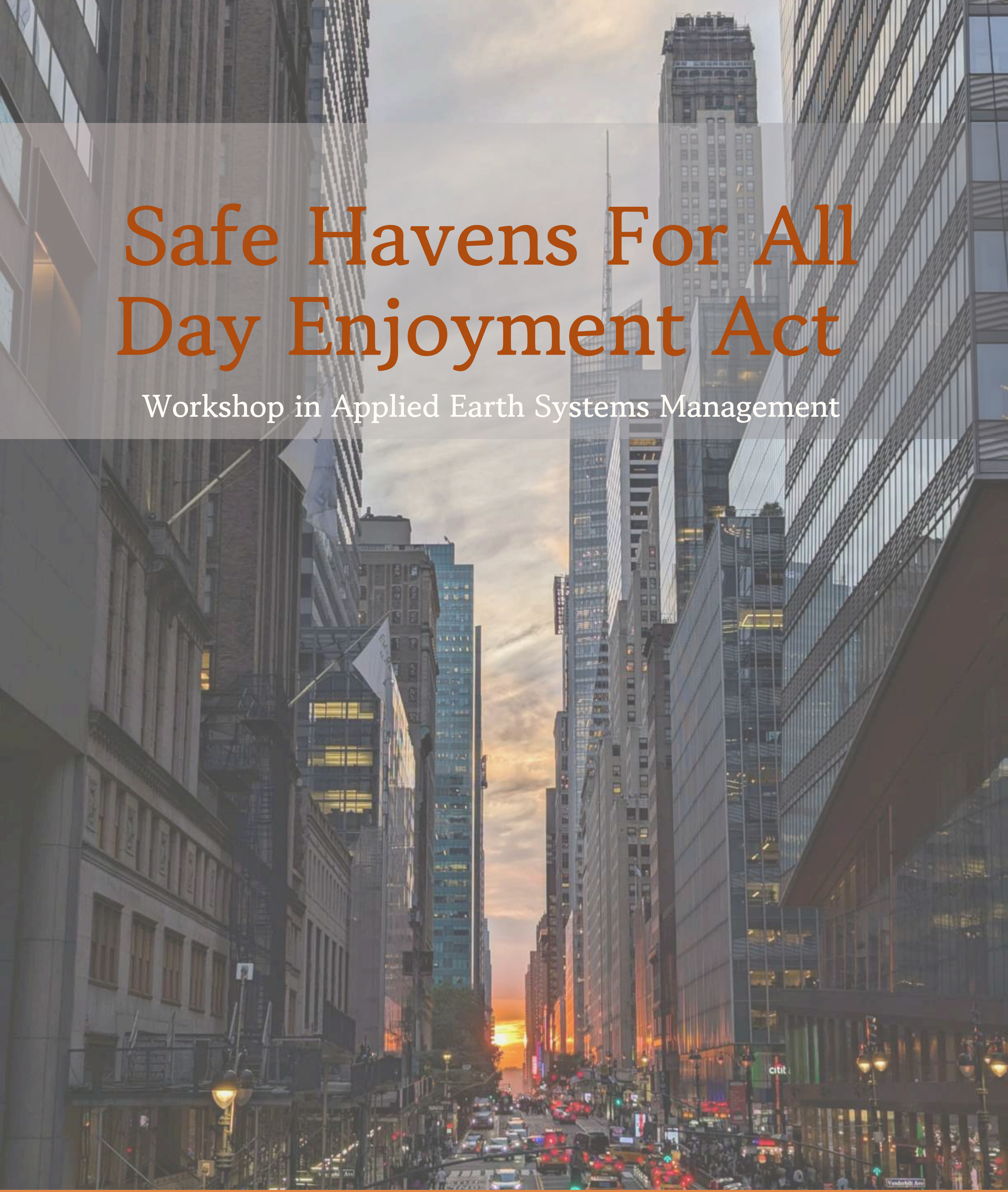

Safe Havens For All Day Enjoyment Act

Workshop in Applied Earth Systems Management

Columbia | SIPA
School of International and Public Affairs

Executive Summary

This report starts with a background of New York State (NYS), providing context on the state, urban populations, at-risk populations, and existing policies tackling extreme heat. We follow with a summary of the SHADE Act and its components. Then, we provide a detailed analysis of the science behind the issues the bill aims to address: the UHIE and its impact on urban populations. The next section provides a comprehensive overview of shade infrastructure and its benefits in mitigating heat-related risks. Next, an overview of various performance indicators is presented to measure their effectiveness in reducing public health risks and enhancing the economic vitality of urban areas. Lastly, we discuss the shortcomings and controversies surrounding the bill, including scientific and social aspects.

The SHADE Act proposes a competitive grant program that helps municipalities in NYS address urban heat stress by developing shade infrastructure in public transportation hubs and outdoor gathering spaces. The Empire State Development Corporation (ESD) will administer the grant program and establish eligibility criteria, guidelines, and requirements. ESD will select municipalities capable of developing the most effective and innovative solutions to combat urban heat in their local transportation hubs and public gathering areas. Grant recipients will be chosen based on two primary metrics: the applicants' demonstrated temperature reduction and the number of people served by the shade infrastructure.

The urban heat issue has multiple dimensions, and the SHADE act adopts a correspondingly multi-dimensional approach to address it. Developing effective shade infrastructure can improve public health, stimulate economic vitality, and ensure that municipalities across NYS take proactive measures to protect themselves from the dangers of extreme heat, bolster their resilience to climate change, and enhance the overall livability of urban environments.

Figure 1: Central Park, NYC

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Background

Figure 2: Albany, NY. Source: Getty Images

New York State & Extreme Heat

NYS is the fourth largest state in the United States by population, with about 19.8 million people as of July 2024. New York City (NYC) is the largest urban center in the state, with about 8.5 million inhabitants, with Buffalo, Rochester, Syracuse, and Albany being other prominent cities.

Rising temperatures over the past decades due to climate change have had a variety of negative impacts across the state, with increased burdens on public health, economy, and infrastructure. NYS's unique demographics make it particularly vulnerable to extreme heat.

Urban Population

The state's population has grown by about 9.2% since the turn of the millennium, from 18.9 million inhabitants in 1999 to about 19.8 million in 2024[1]. Historically, New York has been a predominantly urban state, consistently having one of the highest shares of urban populations in the country[2], and **78% of the state's population live in urban areas as of 2020**[3].

Figure 3: NYC Street. Source: Getty Images

At-Risk Populations

NYS has **15.3 million urban residents**, who all experience higher temperatures than non-urban residents due to the urban heat island effect (UHIE). Additionally, the state has the **highest number of people using the public transport system** across all states in the United States**, with over 6 million daily users**[4]. Urban residents using public transport are forced to be outdoors during daytime when they can experience temperatures of up to a staggering 132°F [5] as a result of heat being re-radiated from asphalt and concrete in the built environment around them. Oftentimes, these are residents from disadvantaged and lower-income communities, and studies show they are more vulnerable to heat exposure[6].

Existing Policies Tackling Extreme Heat

In NYS, heat has been recognized as a threat over the past decades. New York is tackling extreme heat through a science-driven, equity-focused approach that integrates state and city initiatives. The **New York State Climate Impacts Assessment** provides the scientific foundation, detailing how rising temperatures and more frequent heat waves will disproportionately affect vulnerable populations, and guiding adaptation policy[7]. Building on this evidence, the state's **Extreme Heat Action Plan (EHAP)**—finalized in 2024—outlines 49 targeted actions spanning planning, communication, built environment upgrades, and ecosystem-based cooling solutions, with a strong emphasis on environmental justice [8]. Complementing these statewide efforts, NYC's climate strategy, anchored in **PlaNYC**[9] and **OneNYC**[10], draws on findings from the **New York City Panel on Climate Change (NPCC)**, whose 2024 report highlights the intensifying risks of heat waves for low-income and marginalized communities [11]. Together, the state's assessment and action plan, and the city's PlaNYC/OneNYC-driven resilience strategies, create a coordinated framework that prioritizes public health, infrastructure resilience, and the protection of communities most at risk from extreme heat.

As recognized, there is an urgent need to address extreme heat in urban areas. The SHADE Act proposes shade infrastructure as a part of the solution to tackle rising temperatures.

Legislative Summary

BILL OVERVIEW

Full Name: Safe Havens for All-Day Enjoyment (SHADE)

Sponsor: Senator Rachel May

Session: 2025-2026, New York State Legislature

Legal action: Adds §16-bb to the Urban Development Corporation (UDC) Act; Amends §16-m of the UDC Act

Goal: Create a Grant Program for municipalities to create shade infrastructure in public and transit spaces to reduce heat exposure

Eligible projects: parks, plazas, bus stops, bike lanes, city blocks.

Funding: Empire State Development (ESD)

Introduction

Greenhouse gas (GHG) concentrations in the atmosphere have increased significantly due to human activities, such as burning fossil fuels, deforestation, extensive agriculture practices, among others. As a consequence, global average temperatures have risen by about 2.6ºF during the last century. In NYS the pattern is no different with the annual average maximum temperature rising from 71.1ºF in 1910 to 76.1ºF, representing an increase of 5ºF over 110 years. Climate models project that the maximum temperatures during summer could reach 80.9ºF by the 2080s. This would represent an increase of 9.8ºF compared to the average in the beginning of the 20th century [12]. This warming is even more prominent in urban areas due to the UHIE, which is a phenomenon that amplifies heat patterns and its impacts on public health, infrastructure, and economic activities. This is particularly evident in cities like NYC, where high population density, extensive built environment, and frequent record-breaking heat waves exacerbate heart-related risks.

