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How scientists are helping cities adapt to extreme heat

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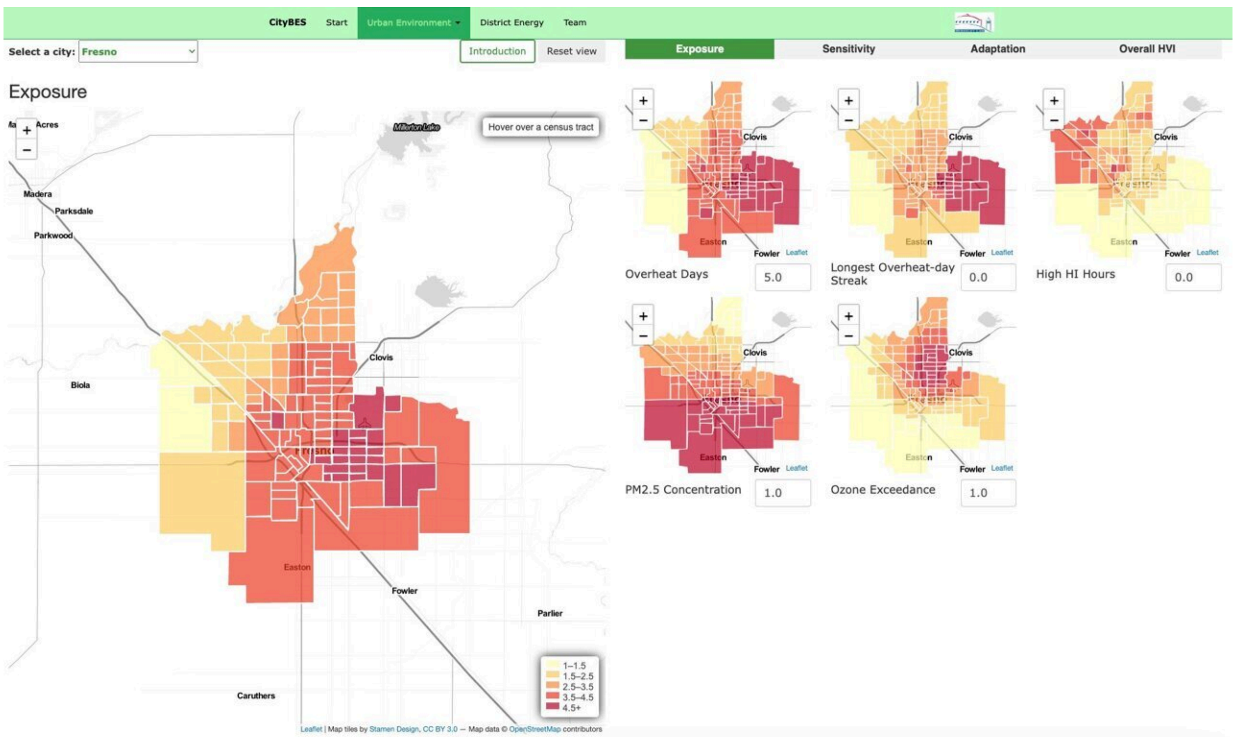

The Heat Vulnerability Index Tool maps a community's exposure to heat, sensitivity to heat, and capacity to adapt to heat. Credit: Tianzhen Hong/Berkeley Lab

Since early July, the Earth has sweltered under record-breaking heat. In the United States, from California and the Desert Southwest to Texas and Florida, a long-lasting heat wave in the triple digits has broken dozens of heat records—and counting.

To mitigate the risks of living in extreme heat, scientists at the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) are working with city, state, and federal agencies as well as nonprofits to develop policy recommendations and toolkits that will help disadvantaged communities adapt and thrive in a warming climate.

"Our primary concerns are human health, safety, and comfort. Extreme heat can exacerbate underlying health conditions and can be especially stressful for the elderly and the very young," said Max Wei, a scientist in Berkeley Lab's Energy Technologies Area. "Those who live in older homes or in disadvantaged areas are not so well-equipped to cope with extreme heat."

Extreme heat is dangerous and is one of the leading causes of weather-related deaths. Where you live shapes how extreme that heat can become.

Studies have shown that in the United States, extreme heat is worse for residents of low-income neighborhoods and communities of color. The combination of more buildings, less vegetation, and higher population density in cities contributes to warmer temperatures than in surrounding suburban or rural areas.

Low-income communities of color also bear a larger burden from extreme heat because they tend to live in older buildings that lack adequate insulation and cooling. In addition, low-income households may be unable to afford the cost of using air conditioning during peak demand. Low-income communities also experience higher rates of underlying diseases, including asthma and heart disease, that are risk factors for heat-related illnesses.

Here are six ways that our scientists are working to ensure resilient cooling for all in a warming world. Their approach could benefit vulnerable communities across the United States—and the world.

Helping central California cope with extreme heat

Wei recently led Cal-THRIVES, a multiyear project to help disadvantaged communities in Fresno, California, adapt to the extreme heat brought on by climate change.

In the neighborhoods studied, one in six households had no access to air conditioning, and 70% of residents surveyed said that indoor temperatures were often uncomfortably high during summer.

