It's Getting Hot in Here

A Roadmap for Stakeholder Involvement in Urban Heat Island Mitigation

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Abstract

Heat is the leading weather-related cause of death in the US (Environmental Protection Agency [EPA], 2021). According to the City of St. Louis Office of Sustainability (2018), cities are experiencing more extreme heat days due to climate change and "urban areas are more susceptible to the effects of extreme heat due to the large numbers of people living in physical infrastructures that intensify the effects of extreme heat." The higher temperatures felt in urban environments relative to their surrounding areas is called the urban heat island (UHI) effect. To combat this, UHI mitigation has become a priority for governments, utilities, city residents, city climate officers as well as health and energy efficiency advocates across the country.
The UHI effect places strain on the electric grid as it increases building cooling loads, often at times of peak energy demand, and intensifies the need for nighttime cooling. This drives up emissions and energy bills (Climate Central, 2021). The issue is also one of environmental justice. For instance, *National Geographic* found that Chicago's declining tree canopy is concentrated in regions of historical racism and poverty (Rivera, 2021). Moreover, these communities face disproportionately greater energy burden and air pollution, together worsened by the UHI effect (EPA, n.d.a).

This paper aims to inform decisionmakers and utilities on equitable heat mitigation strategies in long-range planning processes and energy efficiency programs. Through an extensive literature review, this research provides an outlook on the issue of UHI, including quantitative and qualitative impacts on the grid, building energy use, emissions, energy burden and health. This paper uses interviews with cities, utilities and advocates to compile current efforts and approaches to engage impacted communities and develop initiatives to address the UHI effect. This catalog of ongoing efforts can help decisionmakers identify remaining gaps and guide regulators and utilities toward key areas of support and crucial investments.

Introduction

Due to climate change, cities are experiencing more extreme heat events, defined as at least two to three days of high heat and humidity with temperatures above 90°F (Climate Central, 2022, para. 1; U.S. Department of Homeland Security, 2022). Urban areas are now seeing an annual average of six extreme heat events per year compared to two during the 1960s (EPA, 2022a). The urban heat island (UHI) effect amplifies the felt effects of extreme heat. UHI refers to the phenomenon that urban areas tend to be significantly hotter than their surrounding rural counterparts. Cities on average tend to be 1-7°F hotter during the day compared to their surrounding areas (EPA, 2022b). As measured in St. Louis and the Kansas City metro areas, extreme cases have a rural and city temperature difference of 17°F and 13°F, respectively (City of St. Louis Office of Sustainability, 2018; Sherry, 2021). Cities absorb and radiate heat significantly more than surrounding non-urbanized areas due to large concentrations of heat-absorbing materials such as concrete and asphalt combined with a lack of green space. With over 80% of the U.S. now living in urban areas, more Americans than ever are experiencing extreme heat (National Integrated Heat Health Information System [NIHHIS], n.d.). Thus, UHI mitigation has become a priority for stakeholders across the country.

In addition to the average difference in temperatures between cities as a whole and non-urbanized areas, certain parts *within* cities experience differences in temperature as extreme heat disproportionately affects communities of color as well as areas of historic disinvestment (Anderson & McMinn, 2019). Studies have found that lower-income areas can be as much as 7°F hotter during summer months in comparison to areas of higher income within the same city (Shivaram, 2021). This compounds the existing disparity between urban and non-urban areas and is a cause for concern.

To combat the negative effects of UHI, stakeholders across the Midwest have begun to implement various heat mitigation strategies to lower temperatures and address the health impacts of UHI. As climate change increases the intensity, frequency and duration of extreme heat events, this will only be a growing problem. This paper details the various efforts and best practices used to mitigate UHI and its effects and offers recommendations for Midwestern utilities and stakeholders to consider.

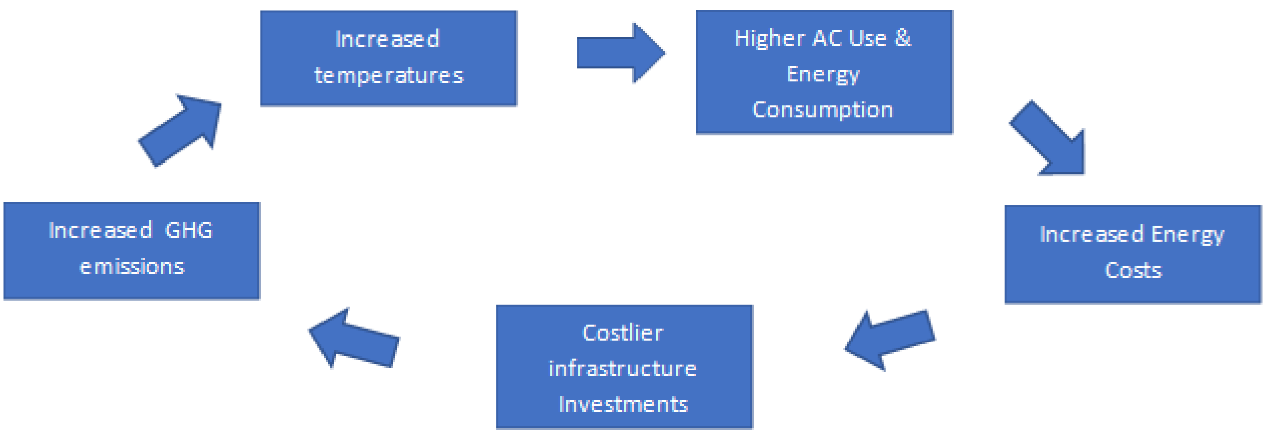
Ricochet Effects of Extreme Heat

As the leading weather-related cause of death in the United States, heat can contribute to deaths from heart attacks, strokes and other forms of cardiovascular disease (EPA, 2021). Heat-related illnesses, such as heat exhaustion or heat stroke, happen when the body is not able to properly cool itself. While the body normally cools itself by sweating, this might not be enough during extreme heat. In these cases, a person's body temperature rises faster than it can cool itself down, potentially causing "damage to the brain and other vital organs" (Centers for Disease Control and Prevention [CDC], 2017). Further, heat stress causes loss of salt and water in sweat, causing hemoconcentration, which in turn causes increases in coronary and cerebral thrombosis. Other deaths in heat waves are likely due to preexisting cardiac conditions which make it harder to meet the need for increased cutaneous blood flow in the heat (Keatinge, 2003).

As temperatures rise, so does the need for air conditioning, driving up energy consumption which puts strain on the grid and drives up greenhouse gas emissions (GHG) which further increases temperatures. As demonstrated in Figure 1, this cyclic phenomenon is known as the positive feedback loop of UHI. Increased energy consumption also results in increased energy costs which may lead to higher energy burdens[1] for customers in certain income levels. According to the EPA (n.d.b, para. 3), peak energy demand increases by 1.5-2% for every 1°F increase in summertime temperatures. Another study found that UHI causes a 1-9% increase in cooling demand for every 2°F increase in temperature (n.d.c para. 1). This is directly felt on the community level, but also contributes to overall increases in future demand and exacerbates strain on the electric grid. To deliver safe, reliable and affordable power in coming years, utilities must adequately consider the source of this strain. Without taking mitigation measures, utilities will face substantial infrastructure investments to meet the need for increased generation, the cost of which will be likely passed through to consumers, jeopardizing affordability. Valuing extreme heat mitigation measures and reducing the UHI effect today is therefore in the interest of utilities and stakeholders, as doing so would ultimately help lower costs for both.

Figure 1

The positive feedback loop of UHI



Note. Increased temperatures caused by UHI lead to higher air conditioning use, energy consumption and energy costs. This increased strain on the electric grid will force utilities to make costlier infrastructure investments to meet the demand for increased generation. Higher energy consumption will lead to increased GHG emissions.

