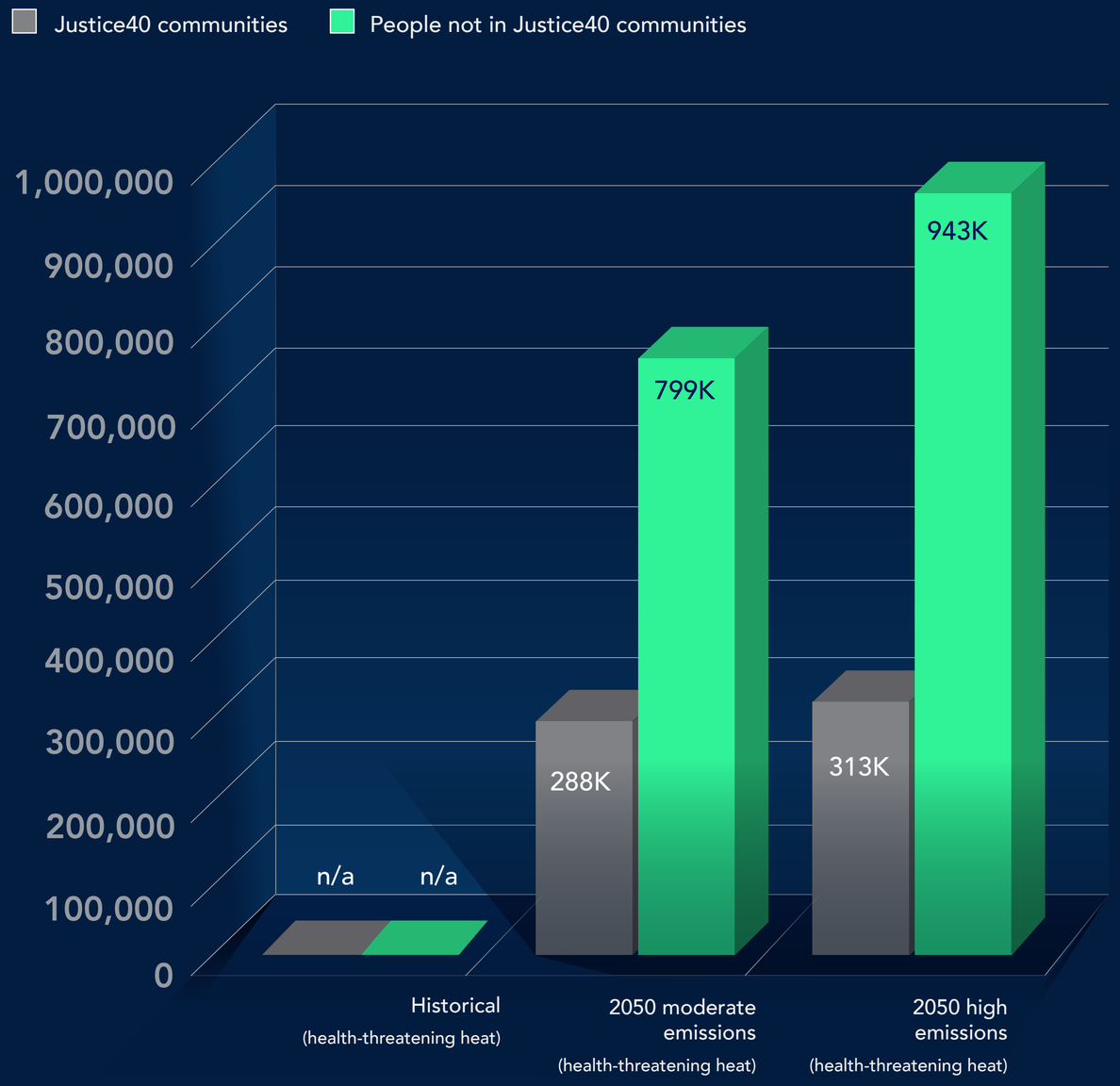


Figure 5: Jacksonville, Florida population exposed to 48+ health-threatening heat days



Source: ICF/ClimateSight®

Extreme heat and energy insecurity in Justice40 communities

Energy providers—electric utilities in particular—play a vital role in helping Americans limit their potential exposure to extreme heat.