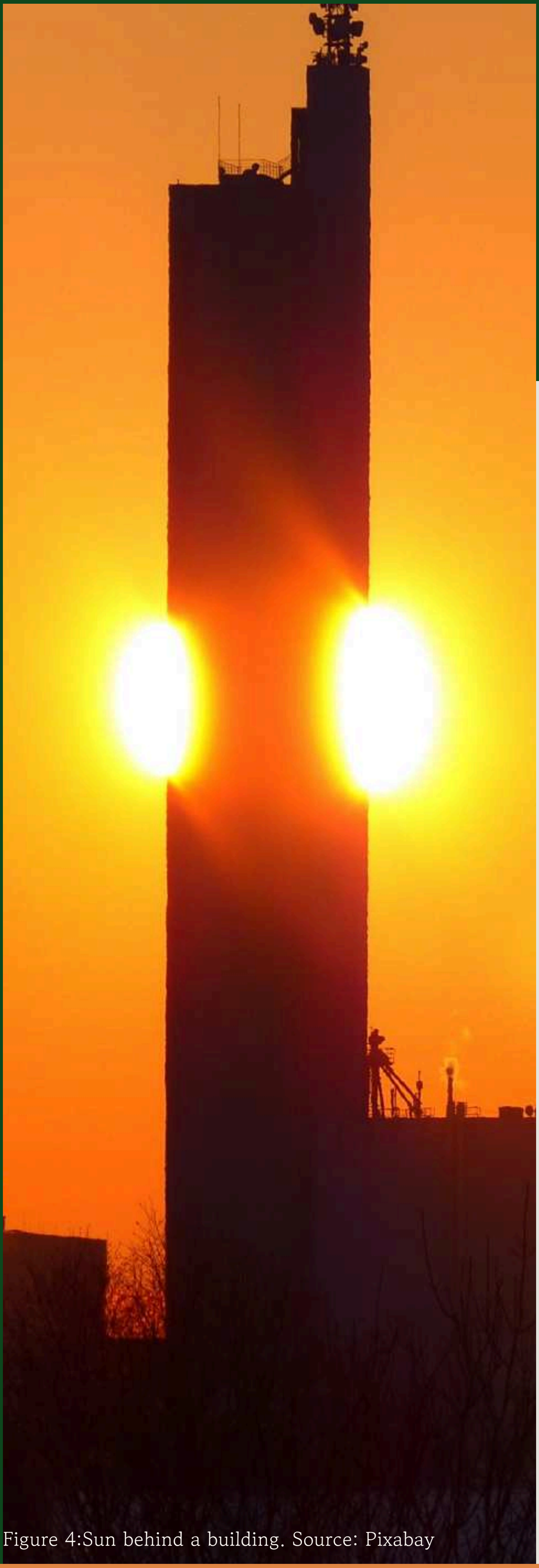

Figure 4:Sun behind a building. Source: Pixabay

NYS has taken steps to combat this issue through the implementation of the Extreme Heat Action Plan (EHAP) in 2024 [13]. The policy outlines a 2024-2030 plan to fight increasing extreme summer temperatures in NYS through initiatives that enhance infrastructure resilience and protect workers. In 2025, the NYS Legislature adopted the SHADE Act as its most recent heat infrastructure adaptation measure.

The Bill

In response to intensifying heat exposure across NYS, exacerbated by climate change and the UHIE, the New York State Legislature enacted the SHADE Act (S1028).

The SHADE Act is a New York State bill that proposes amendments to the New York State Urban Development Corporation (UDC) Act to address rising temperatures and extreme heat risks in public spaces.

It introduces a new shade infrastructure grant program to support local governments in developing cooler, more resilient, and more equitable urban environments within the state's economic development strategy. Senator Rachel May (D-48th District) introduced the bill in the 2025-2026 legislative session.

Policy Objective

The program provides funding to municipalities across the state of New York for the implementation of shade infrastructure solutions in public gathering and transportations areas that currently lack adequate sun and heat protection.

Preceding Legislation

New York State Urban Development Corporation Act

State legislatures originally enacted the UDC Act to address urban blight and promote economic growth, housing, and infrastructure development across NYS. It instated the UDC, a public benefit corporation and political subdivision that is allowed to issue bonds and notes, grant loans, provide tax exemptions, among others [14].

Empire State Development Corporation

NYS's leading economic development agency that promotes business growth, job creation, and regional development [15]. It offers various forms of financial assistance and has been expanding its initiatives related to climate-resilient urban development as legislation in this area progresses. The SHADE Act extended the ESD's mission by including climate resilience, enabling economic development resources to support shade infrastructure for public benefit.

Urban Development Corporation → Empire State Development (ESD) → Empire State Development Fund → SHADE Act Competitive Grant

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Key Provisions

The SHADE Act supports community-led initiatives that deliver benefits to people through proven reductions of mean radiant temperature and UHIE mitigation.

- **Competitive Grant Program:** Municipalities submit proposals for projects that increase shade coverage in public parks, plazas, trails, bus stops, city blocks, and bike corridors. ESD will award grants based on demonstrable impact, including population exposure, site usage data, projected reduction in mean radiant temperature, and alignment with UHIE mitigation goals. Applicants must include performance metrics and evaluation plans in their proposals.
- **Local Funding Match:** The program requires selected municipalities to provide dollar-for-dollar matching funds. Municipalities will have to invest an equal amount of funds to the proposal they apply in the grant.

Key Provisions

- **Shade Infrastructures:** Eligible infrastructure includes tree planting, pergolas, shade sails, canopies, and other engineered or vegetative interventions that demonstrably reduce public heat exposure.
- **Funding Mechanisms:** The SHADE Act will finance shade infrastructure through the Empire State Development Fund (Section 16-m), originally created to support economic growth and public projects. The Act expands the statutory scope of Section 16-m of the UDC Act, which historically supported economic development, to include climate-resilient public infrastructure. This expansion authorizes the use of Empire State Development funds for shade and cooling interventions that combat the UHIE.
- **Administrative Agency:** Empire State Development (ESD) Corporation will administer the program, including grant allocation, performance monitoring, and compliance oversight. ESD will develop implementation guidelines in coordination with relevant state agencies and establish standardized metrics to evaluate program outcomes.

Target Population and Municipal Definition

- **Targeted jurisdictions:** Eligible applicants include all municipalities as defined under General Municipal Law §119-u, including, cities, towns, and villages.
- **Coverage:** The program reaches all 62 counties, which encompass 62 cities and 932 towns and 555 villages throughout the state [16].
- **Demographic Focus:** The Act directs its funding toward densely urbanized areas because these regions contain 78% of NYS's 19.8 million residents. The program focuses on highly urbanized counties, including New York (Manhattan), Kings (Brooklyn), and the Bronx, along with urban centers located throughout Long Island and the Hudson Valley and upstate regions [17].

Conclusion

The SHADE Act seeks to promote creativity in climate resilient urban infrastructure by encouraging tailored solutions for municipalities. It gives cities, towns, and villages the flexibility to design solutions fit for their needs and contribute to broader statewide efforts to combat extreme heat and improve public infrastructure. Together, these elements ultimately enhance community well-being and urban sustainability in the face of rising temperatures.

Defining the Environmental Problem

Figure 5: Sunlight. Source: Getty Images

Introduction

Climate change has led to global, national, and statewide warming. Future projections indicate that hotter days, higher temperatures, and prolonged periods of sustained heat will persist as a threat. Compounded with warming trends is the growing phenomenon of urbanization driven by rural-to-urban migration and population growth. Urban areas are more impacted by rising temperatures due to built environment characteristics that make them hotter. These shifts are accelerating the impacts of climate change across NYS, leading to disproportionate heat exposure among urban populations. Vulnerable populations, especially children, the elderly, and low-income communities, face greater risks from heat exposure and heat-induced stress. This section will explore the following themes: Rising Temperatures; Urbanization; The Albedo Effect; UHIE; New York State's Response; New York State Case Studies; Implications on Health, Economy and Urban Infrastructure.

Rising Temperatures

Cause: Climate Change

The Earth is currently facing an unprecedented rate of warming due to anthropogenic climate change. Burning fuels releases GHGs, including carbon dioxide (CO2), methane (CH4), nitrous oxide (NO2), and ozone (O3), which trap excess heat in our atmosphere and intensify the natural greenhouse effect.[18] Global average temperatures have been steadily increasing as a result of increased GHG emissions, rising by about 2.7°F since 1850. The situation in NYS is no different, with average temperatures rising from 45.0°F to 47.6°F. If current trends continue, scientists project that the average temperature in the state will increase by 5-10°F by the 2080s compared to the 1981-2010 average.

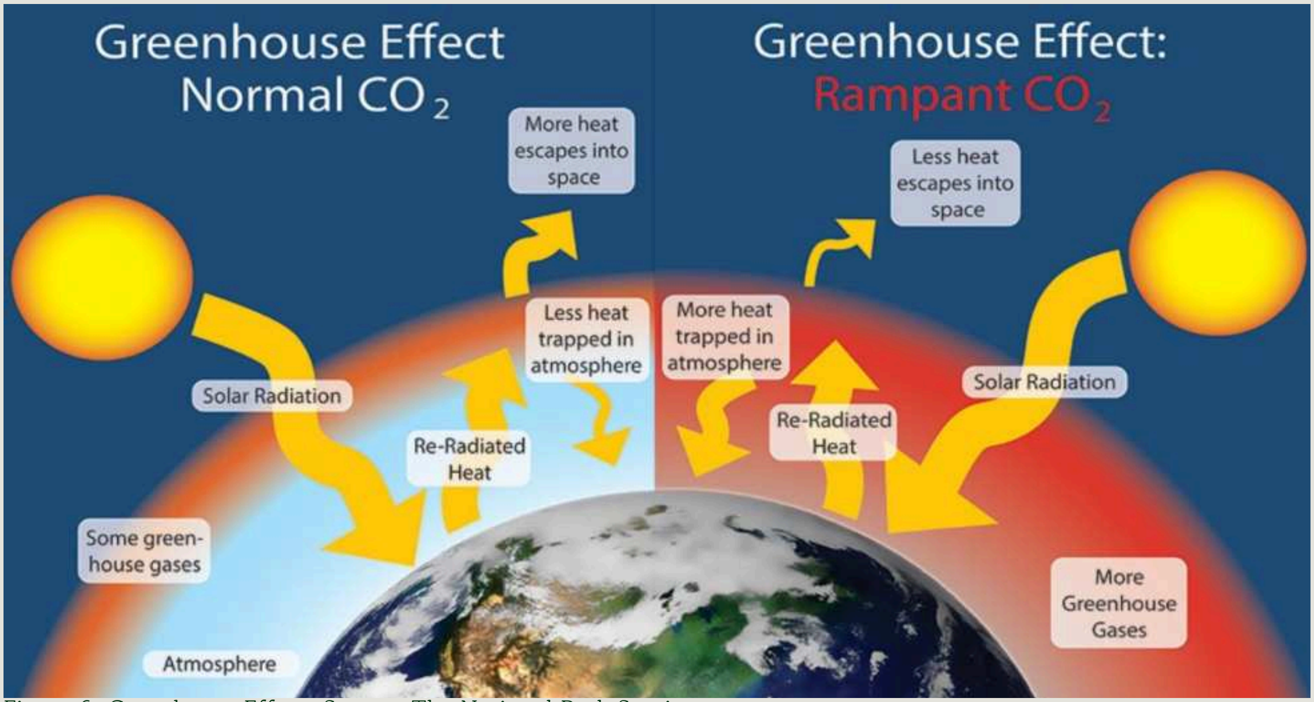


Figure 6: Greenhouse Effect. Source: The National Park Service

In the United States, 2024 was the warmest year since the National Oceanic and Atmospheric Administration (NOAA) began recording measurements in 1895. In 2024, the average annual temperature was 55.5°F, 3.5°F above the 20th-century average [19]. Rising temperatures have drastically changed existing climate patterns.