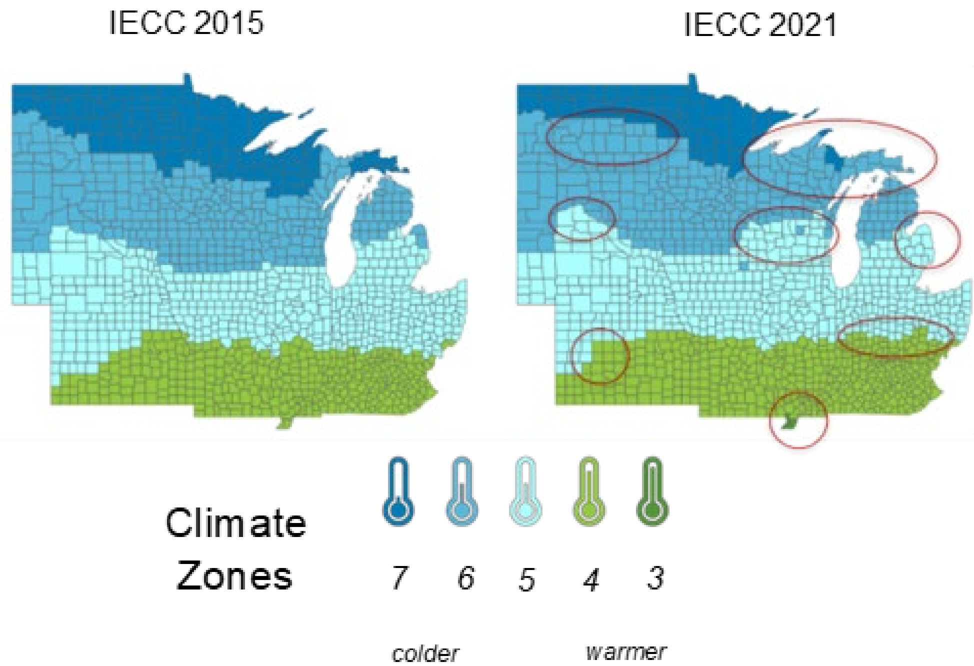
In the communities where UHI impacts are greatest, resources to escape the extreme heat and its associated higher costs are often limited. Residents in underserved communities may not be able to afford cooling systems in their homes and often have significantly lower tree coverage than those in high-income neighborhoods. This further contributes to the UHI effect and reduces residents' ability to find relief under shade (McDonald, 2021). For example, Chicago neighborhoods on the south and west sides, areas of historic redlining and disinvestment, see the lowest tree coverage in the city (Rivera, 2021).

Heat is Here to Stay

Global temperatures have been steadily increasing since the Industrial Revolution and are projected to increase by about 1.5°C (2.7°F) by 2050 (Wisconsin Department of Natural Resources, n.d.). This is observed in the Midwest with documented temperature increases within the last six years. According to the International Energy Conservation Code (IECC), and as portrayed in Figure 2, 176 Midwest counties shifted to warmer climate zones between the 2015 IECC and the 2021 IECC. Of note, some of these changes cover highly populated, metropolitan areas such as Milwaukee, Madison, Cincinnati and Dayton.

Figure 2

IECC Climate zones from 2015 and 2021



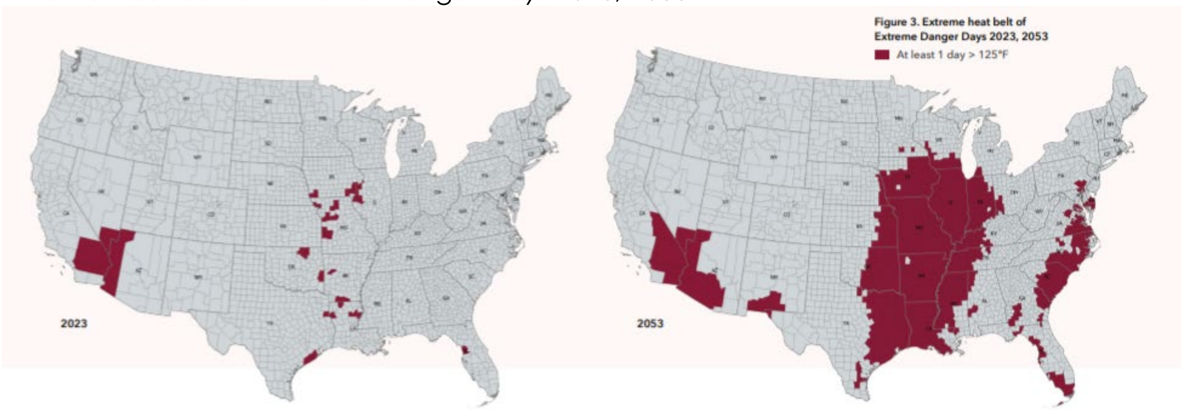
Note. 2015 IECC & 2021 IECC Climate Zone maps generated by MEEA showing 176 counties shifting to warmer climate zones, circled in red.

As the region warms, residents become exposed to increased risks due to extreme heat. The 6th *National Risk Assessment: Hazardous Heat* report generated by the First Street Foundation (2022) notes that nearly 50 counties across the country, home to 8.1 million residents, are expected to experience temperatures over 125°F in 2023. Additionally, that number of counties will likely increase to 1,023 counties likely to see temperatures above 125°F over the next

30 years, as demonstrated by the maps below. A mass cluster of these counties is predicted to form an "Extreme Heat Belt." Stretching from the Louisiana - Texas border up through Iowa, Indiana and Illinois, this belt covers a large portion of the Midwest, including the three major metropolitan areas of St. Louis and Kansas City, Missouri and Chicago, Illinois.

Figure 3

Extreme heat belt of Extreme Danger Days 2023, 2053



Note. Map indicating the extreme heat danger days projected for 2023 and 2053. Reprinted from *The 6th National Risk Assessment: Hazardous Heat report* (p.8), M. Amodeo et al., 2022, The First Street Foundation. Copyright 2022 by The First Street Foundation.

According to the First Street Foundation (2022), many counties in the Midwest will face large increases in "health caution days," which are defined by having a temperature that feels 90°F or more. These days can have significant impacts on energy usage and residents who are vulnerable to extreme heat. Using Energy Information Administration (EIA) data, the First Street Foundation Report predicts that from 2023 to 2053, the average monthly cooling costs for Illinois will increase by almost 20%, from $509 million to $604.7 million (First Street Foundation, 2022, page 22).

Interviews

Guiding Principles

To better understand current UHI mitigation strategies implemented throughout the region, interviews were conducted with the following ten stakeholders. Seven stakeholders are based in the Midwest and three are outside of the region.

- The New School
    - Mike Harrington, Director, Sustainability Engagement at the Tishman Environment and Design Center
- Smart Surfaces Coalition
    - Jack Becce, Project Manager

- Cincinnati
    - Crystal Courtney, Division Manager of Natural Resources, Cincinnati Park Board
    - Molly Robertshaw, Energy Equity Lead at Green Umbrella, City of Cincinnati Office of Environment and Sustainability
- Indianapolis
    - Shannon Norman, Principal Planner Supervisor for the City of Indianapolis Zoning and Codes
    - Morgan Mickelson, Director of the Office of Sustainability
    - Mark Adler, Vice President of Operations, External Programming at Keep Indianapolis Beautiful, Inc
- Chicago
    - Kyra Woods, Policy Advisor for the City of Chicago
    - Bradley Roback, Coordinator of Economic Development for the City of Chicago
- VEIC
    - Sam Dent, IL-TRM contributor

Although discussions varied depending on the interviewee, the following questions were used to guide the interviews.

- What are regional stakeholders doing about UHI?
- What are some best practices within UHI mitigation?
- What funding opportunities are available for UHI mitigation?
- Are utilities involved in this work?
- What other organizations are working on UHI that we should talk to?
- How can utilities best be involved in UHI mitigation?

These interviews along with the literature review inform the findings outlined in this paper.