During extreme heat, access to reliable electricity can be a lifeline to air conditioning, medical equipment, cooling centers, and other resources that reduce health risks. For this reason, people use more electricity than normal during heat waves. This increase in demand for electricity during heat waves can threaten the reliability of energy systems, if the demand for electricity exceeds the available supply at any given moment. As heat events become more frequent, more people in more places are installing air conditioners. On average, air conditioning units run more frequently and for longer durations as heat increases. This vicious cycle creates more stress on utility grid infrastructure also being asked to serve growing demand for electricity from manufacturing activity, data centers, and other sources.

Compounding the problem, critical energy infrastructure—from power plants to substations to transmission lines—performs worse and is more likely to fail during heat events. Due to heat, power plants can face limits on cooling water, transformers become less efficient, and transmission wires deliver less energy when power lines sag.

In many parts of the country, the vulnerability of electric distribution increases when the average daily temperature exceeds 86 F, which is a temperature threshold commonly used in planning the capacity of the system.[5] Only a few areas in the U.S. face many of these "energy infrastructure-impacting heat days" each year. Figure 6 shows that, historically, the Southwest and the southern tip of Texas have faced 70 or more energy-impacting heat days per year. Otherwise, only parts of California's Central Valley and the U.S. central plains experienced more than 10 such days per year.

[5] Most substation transformers—critical components of the energy system—are rated for an average daily temperature of 86 F. This report examines projected total annual days during which average daily temperature exceeds 86 F for two or more consecutive days. Nighttime temperatures, which can be overlooked when tracking daily averages and daytime highs, also are vital for transformers to cool before returning to peak performance the following day. See Methodology section for more information.

Figure 6: Historical energy-impacting heat days[6]

Historical extreme heat (energy)

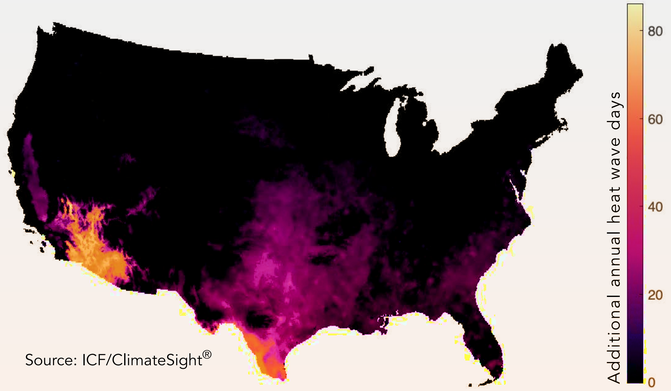
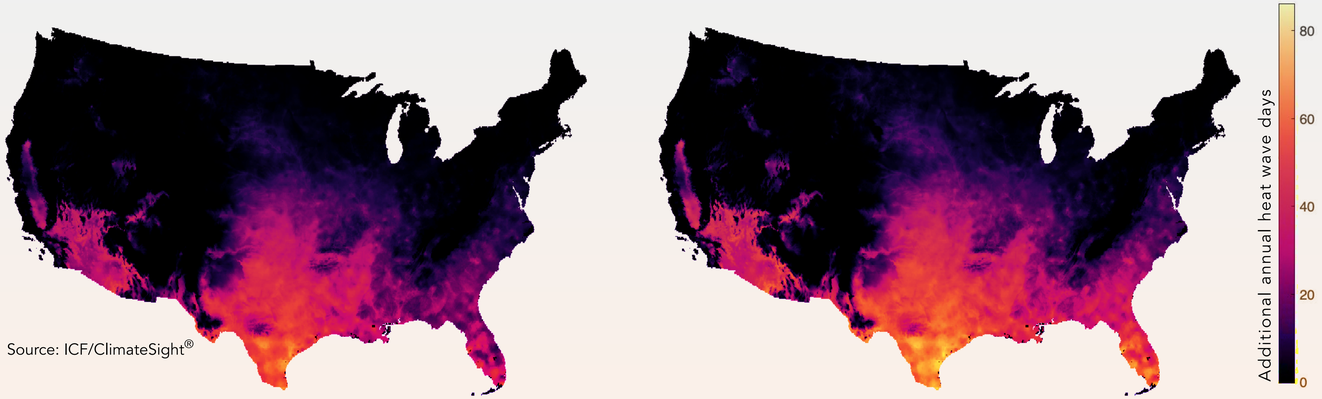


Figure 7: 2050 additional energy-impacting heat days

Moderate emissions scenario (SSP2-4.5)

High emissions scenario (SSP5-8.5)



Fast forward to 2050, and the number of additional energy-impacting heat days is expected to skyrocket in both moderate and high emissions scenarios across broad swaths of the country.