In 2020, **NYC shifted from a humid continental climate zone to a humid subtropical climate zone.** This reclassification requires an average summer temperature above 72°F (NYC has met this threshold since 1927) and average winter temperatures of at least 27°F. Winter temperatures have met this threshold for the past five years.

Temperature Projections

With the advent of climate change, projections point to more widespread, frequent, severe, and prolonged extreme heat events, especially in urban environments. From 1901 to 2000, NYS temperatures averaged 44.5°F [20]. In 2024, NYS averaged 49°F, showing the state has already warmed by 4-5°F compared to those historical baselines [21]. For example, in Tompkins County in central NYS, the average temperature rose at a rate of 0.35°F per decade between 1950 and 2024 [22]. This ongoing trend of rising temperatures has serious risks for both planetary and human health.

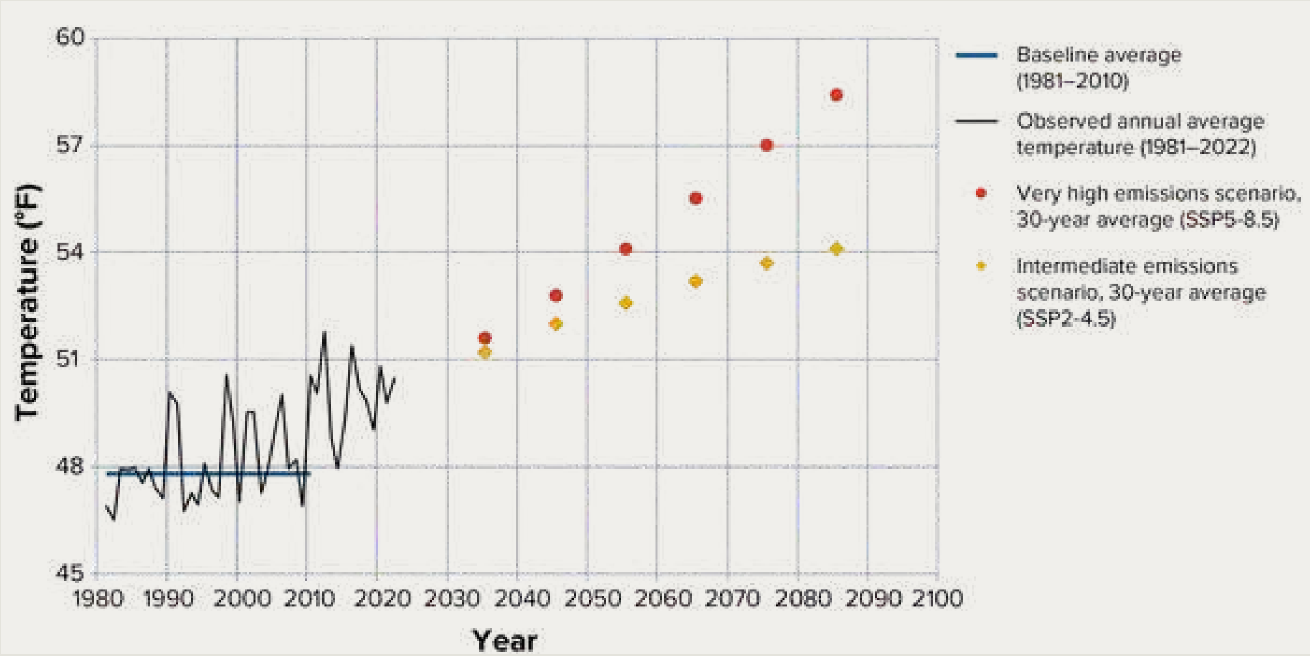


Figure 7. Historical (1981-2022) and projected (2020-2100) average annual temperatures for NYS, compared to the 1981-2010 baseline. Projections are shown for an intermediate emissions pathway (SSP2-4.5) and a very high emissions pathway (SSP5-8.5), highlighting the potential range of future warming and its policy relevance for climate adaptation and mitigation planning.
Source: New York State Climate Impacts Assessment.

Projections indicate that global warming will intensify in the coming decades, with average annual temperatures expected to rise by 2.5-4.4 °F by the 2030s, 3.8-6.7 °F by the 2050s, and **5.1-10.9 °F by the 2080s**, relative to the 1981-2010 baseline of approximately 57.7°F [23].

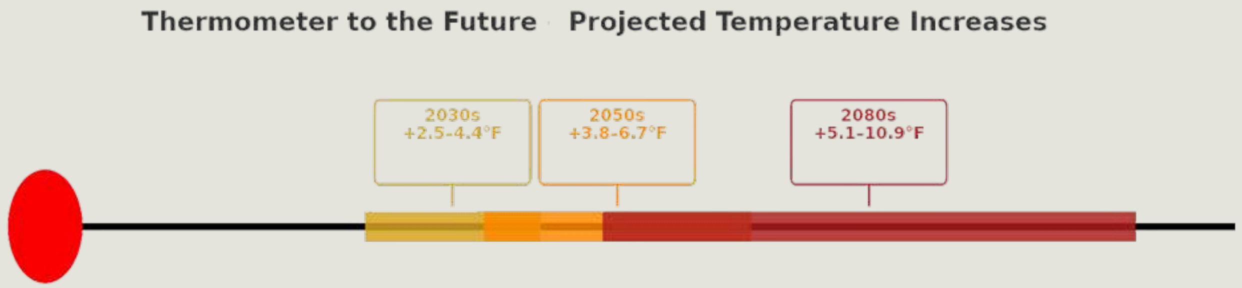


Figure 8: Predicted Temperature Increases

Across NYS, temperatures are projected to increase by 3°F by 2080 [24], with NYC alone projected to experience an increase of up to 9.8°F, compared with the 1981-2010 average [25].

Projected Annual Average Temperature in New York State During the 21st Century

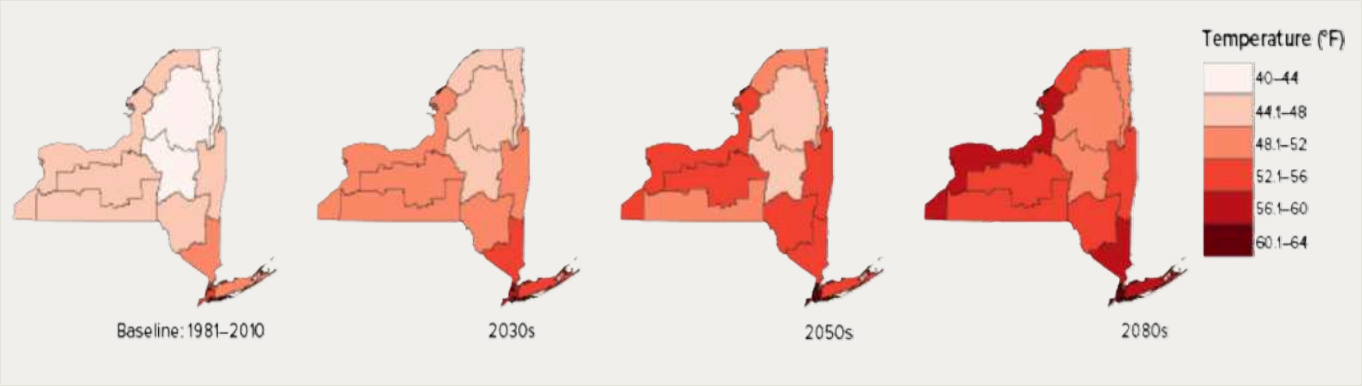


Figure 9. Projected changes to annual average temperatures over the century.
Source: NYS Climate Impacts Assessment

Figure XX illustrates how extreme heat events are becoming more common all around the state, including in regions that weren't as affected previously due to increasing urbanization and land use change. Statewide mid-century and late-century projections indicate that the amount of days above 90°F will increase drastically all across New York [26]. NYS will experience up to 5 times as many heatwaves by the 2080s [27].

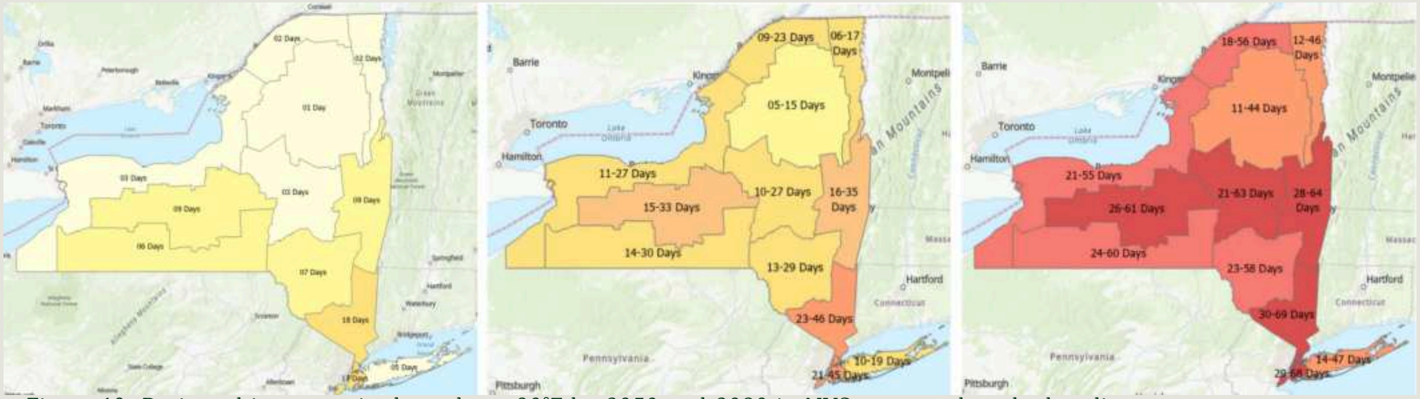


Figure 10: Projected increases in days above 90°F by 2050 and 2080 in NYS compared to the baseline
Source: New York State Extreme Heat Action Plan

In Figure 10 left panel shows the 1981–2010 baseline, with most areas seeing fewer than 10 such days per year [28]. The middle and right panels show projected increases by the 2050s and 2080s, respectively, with the largest gains in downstate and central regions. By the 2050s, NYC may experience 30–46 days per year with a heat index above 95°F (up from six), and the Saint Lawrence Valley could see three to eight annual heat waves by the 2080s. Projections are based on the 25th–75th percentile range of model outcomes from the New York State Climate Impacts Assessment [29].