Overarching Highlights

Through the interviews, it was found that three existing efforts are commonly used throughout the region to better understand and tackle UHI: mapping efforts, community engagement and tree planting. Mapping efforts and community engagement efforts such as temperature surveys, workshops and listening sessions are a common way for stakeholders to understand where UHI impacts are the greatest. These are important efforts as understanding where and who UHI impacts can help decisionmakers decide where to focus mitigation efforts. It is especially crucial that the mapping and community engagement efforts involve those that are directly impacted by UHI as they are often experts of the UHI experience and in most cases, benefit the most from UHI efforts and mitigation. As found through the interviews, mapping and community engagement efforts tend to be reactionary rather than proactive due to the nature of the issue, the stakeholders that are involved and the power and funding streams they have access to.

Another common effort, tree planting, is more proactive in nature but tends to be expensive as Morgan Mickelson, the Director of the Office of Sustainability for the city of Indianapolis, shared (M. Mickelson, personal communication, May 24, 2022). This fact highlights the importance of partnership and the ability to maximize the reach and benefits of given investments. Mickelson shared that Indianapolis is applying for grants with a local university to help understand the benefit of trees native to Indianapolis. Partnerships are also leveraged with non-profit organizations, utilities and different city-run initiatives that are related to zoning. Similar approaches are taken in Cincinnati, with room left for partnerships to grow, namely with utilities helping support data availability and the ever-lasting need for increased funding, Crystal Courtney, Division Manager of Natural Resources at the Cincinnati Park Board elaborated (C. Courtney, personal communication, May 2, 2022).

Many of the interviewees called for UHI mitigation efforts to be holistic and collaborative. Kyra Woods, Policy Advisor for the city of Chicago spoke about UHI elements as they relate to Chicago's Climate Action Plan (K. Woods, personal communication, June 27, 2022). Stakeholders were pulled together from multiple City departments – among them public health, emergency management and a few others to more comprehensively look at who "should" be doing this work. Kyra referred to the necessary holistic element as one for "care and rebuild."

Case Studies

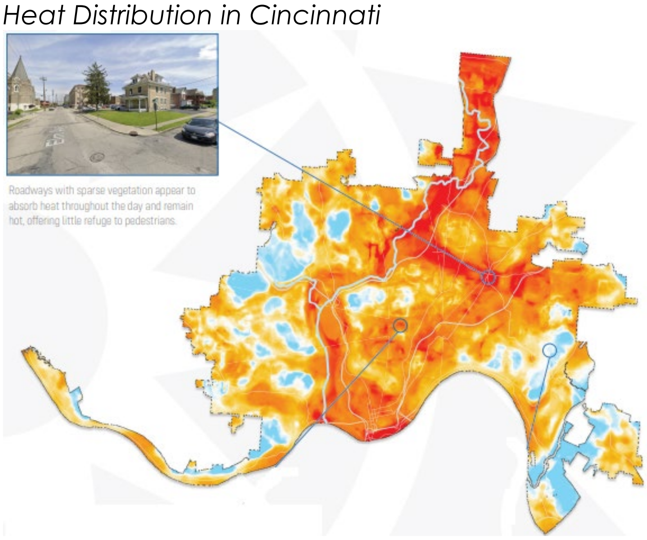
Mapping Heat

As found in the interview portion of this research, before implementing heat mitigation programs of any kind, it is of the utmost importance to understand how extreme heat is affecting the community in focus. This ensures that such efforts are designed for where they are needed most and informed by the impacted residents. Utilities and stakeholders can aid already existing mapping efforts of UHI or pilot their own. A variety of mapping efforts in the region are detailed here.

Since 2017, the National Oceanic and Atmospheric Administration (NOAA) and the National Integrated Heat Health Information System have funded CAPA Heat Watch campaigns in partnership with CAPA (Climate Adaption Planning and Analytics) Strategies to support 60+ communities across the United States in mapping their urban heat islands. The process is a volunteer-based community science field campaign that builds upon local partnerships and engages residents to inform city sustainability plans, public health practices, urban forestry, research projects and other engagement activities. The goal of this campaign is to understand how and where people in the United States are being impacted by extreme heat. Campaign organizers recruit volunteers and prioritize areas experiencing environmental and social justice inequities. These volunteers attach sensors to their cars and drive pre-set routes to capture temperature and humidity data. In addition, volunteers learn about urban heat and share their interest in the project during training sessions.

The final product is a report generated by CAPA Strategies which includes a set of high-resolution air temperature and humidity data as well as a heat index and a detailed analysis of heat distribution throughout the day. Initial observations are also included to provide insight or explanation as to why certain areas are hotter than others. For example, in the final report for Cincinnati, roadways with sparse vegetation are cited as a potential reason for a particular hotspot as noted in Figure 4.

Figure 4
Heat Distribution in Cincinnati



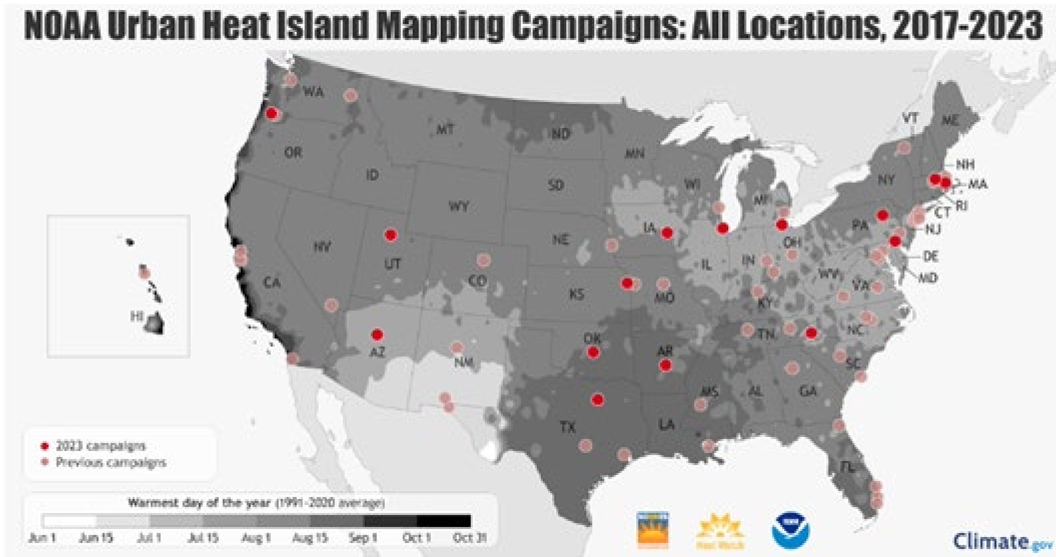
Note. Heat distribution in Cincinnati indicates that roadways contribute to increased temperatures in certain areas. Reprinted from Cincinnati OH Heat Watch Report (p. 8), 2022, CAPA Strategies, LLC. Copyright 2020 by CAPA Strategies.

Campaign communities can use the information in their final reports to work with decisionmakers to implement solutions. Midwest cities that have participated include Detroit, Michigan; Kansas City, Missouri; Richmond, Indiana; Clarksville, Indiana; Columbus, Ohio; Cincinnati, Ohio; Milwaukee, Wisconsin and Omaha, Nebraska, with reports coming for Milwaukee, Wisconsin; Columbus, Ohio and

Omaha, Nebraska. See Figure 5 for a map of all campaign cities from 2017 to 2023.