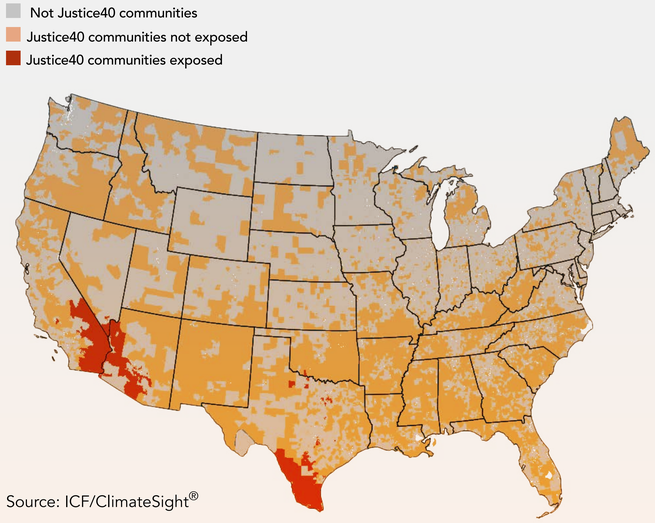
Figure 7 shows that much of the Southeast and Midwest will experience 15 to 30 additional energy-impacting heat days. In the high emissions scenario, most of Texas, the central plains, Louisiana, and the Florida peninsula are expected to experience 50 or more additional energy-impacting heat days. Adding 30 to 50 more of these days in Texas and the Southwest by 2050 means much of the region will experience energy-impacting heat days for a third of the year, on average, every year. Even parts of the Northeast and New England are expected to experience several days per year of energy-impacting heat, which could cause outsized problems considering electric grids in those areas were generally not designed to operate in such extreme heat.

Utilities have traditionally built their systems to meet the test of historical heat exposure. Locations that are expected to transition from experiencing a handful of energy-impacting heat days per year to being exposed to dozens of such days in the future will have to take more drastic action to prepare their systems. They're less likely to be prepared for the changing future, and the cost to get there is going to be higher than places with systems already built to withstand energy-impacting heat days.
When Justice40 communities are in a utility territory exposed to energy-impacting heat, those communities can suffer disproportionate consequences. Power outages lead to increased exposure to the heat, and people in disadvantaged communities are particularly vulnerable to impacts arising from such potential heat exposure.

Air conditioning at home, work, or in community centers is one way people decrease exposure to extreme heat, but a power outage eliminates that option. Overburdened populations have fewer means to adapt to heat. If they lose one strategy, such as air conditioning, they're less likely to have a backup plan available, such as access to transportation to get to an area where they can cool off.

[6]Total number of days classified as heat waves (2+ consecutive days where the daily mean temperature exceeds 86 °F) experienced in a typical year.

Figure 8: Historical Justice40 community exposure to energy-impacting heat

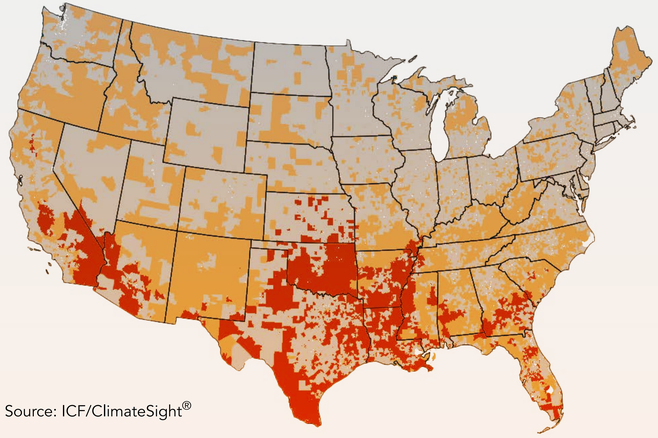


Source: ICF/ClimateSight®

Figure 8 shows that disadvantaged communities historically exposed to at least 24 energy-impacting heat days a year[7] were largely confined to the desert Southwest and southern Texas.