The team found that during heat waves, especially during coincident power outages, cool roofs and cool walls could boost the thermal livability of older (pre-1980) single-story Fresno homes by 10% and 16%, respectively.

They also found that the use of solar-reflective window films, blackout shades (such as opaque, white-colored shades that reflect incoming sunlight), ceiling fans, and window box fans—particularly when outdoor air is cooler than indoor air—could significantly improve the thermal livability of older homes.

The researchers made several recommendations to help disadvantaged communities, including the establishment of minimum design standards for residential cooling, implementing new policies to strengthen cool wall and cool roof standards, creating a program to provide AC for households that need it, and monitoring the health and environmental effectiveness of broadly implemented residential cooling.

Free community cooling tips and fact sheets, based on the Cal-

THRIVES study, are available for free in English and Spanish.

Pinpointing where communities are most vulnerable to extreme heat

To measure how individual buildings and entire neighborhoods in disadvantaged communities would benefit from residential cooling, the Cal-THRIVES Fresno team used free modeling tools developed by Berkeley Lab:

- A Heat Vulnerability Index Tool, which was developed by Berkeley Lab scientist Tianzhen Hong's team, maps a community's exposure to heat, sensitivity to heat, and capacity to adapt to heat.
- CityBES, another online tool developed by Hong and team, can help communities determine the best strategies for energy conservation and residential cooling, such as cool roofs, cool walls, and solar control window films during power outages, heat waves, or chronic summer heat.

Wei and team recently started a new project to measure extreme heat resilience in milder coastal climates such as in Oakland, California.

Building heat resilience in Atlanta, Boston, and throughout the world

Ronnen Levinson, a scientist heading the Heat Island Group in Berkeley Lab's Energy Technologies Area, is leading a project to help underserved communities in heat-vulnerable areas of Atlanta and Boston. The project is part of International Energy Administration Annex 80 (Resilient Cooling of Buildings), a collaboration of more than 15 countries promoting passive and low-energy cooling solutions for comfort, safety, energy efficiency, and decarbonization. The Atlanta, Boston, and international research projects relied on input from communities, building audits, and computer simulations.

The Annex 80 collaboration is exploring 14 different cooling strategies for buildings in a variety of climates around the world. These strategies include exterior window shades, ceiling fans, and cool surfaces, among others. The team has established a set of 37 policy recommendations, including new building codes for residential cooling, and workforce training on the benefits and installation of cool roofs and cool walls.

Standardizing cool roofs and cool walls for all

Levinson is also leading the United States Cool Surfaces Deployment Project. That work aims to accelerate the installation of cool roofs and cool walls around the United States.

Over half of the buildings in the U.S. were constructed before 1980. These older buildings predate modern standards for roof and wall insulation. "Disadvantaged communities are places where you're especially likely to find older buildings that are poorly insulated," Levinson said. "Cool roofs and cool walls can reduce a home's need to run air conditioning by as much as 10 to 40%." Cool roofs and cool walls also mitigate urban heat islands, reduce smog, and help keep homes without AC cooler and safer, he added.

Levinson and team recently convened with cool-surface experts from the roof and wall industry along with representatives from nongovernmental organizations, utilities, and government agencies. They brainstormed ways to dramatically speed up the deployment of cool roofs and cool walls across the U.S., with a focus on helping disadvantaged communities. From that meeting, they devised a plan for 19 "transformative ideas."

These include a "Keep Your Cool" educational campaign for the general public and building professionals, and high-profile demonstrations that bring cool surfaces to disadvantaged vulnerable communities.

"It's a no-brainer to implement cool surfaces, but action is needed to make it happen soon enough to help," said Levinson.

Helping the Pacific Northwest weather extreme heat

Record-breaking temperatures are also creating dangerous conditions in the Pacific Northwest of the United States. Berkeley Lab scientists Miguel Heleno and Tianzhen Hong are working with Portland General Electric to protect vulnerable populations during heat waves.

The Berkeley Lab team is developing new computer models that will inform city and utilities planning by forecasting electric load during current and future heat waves, and estimating where building occupants may be at risk of overheating during power outages.

Developing new codes for energy resilience in a warming world

When you're buying a newly built home in most states of the U.S., the applicable building energy code guarantees it meets the state's minimum standard for energy efficiency.

Now, thanks to the Tri-Lab Resilience Project, there could one day be a building energy code that measures a building's resilience or "passive survivability" against extreme heat during power outages. The project is a collaboration between Berkeley Lab, Pacific Northwest National Laboratory, and the National Renewable Energy Laboratory.

"Our work will inform a new building energy code that will benefit public health during extreme heat," said Tianzhen Hong, project lead and Urban Systems Group Lead in Berkeley Lab's Energy Technologies Area. "There is urgency to this because not every household is equipped with air conditioning or can afford it."

The tri-lab project team developed a standardized methodology to evaluate how new and existing single- and multi-family residential buildings in six U.S. cities representing different climates (Portland, Los Angeles, Minneapolis, Houston, Atlanta, and Detroit) would benefit from improvements in passive survivability if the buildings were upgraded to meet the more stringent requirements of current building energy codes.

Provided by Lawrence Berkeley National Laboratory