Temperature Metrics

There are three main ways that temperature is measured; surface temperature, air temperature, and mean radiant temperature.

Temperature Metrics	Surface Temperature	Air Temperature	Mean Radiant Temperature (MRT)
Definition	Ground heat	Air heat	Radiant heat
What it Represents	Ground feel	Weather report	Felt heat
Variability	High variability	Moderate variability	High variability
Human Implications	Causes burns	Affects comfort	Explains felt heat
Limitations	Surface only	Misses radiation	Hard to measure

Table 1. Comparison of temperature metrics — surface temperature, air temperature, and mean radiant temperature (MRT) — including their definitions, what they represent, variability, human implications, and limitations.

Mean Radiant Temperature (MRT) measures the average temperature of the surrounding surfaces such as pavement, buildings, and other structures that radiate heat. It captures how the human body gains or loses heat through radiation rather than just through the air. The MRT can be much higher than air temperature in urban heat islands and especially next to hot surfaces, indicating greater risk for heat stress. MRT is a key factor in how people experience thermal comfort and is considered the most important environmental factor affecting how the human body regulates temperature in extreme heat conditions [30].

Urbanization

Population

Population growth is one of the main drivers of urbanization as more people move into cities for jobs, services, and opportunities. This expansion typically means denser housing, more infrastructure, and the **conversion of natural or vegetated areas into built environments**, causing the UHIE. The combined effects result in raising temperatures in urban environments. Between 1999 and 2024, NYS's population rose by approximately 9.2% from around 18 million to almost 20 million residents [31]. Out of those roughly 20 million residents, about **78% of this population lives in urban areas**, and 40% of that population is below 14 or above 60 years old, which are considered vulnerable populations [32][33]. According to the 2020 U.S. Census, around 44% of the state's population resides in NYC [34]. In NYS, around 78% of the population resides in dense urban settings. Rural-to-urban migration drives further urbanization in the state, makes urban areas denser, and expands their boundaries.

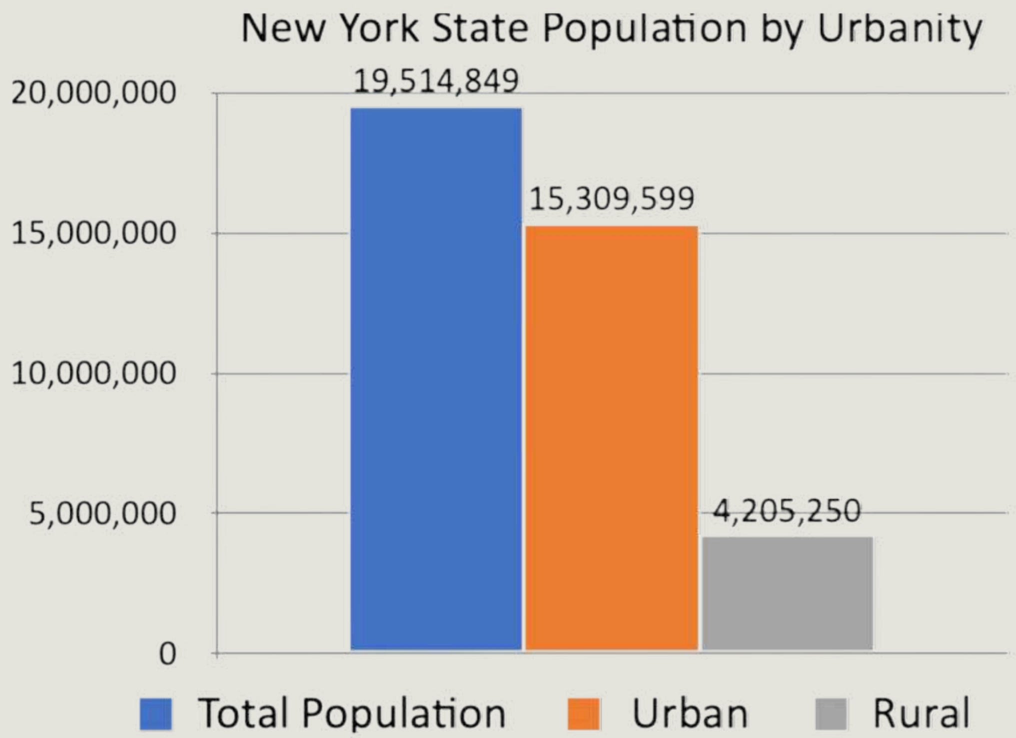


Figure 11. NYS population distribution by urbanity, showing total population (19,514,849), urban population (15,309,599), and rural population (4,205,250). Source: The State of Rural New York Report, 2023.

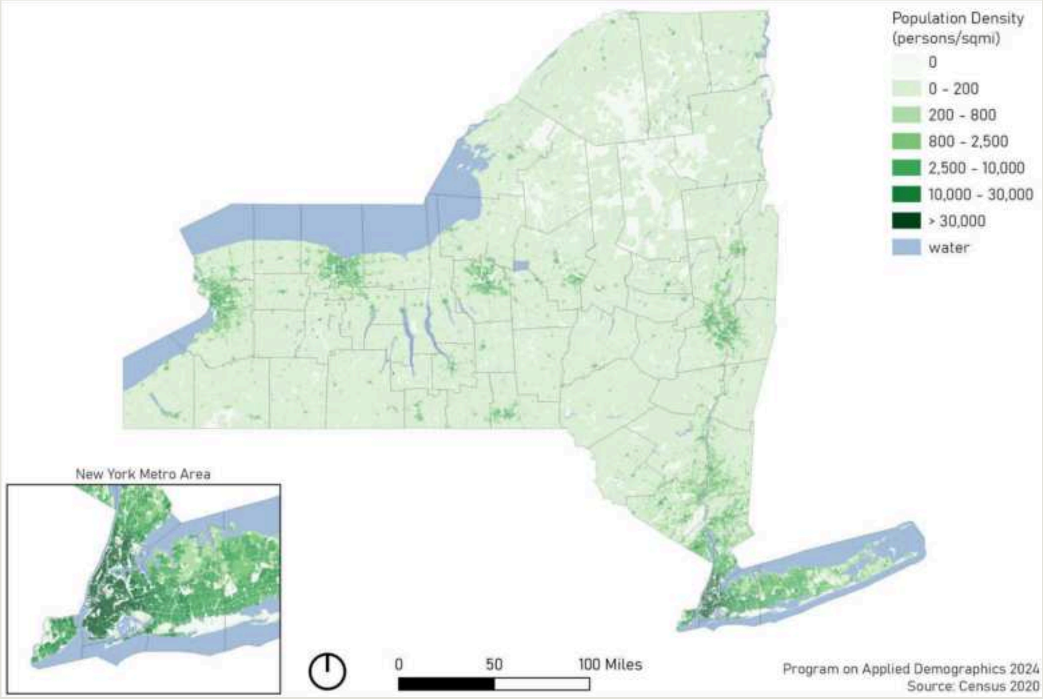


Figure 12. Population density in NYS by county, measured in persons per square mile, based on 2020 Census data. Darker shades of green indicate higher population densities. Source: Program on Applied Demographics, 2024; U.S. Census Bureau, 2020.

Population growth is creating challenges in all residents' access to a safe and healthy environment. As more people move into cities and metropolitan areas, the urban footprint expands, bringing increases in construction, infrastructure development, and the conversion of land from natural to urban use [35]. These changes often reduce green space, increase impervious surfaces, and place greater pressure on local resources and ecosystems, underscoring the need for thoughtful urban planning and sustainable development to protect public health and environmental quality.

Land Use Change and Built Environment

The built environment includes man-made structures such as buildings, roads, public spaces, and other infrastructure. Human society functions, including shelter, transportation, energy access, and work, require modifications from the natural environment to the built environment.

In the 20th century New York State has experienced a striking urban increase, with over 425,000 acres of rural land being converted into urban uses just between 1982 and 1997, representing a **30% increase in urbanized land**, while only a 2.6% rise in population [36]. Nowadays, **urban areas have a 70% built area compared to the urbanized open space, which is approximately 25%** [37]. From 2001 to 2024, the state lost approximately 2.3% of its tree cover area [38], and in NYC, only 22% of the land is covered by the tree canopy. These surface changes drive localized warming, leading to the UHIE

The Albedo Effect

In urban areas, the materials used for buildings, streets, and infrastructure in general play a major role in how heat is absorbed and retained. This is largely explained by the albedo effect, which describes the proportion of incoming solar radiation that a surface reflects back into the atmosphere. Surfaces with a high albedo, such as snow, light-colored sand, or light-colored rooftops, bounce a larger fraction of sunlight away, absorbing less heat. Low-albedo surfaces like asphalt, dark roofs, or dense concrete absorb most of the incoming shortwave solar radiation, convert it into heat, and slowly release it as longwave infrared radiation.

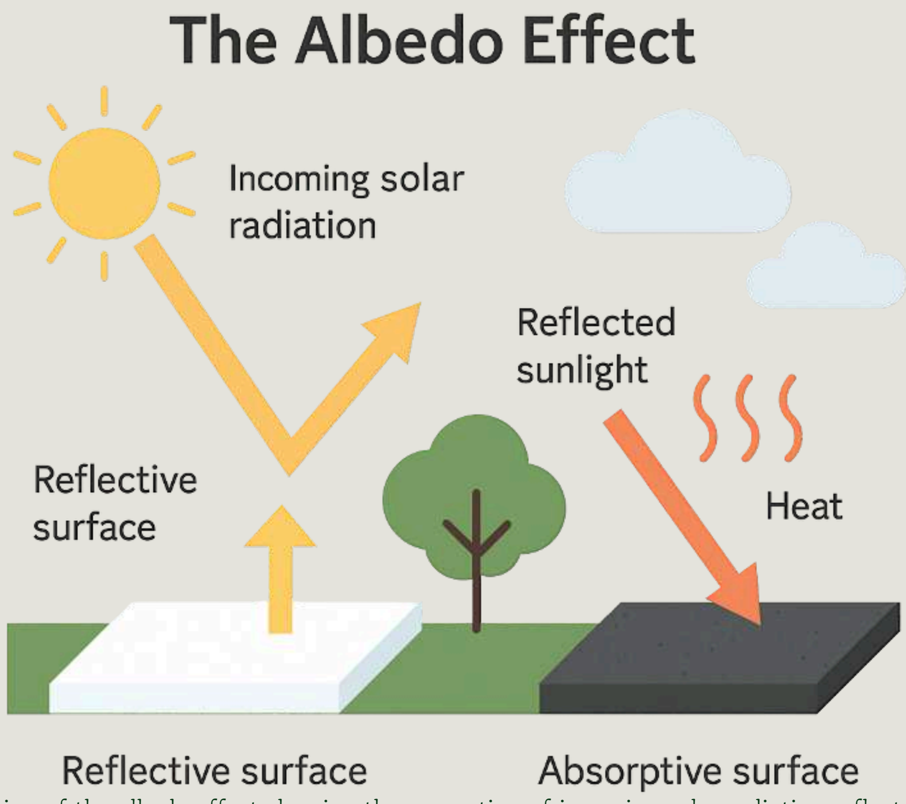


Figure 13: Illustration of the albedo effect showing the proportion of incoming solar radiation reflected versus absorbed by different surfaces.