Figure 9: 2050 Justice40 communities exposure to energy-impacting heat

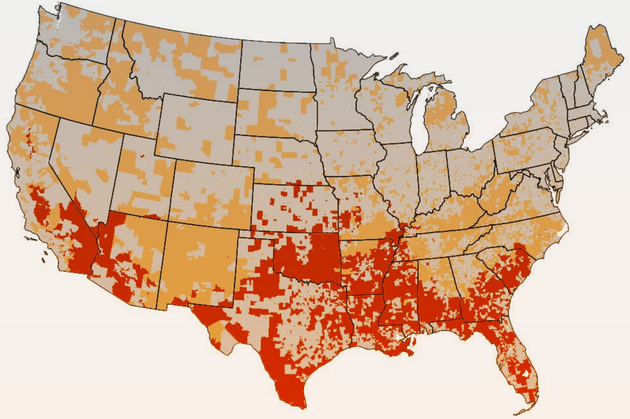
Moderate emissions scenario (SSP2-4.5)



Source: ICF/ClimateSight®

But by 2050, many more overburdened communities in the South, Midwest, and Southwest will potentially be exposed to at least 24 energy-impacting heat days a year in a moderate emissions scenario, as shown in Figure 9.

High emissions scenario (SSP5-8.5)



Under a high-emissions scenario, Justice40 communities stretching across the southern half of the continental United States will have energy systems potentially exposed to this level of energy-impacting heat days.

[7] The 24-day threshold represents the upper end (top 25%) of the historical and future projected annual energy-impacting heat days experienced by Justice40 communities in the United States.

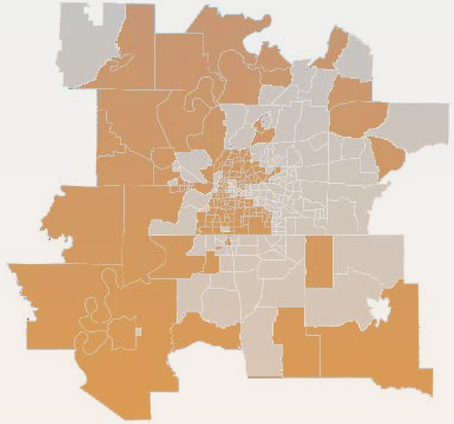
Heat and energy insecurity at the local level

The Memphis, Tennessee, metropolitan area provides a concerning case study on the intersection of potentially energy infrastructure-hampering heat and the overburdened communities that could face outsized exposure from electric service disruptions.

Of the 1.32 million people in the Memphis area, 43% live in Justice40 communities, as seen in Figure 10. The urban heart of Memphis, the location of many disadvantaged communities, has historically faced around 10 to 15 energy-impacting heat days per year.

However, that hardly registers compared to the energy-impacting heat the energy infrastructure in overburdened Memphis-area communities will face by 2050 in either a moderate or high emissions scenario. Most of those communities will face 30 to 40 additional energy-impacting heat days by 2050 in the moderate scenario and 40 to 50 additional days in the high scenario.

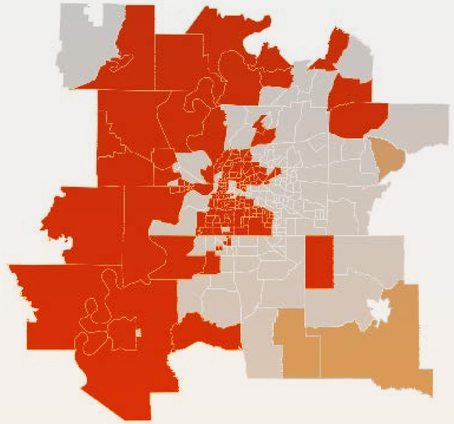
Figure 10: Historical Justice40 community exposure to energy-impacting heat days in Memphis, Tennessee



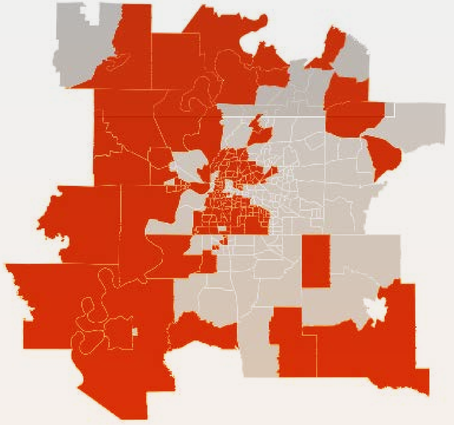
Source: ICF/ClimateSight®

Figure 11: 2050 Justice40 communities exposure to energy-impacting heat days in Memphis, Tennessee