Figure 5

NOAA Urban Heat Island Mapping Campaigns, 2017 -2023

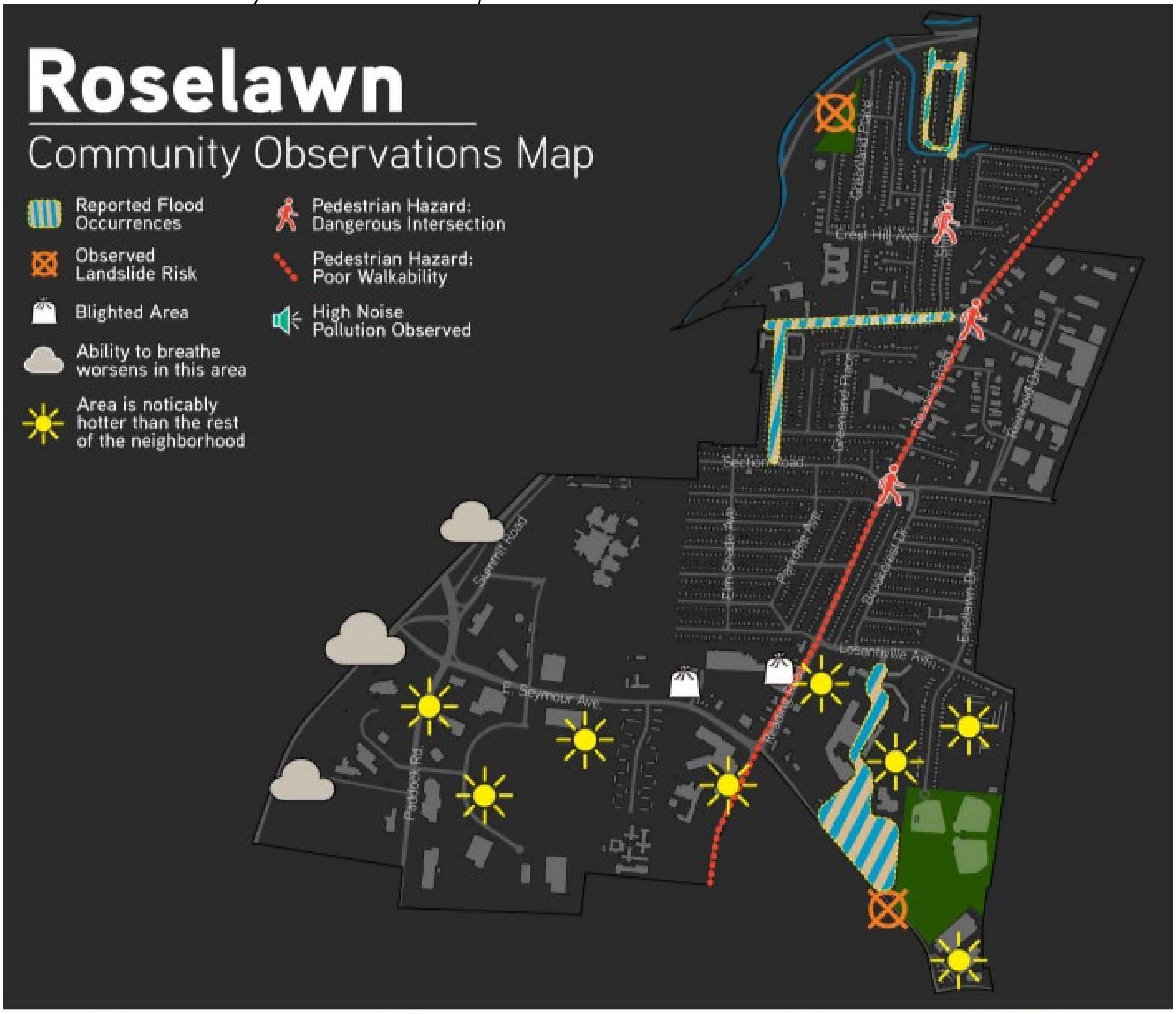


Note. All campaigns cities in the NOAA Urban Heat Island Mapping Campaign project from 2017 – 2023. Reprinted from Mapping Campaigns, by NIHHIS, 2023 (https://www.heat.gov/pages/mapping-campaigns). Copyright by NIHHIS.

Another mapping example is that of the Cincinnati Climate Safe Neighborhoods program. Through Groundwork Ohio River Valley, Cincinnati residents are asked and empowered to report UHI-related observations in their neighborhoods, like worsening ability to breathe or noticeable temperature increases. As seen in Figures 6 and 7, these observations are mapped and shared with the city of Cincinnati Office of Environment and regional groups to inform the creation of community resilience plans, better policies and programs that ensure government plans and implementation strategies are reflective of and address real community needs.

Figure 6

Roselawn Community Observations Map



Note. Community-created Observations Map. Reprinted from Roselawn & Bond Hill, by Groundwork Ohio River Valley, 2021, (https://storymaps.arcgis.com/stories/25ce825c22154ff29cb15a0c0000f633). Copyright 2021 by Groundwork Ohio River Valley.

Figure 7

Roselawn Climate Resilience Plan

Note. Community-created Observations Map. Reprinted from Roselawn & Bond Hill, by Groundwork Ohio River Valley, 2021, (https://storymaps.arcgis.com/stories/25ce825c22154ff29cb15a0c0000f633). Copyright 2021 by Groundwork Ohio River Valley.

In another mapping partnership, the city of Chicago partnered with City Tech Collaborative, Microsoft, Esri and d3i Systems to conduct the Urban Heat Response Study which sought to quantify heat reduction efforts in 26 sites throughout the city. City sustainability officials across the region cited a lack of funds as a common roadblock to quantifying the results of completed mitigation efforts. This partnership, with large private entities removing cost barriers, provides an example for other cities or stakeholders. In this case, they used NASA Landsat data to measure temperature over time, focusing on 26 sites where parks or green spaces were built since 1988. They found that five of the 26 sites had statistically significant reductions in temperatures, proving that green infrastructure is an effective tool for UHI mitigation.

These partnerships are replicable models that utilities and other stakeholders can duplicate to fund and expand existing mapping efforts. Mapping is an important tool for those engaged in this field to understand UHI and its effects. Clearly defining who is most impacted by UHI can help decisionmakers make informed and targeted decisions about mitigation strategies and investments.

Community Engagement

Working with those most vulnerable and most impacted by extreme heat events must be considered in heat mitigation efforts. While not preventative in nature, outreach and support are necessary as UHI effects are already being felt by community members. Utilities and stakeholders can support existing community engagement efforts through their philanthropic endeavors if more direct strategies are implausible.

One example of a community-driven effort is New York City's Be a Buddy (BaB) Program as outlined in the Urban Design Forum report *Turning the Heat* (2020). Started in 2018, BaB focuses on helping at-risk residents and educating the public on climate preparedness. Led by the "Cool Neighborhoods NYC" program, the New York City Department of Health and Mental Hygiene and the Fund for Public Health NY, BaB pairs volunteers with residents who may be at-risk during extreme weather events to strengthen community ties and assist the most vulnerable. In a climate-related emergency like a heat wave, local residents who sign up to be part of the BaB network will be contacted and assisted by local volunteers. The program hopes to better prepare the community for future climate events and build local, social connections. Both of which Mike Harrington of the New School stresses are important for climate preparedness. Harrington points out that many people are not informed of the environmental and health impacts of extreme heat associated with UHI and educating the public can help prepare for the future. With an average of 450 heat-related emergency department visits in New York City every year, BaB aims to reduce this number. In its first two years, BaB served over 1,300 residents with 66 volunteers and 500 engagement events (Davitt, 2022). Harrington also pointed out that BaB seeks to address the added dangers that those who live alone face during an extreme heat event. For example, if a resident were to have a heat stroke, getting necessary medical help would likely be prolonged and potentially cause more severe impacts on that individual's health. The hope is that BaB provides these residents with more frequent checkups and a network they can rely on.

Further, the Indiana University Environmental Resilience Institute's Beat the Heat initiative is another community-centric program that utilizes funding from the Indiana Office of Community and Rural Affairs. In 2021, the town of Clarksville and the city of Richmond were selected as the program's inaugural participants. Each community hired a full-time heat relief coordinator to work with local stakeholders and lead assessments. A long-term plan to protect residents against the negative health impacts of extreme heat was formed through this joint effort. The program timeline consisted of five phases: program launch, community needs assessment, heat relief strategy development, heat relief strategy implementation and continuity planning and program evaluation. As part of the second phase, this partnership connected Clarksville and Richmond to conduct NOAA Heat Watch campaigns. This phase also consisted of collecting community input on how heat impacts the lives of residents. Data collection methods included a public survey, focus groups and public observations. In phase three, heat management strategies that account for both short- and long-term responses to extreme heat were developed. This phase also incorporated more community meetings to garner feedback and other ideas. The fourth phase revolved around implementing strategies and sharing educational materials with community residents about staying safe during extreme heat events. Clarksville and Richmond are both in the final phase of the program and are expected to share continuity plans to ensure the future impact of Beat the Heat in 2023 (Indiana University Environmental Resilience Institute, n.d.).