Urban surfaces, in contrast, are impermeable and dry, eliminating evapotranspiration and intensifying heat retention. Materials like asphalt can have albedo values as low as 0.05-0.10, meaning they reflect only 5-10% of incoming solar energy, while absorbing the rest. Concrete has a somewhat higher albedo (0.20-0.35), but it is still far below the albedo of vegetated areas (0.15-0.25 for grass, 0.15-0.20 for forest canopy) and significantly lower than bright reflective surfaces like white rooftops (0.60-0.90) [39].

In New York State, **urbanization** has shifted the surface energy balance by r**eplacing reflective, moisture-retaining landscapes with dark, heat-retaining materials**. Natural land covers, such as forests and grasslands, typically have higher albedo values and provide additional cooling through evapotranspiration, the process by which plants release water vapor, reducing surrounding air temperature. Even bare soils, though less reflective than vegetation, retain some cooling capacity through moisture exchange.

As mentioned earlier, in NYC, only 22% of land is tree canopy, well below the 40% often cited as a target for urban cooling [40]. This vegetation loss is compounded by the expansion of paved surfaces, particularly in **high-density neighborhoods**, which have some of the **lowest surface albedo levels** in the state.

The net effect is positive radiative forcing: more solar energy is absorbed than reflected, driving up surface and near-surface air temperatures. Because low-albedo materials also have high thermal inertia, they retain heat well into the night, slowing nighttime cooling and creating sustained heat stress conditions.

These changes in surface reflectivity are not just a physical phenomenon, they have direct human impacts. Thus, the albedo effect is a core driver of the UHIE in NYS linking land cover changes directly to environmental health and climate resilience challenges.

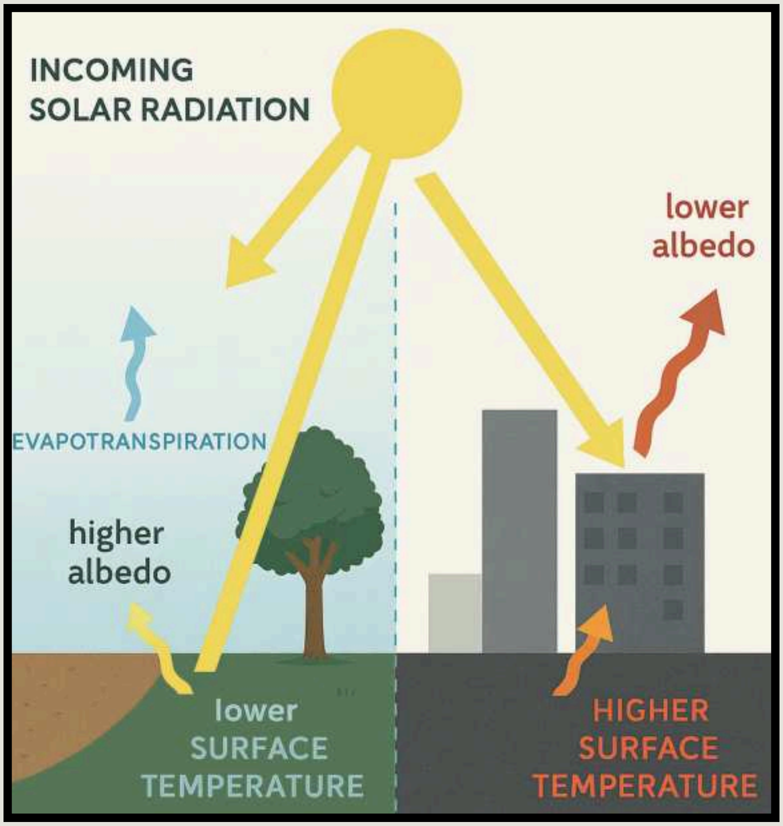


Figure 14: On the left, cool and breezy natural landscapes fight heat with high albedo and evapotranspiration. On the right, dark, heat-hoarding urban surfaces soak up the sun, cranking up surface temperatures and turning the city into a giant stovetop.

Urban Heat Island Effect

All of the previously discussed elements, population growth, urban expansion, land use change, and the prevalence of low-albedo, heat-retaining surfaces, interact to intensify the UHIE. This phenomenon refers to the presence of heat “islands”, where **areas in a city face much higher temperatures and extreme heat than their surrounding areas**. The New York State Climate Impact Assessment from 2024, states that the presence of GHGs in the atmosphere amplifies the issue, which is primarily caused by urbanization, population growth, increased heat-retaining infrastructure, and intensified energy use [41].

Several interrelated urban characteristics drive UHIE

Anthropogenic heat sources that release waste heat directly into the urban atmosphere: emissions from vehicles, machinery, and appliances, widespread use of low-albedo materials like asphalt and concrete increases heat absorption during the day and re-emission at night, intensifying urban temperatures.

Reflective or "cool" surfaces and green roofs can help reduce this heat absorption, but most cities have not widely adopted them [42]. Additionally, concentrated GHG emissions in urban areas further intensify localized warming. This creates a feedback loop, where higher temperatures increase reliance on air conditioning and energy use, which in turn generates more waste heat and GHG emissions, deepening the urban heat burden. The highly dense built environment of cities leads to “urban street canyons,” which hinder natural air circulation, resulting in stagnant urban air that traps heat, as well as pollutants. Tall buildings on narrow streets create urban street canyons that decrease ventilation, trap heat, and hinder nighttime cooling.

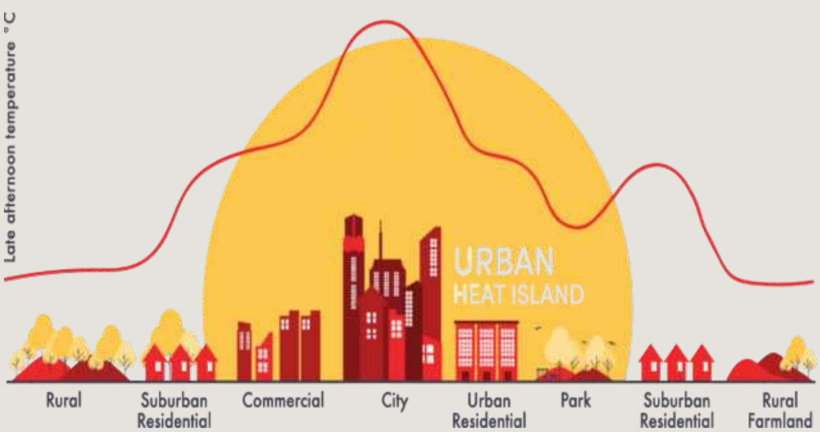


Figure 15: Temperature Variation due to UHIE
Source: Kamyar Fuladlu, World Meteorological Organization

The heat is repeatedly reflected between surfaces and, without airflow, accumulates over time [43]. This leads to persistently elevated surface and ambient temperatures, especially in high-rise zones with little vegetation. The reduction of natural heat sinks, such as vegetation and water bodies, diminishes the city's ability to cool itself through shade and evapotranspiration. Urban vegetation like street trees and parks not only provide shade but also cools the air through evapotranspiration, acting as "cool islands" within overheated neighborhoods. Their removal or underinvestment in certain areas worsens heat exposure and contributes to spatial inequities [44].

Transportation hubs, industrial zones, and paved areas are most at risk, as these built surfaces can have surface temperatures as high as 180ºF in the hottest time of year [45] [46]. In a 2024 study, the nonprofit organization Climate Central found that NYC had an Urban Heat Index of 9.7ºF, which is the temperature difference between the city and nearby rural areas [47].

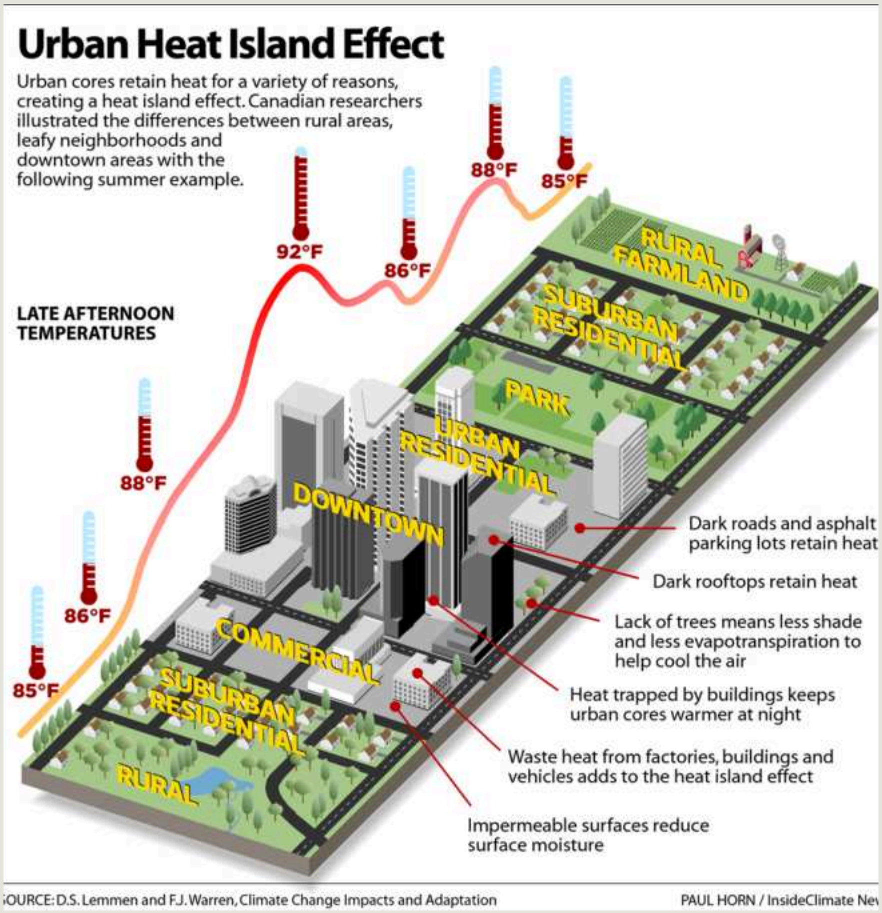


Figure 16. Illustration of the UHIE showing late afternoon summer temperatures across different land uses. Downtown and commercial areas reach the highest temperatures (up to 92°F) due to heat-retaining materials, lack of vegetation, impermeable surfaces, and waste heat, while parks and rural areas remain cooler (around 85°F). Source: D.S. Lemmen & F.J. Warren, Climate Change Impacts and Adaptation; Graphic by Paul Horn / InsideClimate News.