Moderate emissions scenario (SSP2–4.5)



High emissions scenario (SSP5–8.5)



Source: ICF/ClimateSight®

Without adequate planning and action to adapt energy systems, the risk of being unprepared and suffering grid reliability issues will grow in these areas in the future. If 2050 arrives in Memphis with the grid infrastructure serving Memphis today, the system could have trouble serving demand and could face reliability issues. The 43% of the Memphis area population in Justice40 communities—which are more likely to include homebound seniors, people with asthma, schools without air conditioning, and people who work outdoors or go outdoors to use public transit — would feel an outsized impact of system failures.

Strategies to advance extreme heat adaptation in Justice40 communities

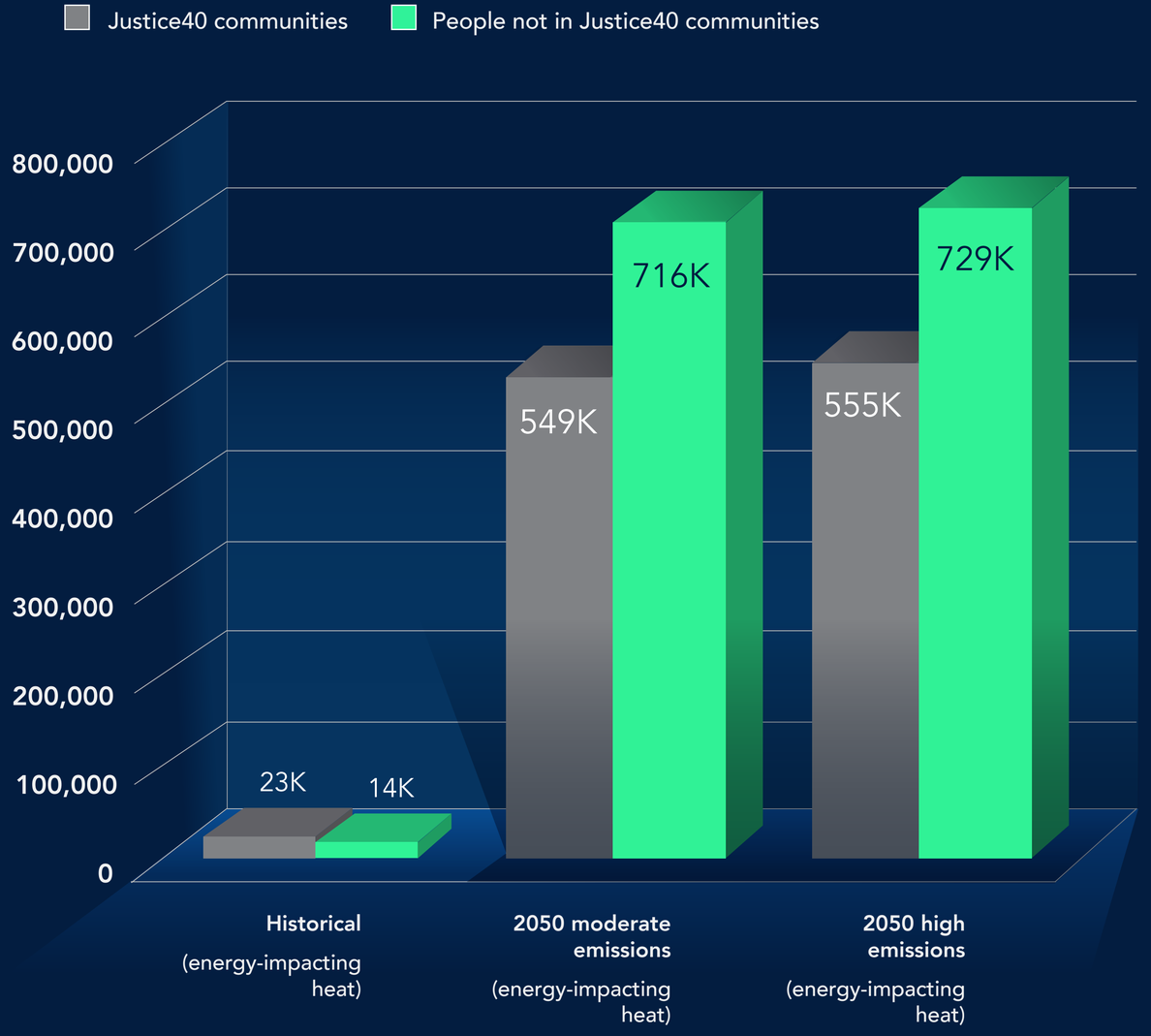
Helping people in overburdened communities adapt to the rise of extreme heat has become a policy and planning priority for the federal government. The federal government is deploying hundreds of billions of dollars in new investment incentives and funding resources through the BIL and IRA. The Justice40 Initiative requires 40% of the overall benefits of climate investments go to Justice40 communities.