A third example comes from the Kansas City metro area, home to some of the most severe heat islands in the country. Out of 60 cities analyzed by the NOAA heat mapping campaign, Kansas City had the seventh greatest urban heat island intensity. In response to this, the Metropolitan Energy Center out of Kansas City, Missouri is planning to host a series of community workshops, funded by the EPA's Environmental Justice Small Grants Program. These workshops will bring together neighbors from Argentine, Armourdale and surrounding neighborhoods. Community members will learn about the UHI effect and then talk about their own experiences during high-heat days in the community. They will participate in activities such as heat mapping, brainstorming solutions to combat the effects of heat on their daily lives and determining how these solutions can best be incorporated into new and existing initiatives in their communities. Like the Cincinnati Climate Safe Neighborhoods, these workshops utilize the existing knowledge of community members through lived experiences to formulate strategies that will have support and uptake from impacted residents.

UHI Mitigation Strategies

Mapping UHI and its effects is an important first step to understanding the issue and identifying where and how to take action. After community outreach, engagement and incorporation of feedback, the next step is to implement strategies that will mitigate UHI. Geography and climate also play a key role in determining what kind of UHI mitigation strategy is most effective. Below, Figure 8 outlines two common strategies for tackling UHI: green infrastructure and reflective surfaces. Green infrastructure refers to trees, green roofs, vegetation and any other natural or semi-natural techniques that shade surfaces, deflect radiation and release moisture into the atmosphere through evapotranspiration. Reflective surfaces refer to any surface that increases albedo.[2] The following table outlines a few examples of each.

Figure 8

Common UHI Mitigation Strategies

Green Infrastructure	Reflective Surfaces
Urban tree canopy	Cool roofs
Green roofs and walls	Cool pavements
Rain gardens/planter boxes/green streets and alleys	Cool walls

Note. Two Categories of *common UHI mitigation strategies: Green Infrastructure and Reflective Surfaces.*

Green Infrastructure & Tree Canopy

An example of green infrastructure and one of the most common avenues taken to address the UHI effect is to bolster tree planting efforts to increase canopy cover. Trees play a direct role in UHI mitigation as they provide shade for buildings, deflect radiation from the sun and release moisture into the atmosphere through evapotranspiration (EPA, 2022c). All of which decrease surface and air temperatures, ultimately reducing energy use and improving air quality. Shaded surfaces may be 20-45°F cooler than the peak temperatures of unshaded surfaces (Akbari et al, 1997) and evapotranspiration can help reduce peak summer temperatures by 2-9°F (Huang et al, 1990). According to the EPA, trees and vegetation are most productive when planted intentionally in strategic locations around buildings or as a tool for shading heat-absorbing materials such as asphalt in parking lots (EPA, 2022). In addition to lowering temperatures, trees have also been proven to reduce stress, lower blood pressure and provide health benefits.

Positive results are not seen immediately after tree planting as trees can take around a decade to mature and provide substantial shade and relief. Many cities across the Midwest include tree-planting goals in their climate action plans, sustainability plans or general city planning efforts. In some cases, cities have worked alone to achieve these goals, but in other cases, they have partnered with existing organizations that have a strong reputation for tree planting. For example, the nonprofit Keep Indianapolis Beautiful (KIB) has the goal to increase tree cover in Indianapolis by planting 100,000 large trees with a diameter of at least one foot in strategic locations. This specification is because the trees are often planted in challenging urban conditions. Trees with a one foot or larger diameter have a greater chance of surviving and make an immediate visual impact on the community (KIB, n.d.). Through a partnership with the city, KIB receives funding to maintain the trees planted for three years before returning to the city's care. KIB utilizes a key neighborhood identification tool, utilizing a social vulnerability index, percent canopy coverage and concentration of litter and illegal dumping complaints, to help determine neighborhoods in the city where KIB resources can have the greatest positive impact. However, it is important to note that this tool utilizes older-than-ideal data, specifically, 2013 light detection and ranging (LiDAR) data. A lack of funding prevents newer data collection that would demonstrate a change in canopy coverage, particularly due to trees coming down with development. KIB is interested in funding streams that would enable the collection of updated and newer data.

Another example of a tree-planting partnership is Our Roots Chicago, a city-wide initiative attempting to tackle the city's low tree canopy coverage, which currently stands at 11% (Rivera, 2021). According to their website, Our Roots Chicago is a community-focused effort to plant 75,000 new trees in the city with a goal "to expand the tree canopy in Chicago through an equitable approach to every neighborhood in Chicago leaving no neighborhood behind" (Our Roots Chicago, n.d.). As part of the 2022 Chicago Climate Action Plan, Our Roots Chicago places emphasis on areas of the city with historically low tree coverage, namely the south and west sides. The program partners with the Community Tree Ambassador Program, a tree equity working group, to train residents to identify gaps in tree coverage. As experts in their neighborhoods, residents are able to submit potential tree-planting sites from their phones. Launched in 2022, Our Roots Chicago plans to complete the project in 2027.

The value of residential shade tree planting is becoming more apparent across the region. For example, and as previously defined, the UHI effect is very present in the Kansas City metro area. Though the entirety of the city faces hotter temperatures than its rural counterparts, there is a disparity in temperatures across neighborhoods of different socioeconomic statuses, as observed when comparing the temperatures predicted and observed in the NOAA Heat Watch Kansas City Report (2021) to the City's geographic poverty distribution (City of Kansas City, Missouri, n.d.). Yet, in the 2022 ParkScore Index, a ranking of park acreage across the country's 100 most populous cities, the Trust for Public Land ranked the Kansas City, Missouri Park system highly, 21st out of 100. Kansas City was awarded 81 out of 100 points on Equity, with residents living in neighborhoods of color having access to 81% more local park space than those living in white neighborhoods. Residents living in lower-income neighborhoods have access to 66% more local park space than those in higher-income neighborhoods. Even with a very strong park system, the UHI effect is felt on such a block-by-block basis, suggesting that tree canopy cover on residential streets is key to providing cooling relief to residents. While parks remain important spaces for relief, city-size parks cannot be counted on to help reduce the heat burden on the homes of nearby residents.

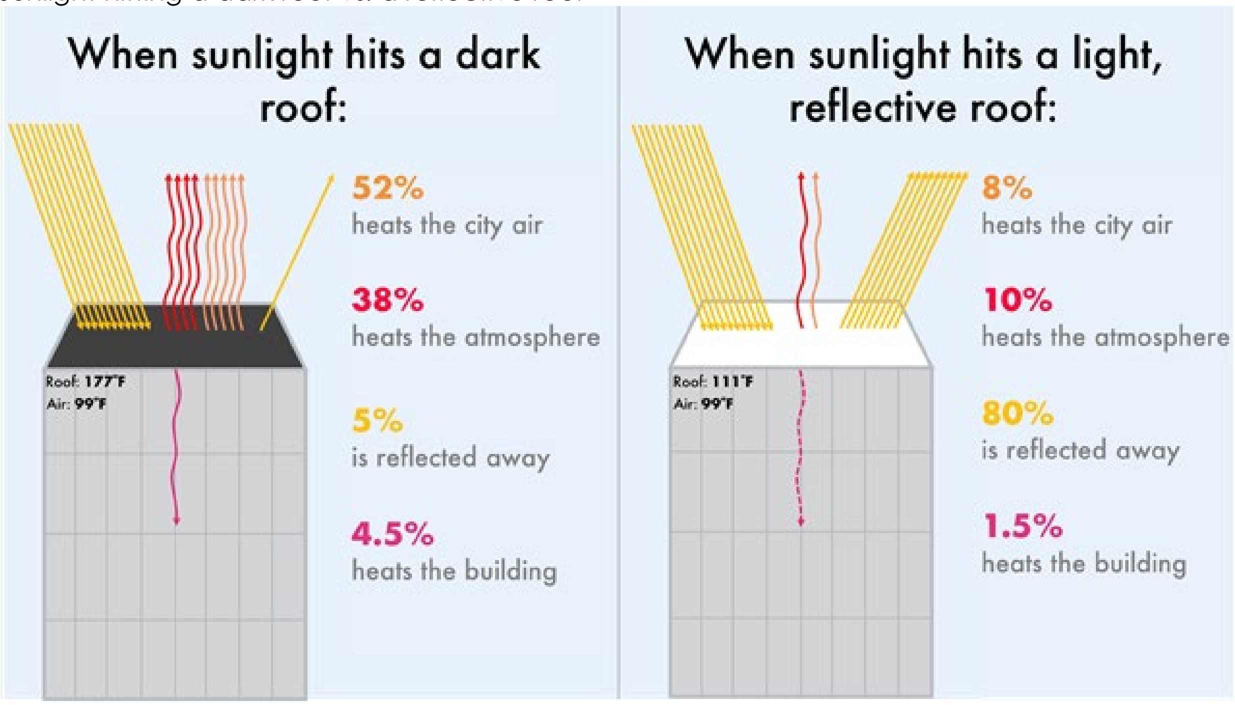
Similar to tree canopy coverage, green roofs, or a vegetative layer grown on a rooftop, can lower city-wide ambient temperatures by up to 5°F, and can be 30-40°F lower than traditional roofs. (EPA, 2022b). They can also reduce building energy use by 0.7% compared to traditional roofs leading to annual savings of $0.23 per square foot of the roof's surface. The city of Chicago has a Green Roof Ordinance that incentivizes the construction of green roofs on buildings in the Chicago downtown mixed-used district, saving the city on stormwater management systems in the long term and reducing the urban heat island effect plaguing Chicago's downtown in the summer months (LeSher, n.d.).