This underscores why tackling the UHIE is a priority for NYS, particularly as its population and urban footprint continue to grow. Expanding shade solutions, such as planting trees, installing shade structures, and integrating reflective or green roofing, can significantly lower surface and air temperatures, improve thermal comfort, and protect vulnerable populations from heat-related risks, making them a key strategy for creating a cooler, healthier, and more resilient city.

New York State's Response

As outlined in the previous section, extreme heat is a problem NYS is currently facing. NYS recognizes the urgent need for action and commits to both immediate protective measures and long-term resilience strategies. There are two major efforts to address this issue: the New York State Extreme Heat Action Plan, which coordinates adaptation, mitigation, and emergency response at the state level, and the Plan NYC Sustainability Report, which outlines NYC's strategies to reduce heat exposure and protect residents.

New York State Extreme Heat Action Plan [48]

The Extreme Heat Adaptation Planning Work Group (EHAPWG) aligns environmental, energy, health, and emergency management strategies, with agencies implementing adaptation measures, strengthening preparedness, and targeting heat-health risks. NNYS tracks health outcomes such as heat-related deaths and hospitalizations, along with environmental and social factors including temperature reduction from urban heat island projects, tree equity scores, canopy coverage, and transportation access.

Community engagement is also a key priority, with EHAPWG members monitoring outreach to municipalities, community-based organizations, and residents to ensure strategies reflect local needs and equip New Yorkers with resources to reduce heat risks.

PlaNYC Sustainability Report [49]

PlaNYC is expanding outdoor cooling solutions to lower surface and air temperatures, reduce heat exposure, and improve comfort in public spaces. The plan invests in large-scale tree planting, aiming for a 30% citywide tree canopy cover by 2035, with a focus on neighborhoods that have high Heat Vulnerability Index (HVI) scores. Agencies are preserving existing mature trees, planting tens of thousands of new trees in heat-vulnerable areas, and partnering with community stewards to maintain and expand shade coverage.

PlaNYC is also piloting Cool Corridors, which use shade structures, reflective materials, and strategic landscaping to mitigate the UHIE along streets, public plazas, and corridors. By prioritizing shaded streets, green space access, and cooling features in high-risk neighborhoods, PlaNYC is directly reducing outdoor heat exposure and building long-term resilience.

Case Studies: UHIE in Cities in NYS

Major cities in the state are more impacted by rising temperatures, with NYC being hardest hit by the UHIE, and smaller cities like Buffalo and Albany are less impacted due to decreased levels of urbanization and higher proximity to vegetation. These cities represent two ends of the urban spectrum in NYS. Despite their size difference, the following cities each experience the UHIE at different intensities and scales. NYC has one of the highest UHIE intensities in the U.S., with surface temperatures averaging up to 9.5°F higher than surrounding rural areas. Its dense built environment, high-rise structures, and limited tree canopy in many neighborhoods amplify heat exposure.

In contrast, Buffalo's UHIE is less intense, with surface temperatures reaching up to 13°F higher than nearby green areas but still significant, especially in East Buffalo and other areas lacking vegetation. Albany has a smaller population density than NYC at 4,809 people per square mile, but it has still seen significant increases in heat in conjunction with its growing population.

Figure 17: Buffalo, NYS. Source: Getty Images

Vulnerability is high in these cities, particularly among low-income and marginalized communities without adequate cooling or green infrastructure. While NYC faces challenges on a larger scale due to population density, Buffalo's aging infrastructure and economic disparities also demand targeted adaptation strategies, and Albany's high poverty rate emphasizes the disproportionate effect that the UHIE is having on low-income communities. Together, these cities underscore the statewide urgency of urban heat mitigation through equitable climate resilience planning.

Albany

Albany is the capital of NYS and has a population of 102,905 residents as of 2025, growing by 4.3% since the 2020 census [50]. Albany is considered a high-poverty municipality, as the city's current poverty rate is 23.5% [51]. While smaller than both NYC and Buffalo, there is still a significant UHIE occurring as Albany has a Urban Heat Island (UHI) Index of 7.7 ºF across all neighborhoods and a 10.0 ºF UHI index in its urban center [52]. According to Jason West, the Director of Sustainability for the City of Albany, public awareness of urban heat is growing, and climate projections indicate a worrisome shift that will leave Albany with the climate of Northern Louisiana by 2080, a projection the local government is well aware of. Combatting the current heat is a goal for the City of Albany, but their primary focus at the moment is installing more accurate temperature sensors, as current measurements tend to underestimate urban heat and do not factor in humidity, as well as indoor cooling systems for the public to utilize [53]. Mr. West also points out that historic redlining has led to uneven tree cover and vegetation, especially in the neighborhoods of South End, Arbor Hill, and West Hill which are now the hottest and most exposed neighborhoods, whilst being some of the poorest.

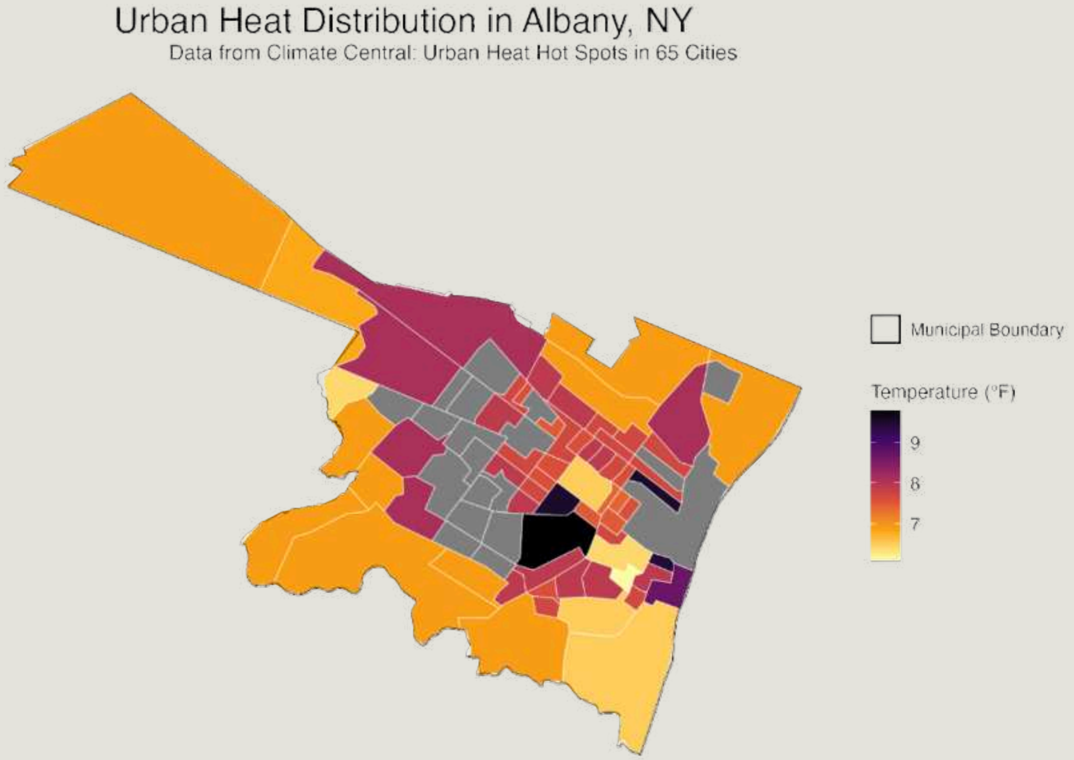


Figure 18. Urban heat distribution in Albany, NY, showing temperature variations across neighborhoods. Darker shades indicate higher temperatures (above 9°F relative to surrounding areas), while lighter shades indicate cooler areas (around 7°F). Data source: Climate Central, Urban Heat Hot Spots in 65 Cities.

Buffalo

Buffalo is home to roughly 272,762 residents, while its metro area extends to about 1.17 million residents [54]. Buffalo's population is currently declining at a rate of -0.35% annually and its population has decreased by -1.73% since the most recent census, which recorded a population of 277,551 in 2020. Though smaller than NYC, Buffalo still experiences a measurable UHIE: surface temperatures can reach about 13°F above surrounding cooler areas on hot summer days [55]. The city's large footprint of impervious surfaces combined with reduced tree canopy, especially in older East Side neighborhoods impacted by highway infrastructure, has worsened heat retention and localized warming [56]. Home assessment has rated 88% of Buffalo households with moderate or higher heat vulnerability. As regional climate warms, more frequent and intense heat waves are projected, posing escalating risk to older homes, those without air conditioning, and communities lacking green space adaptation measures.