While the federal government will directly manage some of the new funding, a large portion of the incentives will be managed by states, local governments, utilities, and nonprofits in the form of federal grants, rebates, vouchers, tax breaks, and other incentives.

ICF identified five promising approaches planners are using today that climate stakeholders, including Justice40 community leaders, utilities, and other organizations, can consider adopting as they leverage federal funding to adapt to the rise in extreme heat over the coming decades.

1. **Identify location- and population-specific climate risks:** Planning efforts should prioritize identifying populations at elevated risk through analyses that would vary by region and might consider income, race and ethnicity, age, overall health factors, and more. Each community should seek to understand who is disadvantaged in their geographic area.

Figure 12: Memphis, Tennessee population exposed to energy-impacting heat



Source: ICF/ClimateSight®

This could call for a partnership with the local and state public health departments who have detailed relevant data. The analysis in this report offers a national view of extreme heat exposure to disadvantaged communities. Planners will need to leverage climate risk analytics platforms and the National Heat Health Information System to get a better understanding of how extreme heat exposure will evolve at the local level in the coming decades.

The federal government has been considering a National Climate Service —similar to the National Weather Service— that would offer projections for extreme heat and other climate-related risks. Such a service could go a long way to identifying location-specific extreme heat risks for overburdened communities.

2. **Engage stakeholders:** Authentically engaging communities that have been historically marginalized is an important step in understanding their specific heat-related challenges and potential adaptation strategies. Sharing decision-making power with communities and ensuring community members have real agency improves program outcomes.

   For example, public buildings can serve as cooling centers during extreme heat events. However, these cooling centers must be in places that people find comfortable and want to go. It may be better to put them in a trusted gathering place like a church or recreation center instead of an unfamiliar government building, but finding out for sure requires asking the community and ensuring the choice is guided by its voice. It requires active listening by planners who look like, live like, and relate to the community to best ensure community members' voices are respected and heard. With community input, planners can develop successful adaptation approaches that would otherwise fail.

   Ways to engage communities that have been historically disadvantaged include:

   - Leading with planners who have authentic lived and learned experience engaging the communities.
   - Gathering information via surveys, community meetings, or focus groups.
   - Forming formal advisory groups with community residents.
   - Providing seats on decision-making bodies to community residents.
   - Leveraging community health workers to gather information or actively involve community members.

3. **Develop a plan:** Including heat strategies to help disadvantaged communities in state and local planning efforts, such as hazard mitigation plans, can help those plans meet Justice40 criteria and, therefore, increase their competitiveness for securing federal funding.

   Best practices in mitigation and adaptation plans that have already been developed:

   - Consider tree cover and ensure communities have shade.
   - Promote buildings with passive cooling.
   - Implement "buddy systems" for older adults living alone or people with disabilities.
   - Build more inclusive heat-related health education and heat alert systems that account for the needs of those in disadvantaged communities, such as those without internet or cell phone service and those who don't speak English.
   - Recognize the potential cooling benefits of community resources in overburdened communities, such as libraries, pools, and other public recreational centers.

4. **Leverage multiple funding sources:** There are many funding streams available to implement climate plans. Climate stakeholders can leverage multiple programs to achieve a single goal or multiple goals simultaneously.