Reflective Surfaces

Another UHI mitigation technique is the installation of reflective surfaces, which refers to any process or emerging technology that increases a surface's albedo, or, in other words, reflects heat back into the atmosphere. Typical paving materials are extremely hot. Asphalt or concrete can reach peak summertime temperatures of 120-150°F and traditional roofs can reach peak summertime temperatures of 150-185°F (EPA, 2022e; EPA, 2008, page 1). Dark surfaces heat the surrounding air, the atmosphere and the building they are attached to much more than light surfaces. This is due to the difference in the absorption and reflection of sunlight. Absorption of sunlight causes the molecules of the surface it strikes to vibrate faster, increasing its temperature. The energy is then re-radiated by the Earth in the form of heat. As seen in Figure 9, when sunlight hits a reflective roof, the amount of heat that is emitted is dramatically different than when sunlight hits a dark-colored roof. The application of cooling surfaces such as cool coating on a roof or a cool colored exterior wall paint can reduce the amount of heat these materials and surfaces typically absorb and then emit into the air. Cool roofing products can be approximately 50-60°F cooler during peak summer weather than traditional roofing materials (EPA, 2008, page 1).

Figure 9

Sunlight hitting a dark roof vs. a reflective roof



Note. Showing how sunlight hits a dark roof in comparison to sunlight hitting a reflective roof. Reprinted from *The Cool Roofs and Cool Pavements Toolkit* (p. 10), by Global Cool Cities Alliance, 2012. Copyright 2012 by Global Cool Cities Alliance.

It is important to note that reflective surfaces may not save significant energy savings in a heating-dominated climate. However, as discussed earlier, many Midwestern cities will be shifting to warmer climate zones, meaning cooling surfaces will be increasingly effective for the region. Further, cool roofs are likely to cause an increase in energy usage for heating but typically result in a net reduction when heating and cooling energy usage are considered in tandem. Several cities and utilities around the country offer rebates and incentives for both green infrastructure and reflective surfaces. The Cool Roof Rating Council keeps a comprehensive list of the current cool roof or wall financial incentives offered under the resources section on their website. Incentives help with the cost concern of smart surfaces[3] which is a primary concern in the industry as Jackson Becce, of the Smart Surfaces Coalition, pointed out. Further, cost typically outweighs climate benefits in project planning by city entities. Cool surfaces offer both reduced costs in the long run and climate benefits, but to gain project support, focusing on cost benefits associated with reduced maintenance and longer lifespan of surfaces can be effective (J. Becce, personal communication, July 27, 2022).

Incentivizing green infrastructure and reflective surfaces is an opportunity where utilities can invest in UHI mitigation strategies, such as offering rebates to customers who implement these strategies. However, as Becce states, it is often not enough for cities to implement just one UHI mitigation strategy rather, they should strive to implement a portfolio of efforts. In many of their suggestions to cities, the Smart Surfaces Coalition recommends a variety of UHI measures. For example, in their analysis for Baltimore, they suggest an increase in the tree canopy as well as the installation of both green and cool roofs (Kats et al., 2022).

Building Energy Codes

Another way stakeholders can help reduce the negative impacts of UHI is to advocate for stronger building energy codes. As Figure 1 shows, increased energy demand (via AC use) caused by increased temperatures leads to increased GHG emissions, as well as higher infrastructure costs for utilities. Building energy codes can help lessen the intensity of this positive feedback loop by reducing peak energy demand and overall energy use in buildings. According to the Department of Energy, model building energy codes for residential and commercial buildings are predicted to help save $138 billion in energy cost savings, 900 MMT of avoided CO_2 emissions and 13.5 quads of primary energy between 2010 and 2040 (Office of Energy Efficiency & Renewable Energy, n.d.). Moreover, stronger building energy codes can help reduce stress on the grid, make homes more resilient against extreme temperatures and weather events and provide additional environmental, health and safety benefits.

Funding UHI Mitigation

Federal Funding for Green Infrastructure

Recent federal initiatives coming through the Infrastructure and Jobs Act (IIJA) and Inflation Reduction Act (IRA) provide investments targeted at combating extreme heat. Utilities and stakeholders should be aware of these funding opportunities as service territories may overlap with areas awarded with funding. Additionally, utilities are well-resourced and well-situated to provide technical assistance to applying grantees if not applying for funding themselves.
Section 11406 of IIJA is the Healthy Streets Program, which supports the deployment of cool and porous pavements and the expansion of tree canopy cover specifically in low-income and disadvantaged communities. This program

has been funded with a total of $500 million total or $100 million annually from 2022 through 2026 and states, metropolitan planning organizations, tribal governments and nonprofits are eligible to apply for up to $15 million per grantee.

There are various relevant tax credits in IRA for extreme heat mitigation. This includes rebates and tax credits for energy-efficient air conditioners and heat pumps for income-eligible households and tax credits for homebuilders constructing high-efficiency multifamily housing. Additionally, there are grants to help states and localities adopt and implement new building codes that encourage energy-efficient design for income-eligible households. The Environmental and Climate Justice Block Grants have earmarked $2.8 billion for various activities in disadvantaged communities, including mitigation of climate and health risks from urban heat islands, extreme heat, wood heater emissions and wildfire events. Eligible entities include a partnership between a Tribe, local government or a higher education institution and a community-based nonprofit organization, a community-based nonprofit organization and a partnership of community-based nonprofit organizations. The funding is to remain available until 2026.

IRA also includes significant investments in the U.S. Forest Service for Urban Forestry and NOAA. $1.5 billion is allocated for the U.S. Forest Service's Urban and Community Forestry Program to help bring cooling and pollution-fighting urban tree cover to all corners of the country, maximizing the multifold benefits of trees in combating climate change. $3.3 billion is allocated over the next five years for NOAA to bolster research, development and preparedness strategies for extreme climate events, including extreme heat. This will improve supercomputing capacity and research on weather, oceans and climate, strengthen NOAA's hurricane hunter fleet and replace aging NOAA facilities.