Urban Heat Distribution in Buffalo, NY

Data from Climate Central: Urban Heat Spots in 65 cities

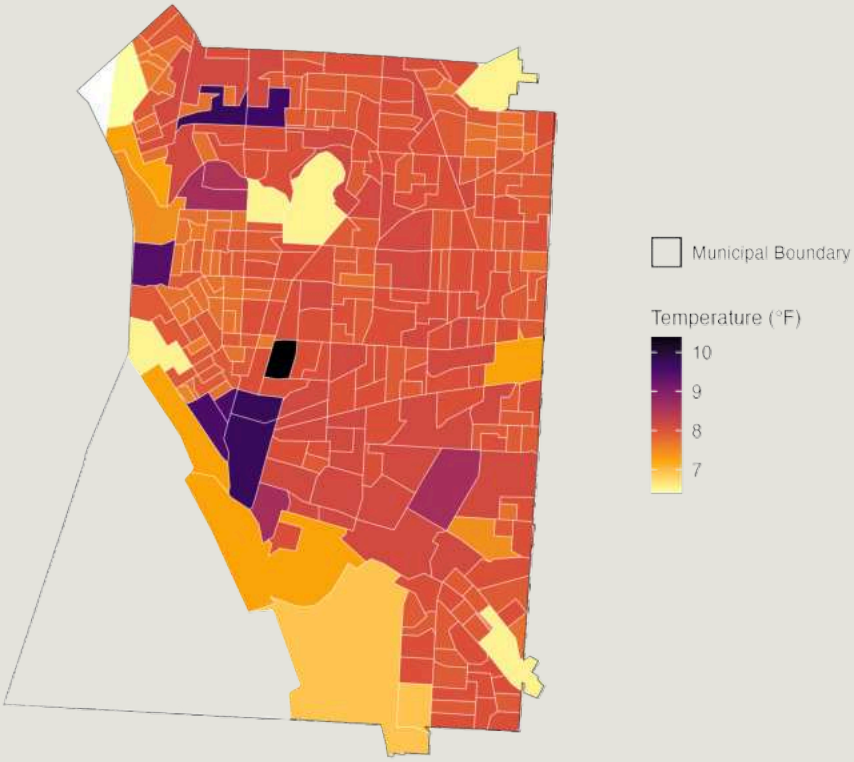


Figure 19. Urban heat distribution in Buffalo, NY, showing temperature intensity by neighborhood. Dark purple and black areas represent the hottest locations (9-10°F above surrounding areas), while yellow areas indicate cooler zones (around 7°F). Data source: Climate Central, Urban Heat Hot Spots in 65 Cities.

New York City

NYC is not only the largest city in New York State but also the most populous in the United States, with over 8.8 million residents and a metro area of nearly 20 million. Due to its dense built environment, NYC experiences one of the highest UHIE intensities in the country, with urban temperatures averaging up to 9.5°F higher than surrounding areas [57]. Vulnerable neighborhoods, like the South Bronx and parts of Brooklyn and Queens have lower tree canopies cover and higher exposure to asphalt, making residents more susceptible to heat stress. Projections show that NYC could face 57 days per year above 90°F by the 2080s, up from about 18 days historically, and 6-7 annual heatwaves by mid-century [58]. More than 6 million New York residents, roughly 78% of the city's population, live in neighborhoods that feel at least 8°F hotter due to UHIE. Approximately 3.8 million residents live in areas experiencing 10 °F or more additional heat. In certain heat-vulnerable neighborhoods, such as parts of the Bronx, East New York, and the Upper East Side, the heat index reaches 12 °F above rural baseline levels, while Central Park remain cooler at around 7-8 °F above rural zones [59].

Urban Heat Distribution in NYC, NY

Data from Climate Central: Urban Heat Spots in 65 cities

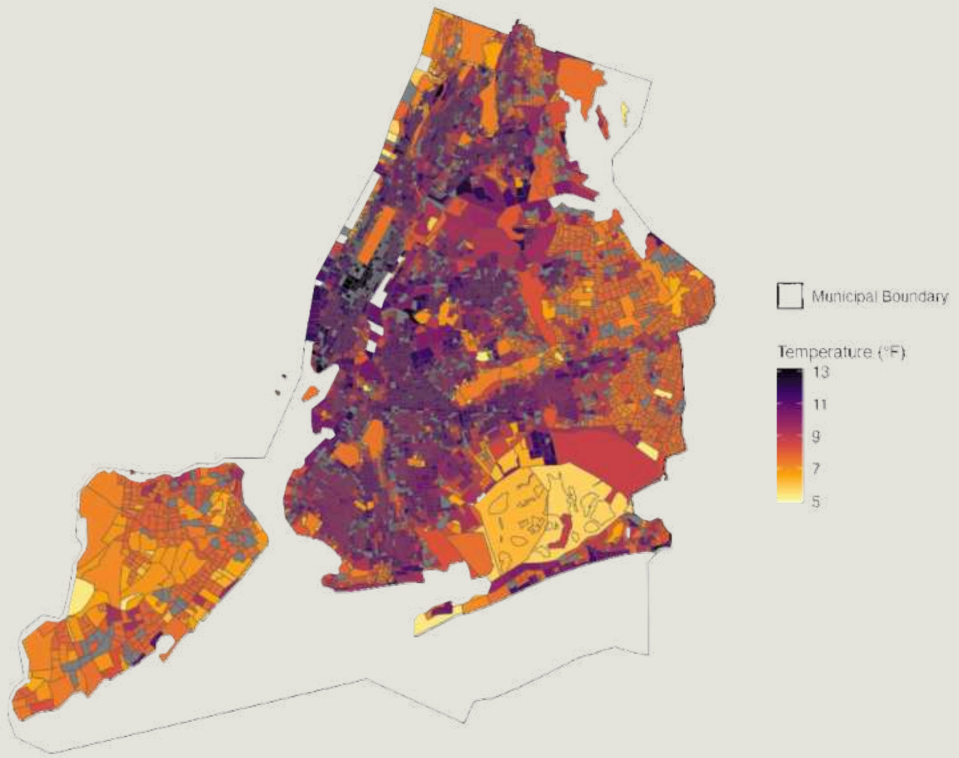


Figure 20. Urban heat distribution in NYC, NY, displaying temperature intensity across neighborhoods. Dark purple and black areas indicate the hottest zones (up to 13°F above surrounding areas), while yellow areas represent the coolest zones (around 5°F). Data source: Climate Central, Urban Heat Hot Spots in 65 Cities.

Heat-Related Challenges

Rising urban temperatures bring a range of **heat-related challenges that extend beyond physical discomfort**, affecting public health, infrastructure, economic implications, and social equity. Extreme heat increases the risk of illness and death, with disproportionate impacts on low-income communities, older adults, children, among others. It also reduces worker productivity, raises energy costs, and strains infrastructure.

Public Health

Heat-related illnesses are medical conditions that occur when the body is unable to cope with excessive heat, leading to an increased internal temperature. There are a wide variety of heat-related illnesses, according to the Centers for Disease Control and Prevention (CDC), namely heat stroke, heat exhaustion, heat cramps, heat rash, and heat syncope, referring to dizziness [60] [61]. NYC's Environment and Health Data Portal recognizes that heat can harm people's health, as more than 500 people die from heat-related causes each year in NYC. The data portal shows a direct relationship between maximum daily temperature and heat-related emergency room visits [62].

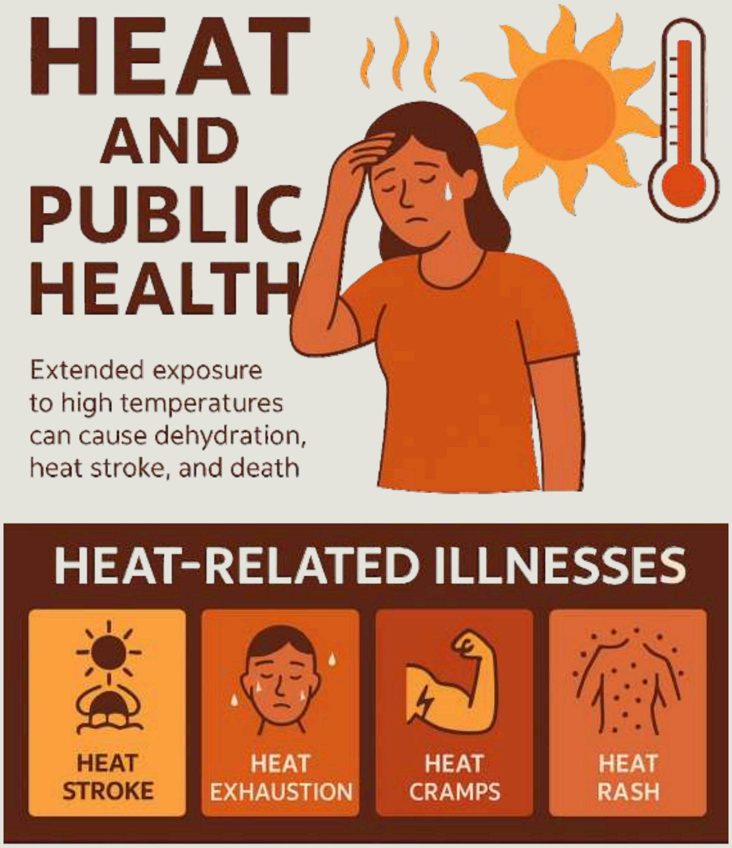


Figure 21. Heat and public health impacts in NYC.

Emergency rooms in NYC received an estimated 725 heat-related visits in summer 2022, a 13% increase from the same period in 2018 [63]. Researchers project this figure could increase sixfold by 2080-2099 compared to the period 1991-2004. Rising temperatures will exceed human body thresholds and strain healthcare systems. Studies have also found statistically significant increases in adverse health effects when the daily maximum heat index is between 76°F and 90°F, including excess cardiovascular hospitalizations, heat stress, dehydration, and kidney failure [64].

Heat Vulnerability

Certain groups are more vulnerable to heat exposure due to systemic hindrances that limit their ability to cope with heat.

The effects of heat are unevenly distributed, with children, pregnant women, senior citizens and people with pre-existing thermoregulation conditions being the most at risk due to physiological and developmental factors that hinder their ability to effectively regulate their body temperature. Over 40% of NYS's resident population is either below 14 years or over 65 years old, which indicates that a large section of the total population is at risk of heat stress [65].

Figure 22. Populations at risk of heat stress in NYS. Vulnerable groups include children, pregnant women, older adults, and low-income and racial/ethnic minorities.

Various socioeconomic factors, such as income and race and ethnicity, influence the vulnerability of certain populations to heat stress as well [66]. In NYS, vulnerability to extreme heat is also closely linked to race. City findings reveal that Black New Yorkers are twice as likely to die from heat stress compared to white residents. Neighborhoods like Harlem and the South Bronx, predominantly Black and Hispanic, can be up to 8°F hotter than wealthier, tree-lined areas. Fewer parks, higher pollution, and limited access to cooling, conditions rooted in historic **redlining** and disinvestment, compound these communities' heat risk.

Low-income and minority residents are more likely to rely on public transportation to get to work and move around their urban environment. Waiting for transit at uncovered stops increases exposure to high temperatures and many public transportation systems lack adequate ventilation and cooling mechanisms. In addition, a large portion of these populations work in jobs with higher outdoor time such as construction, manufacturing and transportation which increases their heat exposure. Both of these factors are exacerbated by the fact that minority communities have been systemically disinvested in, lack adequate green space, and have more heat-trapping infrastructure.