   This includes existing federal programs, such as the U.S. Federal Emergency Management Agency's Building Resilient Infrastructure and Communities (BRIC) program and new programs through the IRA and BIL. Additionally, the U.S. Centers for Disease Control and Prevention's Building Resilience Against Climate Effects (BRACE) program provides planning grants for sectors including public health, emergency preparedness, energy, elder affairs, businesses, and community-based organizations.

5. **Prioritize disadvantaged communities in program implementation:** Addressing heat risk in marginalized communities will require implementing programs that specifically target those communities and ensure they are priorities in city- and state-wide programs. Programs and project implementations that account for overburdened community needs are more likely to factor in the disproportionate health and energy risks arising from greater exposure to extreme heat.

Disadvantaged communities face more exposure to extreme heat, are more sensitive and vulnerable to rising heat, and have lower adaptive capacity and less access to measures that could protect them from extreme heat. That equation means people living in overburdened communities will disproportionately suffer the negative health and energy insecurity risks sparked by extreme heat. As climate change causes extreme heat to spread and become more frequent, the health and energy insecurity impacts faced by vulnerable populations will grow, too.

It's a thorny, multifaceted challenge that requires robust climate risk assessments, adaptation planning, and program implementation. Fortunately, stakeholders can access the funding and expertise needed to act now.

Appendix: Methodology, assumptions, and limitations

This report leverages ICF ClimateSight to provide national and local scenarios of future extreme heat in the contiguous United States.

Extreme heat projections use downscaled Coupled Model Intercomparison Project Phase 6 (CMIP6) Localized Constructed Analogs Version 2 (LOCA2) datasets (Pierce et al., 2023).[9]

The scenario modeling holds many population and demographic variables constant in its projections. In other words, today's population is held constant to focus on understanding the challenges posed by the changing climate.

The data and analysis presented in this report can illustrate climate risk challenges and opportunities, but it does not replace custom risk assessments. Custom risk assessments at the local level are critical to identify and plan for important differences between community exposure, sensitivity, and adaptive capacity.

The health-threatening heat modeling in this report uses a heat wave definition initially proposed by the U.S. Environmental Protection Agency[10]: A heat wave is two or more consecutive days when the daily minimum temperature exceeds the 85th percentile of historical July and August temperatures.

Potential heat wave exposure is expressed as the total number of heat wave days in a year (i.e., summing all days included in a heat wave). If a given year had one two-day heat wave, one three-day heat wave, and two four-day heat waves, that year would have 13 heat wave days. Given that regional populations are already accustomed and generally adapted to the historical temperatures in their area, we assume that heat waves relative to historical summer temperatures are the most relevant to human health rather than defining a heat wave relative to a baseline temperature (e.g., 95 degrees).

The energy-impacting heat modeling in this report uses historical and projected multiday (two or more) heat events during which the daily average temperature exceeds 86 F. The 86 F temperature point is the Institute of Electrical and Electronics Engineers standard for rating power transformers and is a standard used by many U.S. utilities. While average daily temperatures exceeding 86 F for 48 hours or more does not guarantee energy infrastructure will be negatively impacted, it is a relevant heat metric to assess the point at which heat stress on infrastructure could lead to increased reliability challenges.

[9] Future Increases in North American Extreme Precipitation in CMIP6 Downscaled with LOCA and LOCA version 2 for North America (ca. Jan 2023).
[10] Climate Change Indicators: Heat Waves | US EPA.

Authors

Judsen Bruzgul
Vice President, Climate Resilience
judsen.bruzgul@icf.com

Mason Fried
Director, Climate Science
mason.fried@icf.com

Durban Keeler
Senior Climate Resilience Specialist
durban.keeler@icf.com

Adam Parris
Director, Climate Resilience
adam.parris@icf.com

Raquel Silva
Health Scientist, Lead
raquel.silva@icf.com

ICF CLIMATE center

twitter.com/ICF
linkedin.com/company/icf-international
facebook.com/ThisIsICF
#thisisicf

icf.com/climate

The ICF Climate Center offers compelling research and unique insights that help organizations establish clear, practical pathways forward through the combination of climate science and predictive analytics.

The Center builds upon the work of 2,000+ climate, energy, and environment experts worldwide—making us one of the world's largest science-based climate consultancies. ICF works with business, government, and nonprofit organizations to design and implement programs and policies that drive low-carbon transitions and build resilience against the effects of climate change.