Philanthropy Funding

Tree planting efforts are at times funded through utility philanthropic dollars. One example of this model is the Duke Energy Foundation awarding more than $250,000 in grants to support environmental initiatives in 20 communities run by local nonprofits. Many of these grants incorporate tree planting as a priority, as seen in the following three examples. For example, Canopy Bloomington in Monroe County, Indiana received $15,000 for tree planting in economically disadvantaged areas that currently lack tree canopy cover (Duke Energy, 2022). The funding is designated to support the long-term maintenance and care of the trees. Louisville Grows in Clark County, a nonprofit in Kentucky, has included similar specifications in their $15,000 grant for tree planting in Jeffersonville and Clarksville. These cities are seeking to increase the tree canopy in low-income neighborhoods near I-65. The grant money will be used for an estimated 200 shade trees[4] that will be selected and planted by volunteers with urban forestry expertise. Additionally, Taking Root, another nonprofit, was awarded $10,000 to provide trees to communities in Ohio and Kentucky that were identified based on current tree canopy, heat island and demographic data.

Moving Beyond Philanthropy: Energy Savings from UHI Mitigation

It is important to note that philanthropic donations in all industries are commonly criticized. Such criticism often includes being labeled as "band-aids" rather than addressing systematic causes of an issue (Moody, 2022). Michael Moody from the Johnson Center (2022) suggests there may be a "lack of coordination, bureaucratic bottlenecks, ineffective systems of information sharing or failure to adapt to changing circumstances." Donating large sums of money to relatively small organizations introduces an unfortunate element of expecting these organizations to bear the entire brunt of implementation with limited administrative capacity. Additionally, there may not be repeat philanthropic funding to continue the work. Further, Moody (2022) continues, "foundations might give only to groups that provide easy-to-see results, rather than doing the work to find out which programs the community really needs, or which ones produce more long-term or hard-to-measure outcomes." Promoting the dollar amount donated serves as a shareable result in many cases with no further result or measurable impact needed. This may be an easier philanthropic metric compared with more granular methods of involvement. These critiques of general philanthropy are relevant to understand as the money utilities put towards heat mitigation efforts are largely considered charitable contributions, distinct from investments in their energy efficiency portfolios. Donations in this form have been linked to one of the methods utilities use to influence politics and increase investor profits (Energy and Policy Institute, 2019). For example, findings indicate that in Ohio, charities that represent low-income and minority communities have supported bailouts for power plants that would be paid for by those consumers (Anderson, 2019 as cited in Kowalski, 2019, paragraph 6). In 2018, there was a massive uptick in total 'donations' reported by FirstEnergy subsidiaries in Ohio.

Also in 2018, a wave of dark money political spending by murky social welfare 501(c)(4) groups crashed across Ohio. Section 501(c)(4) groups are not required to identify their donors on annual returns with the Internal Revenue Service, but they are allowed to contribute to political action committees and other organizations that partake in lobbying. There is an ongoing push for increased transparency of utility spending after various incidences of utility money and donations being used to exercise influence were discovered. As Michigan Attorney General, Dana Nessel states, "Utilities are government-created monopolies regulated by the state. Accordingly, customers of these monopolies should have the right to know whether and how much their utility is spending to influence legislation or other public policy that impacts the utility and consumers." (Nessel, 2023 as cited in Noble, 2023). Objectively, there is a gaping hole related to the transparency and disclosure of donations in this form. Considering philanthropy is currently the prevailing way utilities engage in urban heat island mitigation efforts, other methodologies are worth expanding.

Valuing UHI Mitigation

Claiming Savings: An Opportunity for Utilities

In most Midwest states, investor-owned utilities (IOUs) run ratepayer-funded energy efficiency programs, offering incentives and rebates for energy efficiency products and services to their customers. Utilities count the resulting energy savings towards mandatory energy efficiency resource standards or voluntary goals and typically receive financial incentives for meeting or exceeding goals. Utility energy efficiency investments are the single-greatest source of energy efficiency investment in the country and Midwest region. In turn, utility energy efficiency programs could play a key role in advancing targeted and broad heat mitigation efforts that result in building energy savings.

An example of this is currently playing out in Illinois where tree planting was recently included in the most recent version of the statewide technical reference manual (IL-TRM.) The IL-TRM defines consistent and reproducible calculations for energy consumption (electric kilowatt-hours and natural gas therms) and energy demand (electric kilowatts (kW)) savings from energy efficiency programs run by utility companies throughout the state. In Illinois, this means that utilities will be able to claim savings from tree planting, similar to more traditional efficiency measures, such as wall insulation or high-efficiency boiler installations. If utilities can claim energy efficiency savings from tree planting, they are also able to design specific programs offering rebates or incentives to bolster these efforts.

In the IL-TRM, the measure specifies that to claim savings, the trees must be planted within 15 feet of the walls of homes so that they provide shading during summer days when the sun is at a high angle. The trees must also provide shading to at least the third story of a home in the cooling season, requiring trees to be a minimum of 30 feet tall when fully mature. Strategically placed shade trees can reduce cooling demand for utility customers. Any opportunity for relief on the grid is important, as air conditioner and electric fan use accounts for about a fifth of the total electricity used in buildings around the world (IEA, 2018) and trends of greater electricity demand "would be especially fought in an era of frequent heat waves." (E&E News, 2018). Utility investment in urban heat island mitigation through shade tree planting and general efficiency upgrades avoids costlier investments, such as infrastructure build outs to support future un-tapered demand. The new measure in the IL-TRM Version 11, 5.7.5 Tree Planting, describes savings from a program where utility sponsored staff work with homeowners or building operators to determine the appropriate location and ultimately plant trees to maximize savings (IL SAG, 2022, p. 469-479). The primary effect is defined as reduced insolation into residences through windows, also referred to as direct solar impacts. A secondary effect is reduced wall and roof temperatures which decrease conduction through walls and roofs into residences. This is referred to as infiltration.

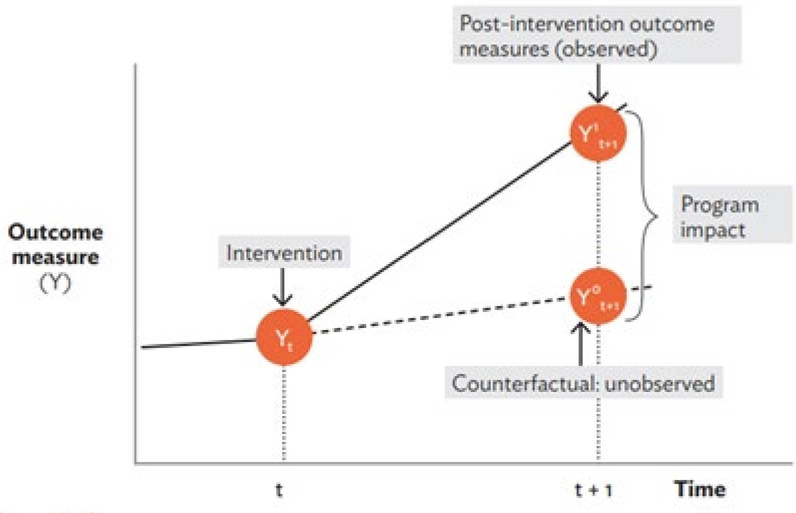
The TRM methodology is publicly available and includes different assumptions in its calculations to create an estimate for the sum of the two noted effects: insolation and infiltration. Once adjusted for tree life expectancy and time to realize savings, the calculation provides the total energy savings of an implemented tree planting measure. Some elements that this calculation considers: values for number of eligible trees planted, the net annual therms of heating increase per tree due to shading, the net annual Ton-hours of cooling saved per tree due to shading, the percentage of homes that have electric heating and cooling and the average infiltration reduction per tree during heating and cooling seasons due to wind. It is understood and reflected in the math that tree planting measures will always cause an increase in energy use during heating seasons because of lost insolation and the fact that what keeps a home cooler in the summer will also keep it marginally cooler in the winter as well. One way this is attempted to be curtailed is through the types of trees that are permitted to be planted on certain building facades. The TRM specifies that on north-facing walls, which receive the least amount of light, only coniferous trees (trees that retain leaves all year) are eligible. On both east-facing walls, which receive morning light and south-facing walls, which receive the greatest amount of light, only deciduous trees (trees that lose all leaves in fall) are eligible. On west-facing walls, which receive afternoon light, both deciduous and coniferous trees are eligible. By balancing the type of tree planted with typical amounts of sunlight and therefore reducing insolation entering a home, necessity for increased heating in colder weather is minimized. Overall, the increase in energy for heating is negated by the net energy savings realized throughout the rest of the year, making the impact of the measure still positive.

Avoiding the Worst Case

When determining the best path forward for UHI mitigation, it is worthwhile to adopt a perspective that utilizes a counterfactual analysis, or a study of what might have been. Counterfactuals are used to imagine and quantify disasters that may have occurred without a point of intervention. The current various forecasts of increased extreme heat incidences may serve as the disaster case. As mentioned previously, The 6th *National Risk Assessment: Hazardous Heat* report generated by the First Street Foundation (2022) found that by 2053, 1,023 counties in the United States are expected to exceed 125°F, an area that is home to 107.6 million Americans, covering a quarter of United States land area. Stakeholders such as utilities can interfere in this forecast by implementing UHI mitigation measures such as green infrastructure or reflective surfaces, which have proven temperature reduction benefits. The extent to which their efforts disrupt the forecasts is measurable and can be considered savings utilities should be able to claim. As Figure 10 portrays, the impact of implemented program(s) or other intervention(s) can be quantified as the difference between the post-intervention outcome measures that are observed and the counterfactual, or the unobserved initial prediction about the future. Though predicting the future is inherently impossible, utilities are regularly required to make predictions about the future in estimating supply and demand to ensure reliability and stability. During this style of planning, it is relevant to account for general notions of the social cost and time value of carbon, that it is more valuable (less costly long-term) to make investments avoiding disaster today. If it is accepted that it is less expensive to be proactive rather than reactive and using a counterfactual method allows utilities to claim savings from a disaster-avoided, perhaps mitigation investments would increase.

Figure 10

Illustration of an Impact Evaluation



Note. A visual representation of an impact evaluation where t represents time and Y represents outcome measure. The difference between the post-intervention outcome measures that are observed (Y^1_{t+1}) and the counterfactual (Y^0_{t+1}), or the unobserved initial prediction about the future, is the program impact. Reprinted from *Impact Evaluation of Development Interventions*

Practical Guide (p. 32), by H. White and D. Raitzer, 2018, Asian Development Bank. Copyright 2018 by Asian Development Bank.

This idea of measuring the counterfactual and in turn, attributing claimable energy savings to a utility for their role in the intervention is similar to how market transformation programs are administered and evaluated. In a market transformation program, the utility and their evaluators work on estimating a natural market baseline, which is a forecast of the future in which no utility-funded energy efficiency programmatic intervention exists. As long as the utility documents their interventions and their theory of change to accelerate market adoption, the utility can claim credit for a shift in the market above the forecasted natural market baseline. For illustrative purposes, a similar framework could be used for allowing utilities to claim credit for mitigating the need for increased future electricity demand in a warmer climate, through interventions to address UHI. The utility would need to gain consensus with their regulators and intervening stakeholders on the forecasted future, carefully document interventions taken and determine progress indicators to assess the impacts. Strategies for designing and implementing market transformation programs have been developed and agreed upon through several utilities' stakeholder and regulatory review processes, which could be leveraged and replicated for UHI mitigation.

Regulation Imposed Utility Involvement

Existing Heat Mitigation Measures Offered by Midwest Utilities

Currently, there are no utilities in the Midwest that offer energy efficiency program measures under ratepayer programs explicitly for the goal of mitigating the UHI effect. Although, two non-utility examples of measures to reduce heat transfer to buildings, thus reducing building cooling load are worth pointing out, in Illinois with the city of Chicago and in Kentucky with the Louisville-Jefferson County Metro Government. Chicago and Louisville offer cool roof rebates through the Small Business Improvement Fund and the city of Louisville Cool Roof Rebate program, respectively. Utilities may be uniquely positioned to provide needed financial support for similar UHI mitigation measures to those exemplified by Chicago and Louisville. Utilities can provide even greater investment in the range of heat mitigation strategies and coordination with stakeholders.

Missouri Case Study

The region's strongest examples of utility engagement on UHI exists in Missouri. The state's energy efficiency-enabling statute, the Missouri Energy Efficiency Investment Act (MEEIA), allows the state's electric IOUs to voluntarily apply for and offer programs targeted to its residential, commercial and industrial customers. In a series of MEEIA proceedings for the state's electric IOUs, Evergy Missouri (Evergy) and Ameren Missouri (Ameren), the Office of Public Council secured commitments from the two utilities to work with stakeholders and subject matter experts to identify solutions for UHI mitigation. Specifically, the Commission ordered Evergy to explore the impacts and potential mitigation of UHI over the greater Kansas City urban area over a twenty-year IRP cycle (File No. EO-2022-0055, Order at 4). Additionally, the Commission voted to allow Ameren and Evergy to allocate funds under their Research and Development initiatives to convene stakeholder engagement workshops, feasibility and vulnerability studies and convene public workshops to understand the issue of the UHI effect within the IOUs' respective service territories.

Evergy held four stakeholder workshops to identify relevant information, potential partners, outside funding streams and other considerations for a feasibility and vulnerability study regarding a UHI mitigation program for their Cycle IV MEEIA filing. Participants in the workshops included representatives from various stakeholder groups including Mid-America Regional Council, University of Kansas, University of Missouri- Kansas City, Building Energy Exchange Kansas City, Missouri Office of Public Counsel, Missouri Department of Natural Resources, Metropolitan Energy Center and more. These workshops will culminate in the formation of a Heat Island Mitigation or Cool City Plan.

As part of Ameren's inclusion in the company's Cycle III MEEIA filing (File No. EO-2018-0211, Non-unanimous Stipulation), Ameren collaborated with East-West Gateway Council of Governments (EWG) staff to track urban heat in the Ameren service area. In the summer of 2022, EWG staff conducted a UHI preliminary analysis for the St. Louis area, using air temperature data from NOAA and local weather stations, land cover data from a partnership between Missouri Resource Assessment and EWG and electrical usage data from Ameren. In their findings, EWG did observe higher temperatures in urban areas compared to surrounding suburban and rural areas. They also noted that "areas that experience higher temperatures also heat up earlier in the day and stay hotter longer into the evening" (East-West Gateway Council of Governments, 2023, p.12). However, they did not find a correlation between higher temperatures and increased energy usage in their data but noted that they used a limited set of data and further data collection and analysis should be done in the area.

Integrated Resource Planning

Missouri's electric IOUs are required to consider and analyze "special contemporary issues" in their integrated resource plans "to ensure that evolving regulatory, economic, financial, environmental, energy, technical, or customer issues are adequately addressed by each utility." Following the recommendation of the Office of Public Council in Evergy's 2021 Special Contemporary Resource Planning Issues docket, the Commission ordered

Evergy to "explore the feasibility, impacts, and potential mitigation of a potentially more pronounced urban heat island over the greater Kansas City urban area over a twenty-year IRP cycle." (File No. EO-2022-0055, Order at 4).

Moving Forward

As cities continue to get hotter and more populated, urban heat islands are a growing problem that should not be ignored. The associated negative health impacts and increased energy costs, disproportionally burdening the most vulnerable populations, can be mitigated with strategic efforts by stakeholders. This can be done by contributing to existing mapping initiatives and community engagement efforts and incentivizing UHI mitigation strategies such as green infrastructure or reflective surfaces through utility-claimed savings or other clean energy funds. There is a great opportunity and need for involvement. With inaction, cities, residents, utilities and other stakeholders will be forced to pay increased costs down the line. Residents will continue to feel the adverse health effects and heightened costs of increasing temperatures while cities and utilities will face costlier infrastructure investments arising from untampered energy demand. Heat and extreme weather event-related outages will continue to have increasingly severe health and monetary consequences, emphasizing the role utilities play in their customer's livelihood. To serve not only their customers reliably, but to make good on their fiscal responsibility to investors, utilities are uniquely situated to engage accordingly now and avoid higher costs in the future. A future lack of action from utilities in this space may indicate a misalignment of utility incentives.

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