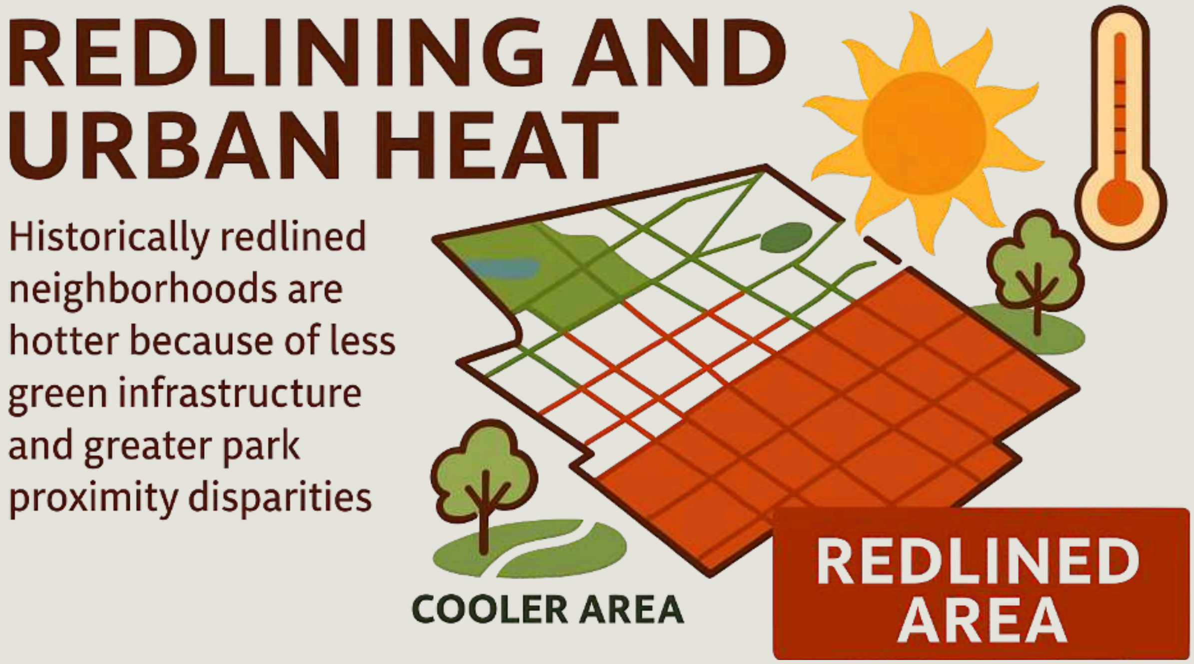


Figure 23. Relationship between historical redlining and urban heat. The graphic shows how formerly redlined neighborhoods experience higher temperatures due to reduced green infrastructure and limited park access.

What is redlining?

In NYS, several cities, including NYC, Albany, and Buffalo, had a historical discriminatory policy of redlining, denying services to residents of certain neighborhoods based on their race or ethnicity. Government agencies primarily denied services by labeling neighborhoods as hazardous and too risky for banks to provide financial services such as loans, mortgages, and insurance [67]. Redlining practices have disproportionately harmed Black and Latin communities, and the effects remain far-reaching [68]. Governments and developers invested less in green infrastructure in historically redlined neighborhoods when compared to their white counterparts, and the disparity is shown in park proximity and tree canopy density in these neighborhoods [69].

The city's coolest areas in recent summers are in proximity to major parks such as Central Park, Prospect Park, and Brooklyn Bridge Park [70]. Further analysis found that out of 179 major U.S. cities, 150 of them show historically redlined districts experiencing hotter summers than non-redlined areas. Communities that experienced housing discrimination in the past are also subject to hotter temperatures today and therefore are more susceptible to heat-related illnesses such as heat stroke and heat exhaustion [71] [72]. Additionally, the cities of Buffalo and Albany experience disproportionate levels of heat and reaffirmed the notion that formerly redlined neighborhoods experience this inequity in heat intensity outside of NYC [73].

Economic Impacts and Vitality

In hot weather, people on the streets avoid unshaded streets and open-air venues, leading to harmful economic impacts. Reduced outdoor activity during summer months means decreased event durations, lower visitor retention and decreased usability of public spaces. On average, public transit trips fall by nearly 50% on extreme heat days and when hourly temperatures reach 86°F, people are 5% less likely to go to public parks, and when hourly temperatures hit 95°F, people are 13% less likely to go to those parks [74]. Researchers found that outdoor leisure begins to decline around 90˚F, and higher temperatures lead to larger, statistically significant drops [75]. Daily maximum temperatures over 100˚F reduce outdoor leisure by 22 minutes compared to days between 76˚F and 80˚F [76]. Production by workers in extreme heat also declines, as a 1°F increase in the average summer temperature is associated with a reduction in the annual growth rate of state-level output of up to 0.25 percentage points [77]. Heat-related decreases in labor productivity alone are estimated to cost approximately $100 billion annually in the United States. These production and consumption trends during extreme heat events are problematic for the New York State economy as the frequency of extreme heat days are projected to continually increase.

Figure 24: Market in NYC.
Source: The Bluntness

Infrastructure

Increased heat leads to increased energy consumption by individuals, which strains the power grid and leads to increased energy costs. The 2024 New York State Climate Impact Assessment states that changes in outdoor temperature will influence the amount of energy New Yorkers use to heat or cool their homes and buildings, and more widespread heat waves will limit energy supplies for New York as neighboring states face high demand for cooling [78]. Indoor cooling systems, such as air conditioning units, accounted for a 37% increase in electricity demand in the United States from April to September 2024 compared to the same period in 2023 [79]. The adoption of air conditioning is projected to keep increasing in the United States, as the number of households with Air Conditioners has increased from 66.1 million in 1993 to over 100 million in 2015, an adoption rate change from 66.1% to 87% [80]. NYC has already recognized the increasing strain on infrastructure to meet increasing energy generation and passed Local Law 84 in 2009 to mandate reporting of energy use by buildings above certain loads to reduce strain on the energy infrastructure [81].

As temperatures rise, materials like concrete, asphalt, and steel expand and can develop cracks. Engineers include joints in roads to accommodate this movement, but when heat exceeds the design limits, the materials continue expanding until they buckle, heave, or develop bumps and cracks. At points where moisture has seeped in, the expansion effect is magnified [82]. The sun heats steel rails, causing them to expand, reaching much hotter temperatures than the surrounding air. The expansion can cause the rails to bow outward or curve, jeopardizing the rail's ability to operate safely [83]. Prolonged exposure to high temperatures can even degrade electronic traffic signals, causing control units to overheat and malfunction [84].

Conclusion

Climate change is increasing temperatures in NYS. Along with rapid urbanization and population growth across NYS, the intensity and frequency of extreme heat events in urban areas are increasing. Higher annual temperatures and the growing prevalence of heat-retaining materials in the built environment increase heat-related health risks and place disproportionate burdens on vulnerable populations, including children, the elderly, and low-income communities. Not only do these trends intensify heat-related illnesses and strain public health systems, but they also compromise critical infrastructure and economic vitality. As urban areas continue to expand, the need for comprehensive adaptation and mitigation strategies becomes increasingly urgent. Efforts to address these challenges must prioritize equitable solutions that reduce exposure, increase community resilience, and promote sustainable urban development in the face of worsening climate change.

The Proposed Solution

Figure 25: Buffalo, NYS. Source: Getty Images

Introduction

To address the growing threat of rising temperatures and UHIE, the SHADE Act (S1028) establishes a competitive grant program for New York State municipalities to propose shade infrastructure projects in their communities. Shade structures serve as a cooling solution and adaptation strategy to reduce the strain on individuals and their environments in public gathering spaces and transportation areas. This section explains how the SHADE Act's proposed solution directly addresses the problem and outlines the scientific evidence of shade. It also compares different types of shade infrastructure and presents case studies that demonstrate their effectiveness in reducing extreme heat and rising temperatures.

Scientific Principles Behind Heat Mitigation

ALBEDO

Albedo is the percentage of solar radiation that a surface reflects. Materials with high albedo, like leafy tree canopies, white high-density polyethylene (HDPE) shade sails, and polished metal panels, reflect a substantial portion of the sun's short-wave radiation into the atmosphere before the surface converts the radiation into heat. Light colored materials typically have a higher albedo and absorb less solar radiation [85]. By reducing absorbed energy, shade can lower concrete surface temperatures in these areas by up to 68ºF. Reflecting rather than absorbing solar heat also weakens the UHIE by limiting the energy that pavements and roofs store and later release.

EVAPOTRANSPIRATION

Trees and other plants cool their surroundings by releasing water through microscopic pores in their leaves, called stomata. Trees draw water up from their roots, and as the water evaporates at the leaf surface, it absorbs latent heat—about 8,000 kJ per gallon (2.3 kWh)[86]. This process can cool neighborhood temperatures by about 3-9ºF on a hot afternoon [87]. Even a 10% increase in tree canopy can lower local temperatures by 0.18°F on heavily paved urban blocks. Larger leaf area increases the cooling effect.

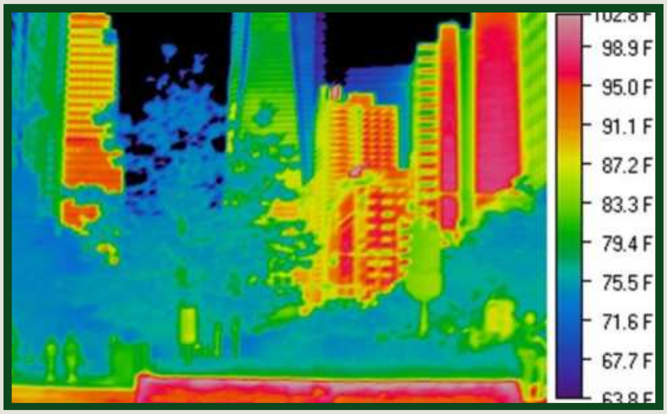


Figure 26: Thermal imaging shows how built environments trap heat, with buildings reaching the highest temperatures while surrounding vegetation remains cooler.
Source: Photo © Nickolay Lamm

Figure 27: Tensil shade infrastructure

AIRFLOW ENHANCEMENT

Gaps between tree trunks and perforations in lightweight canopies disrupt the stagnant boundary layer that hovers around hot pavement. These features promote breezes that carry away stored heat and cool the surrounding air. By shading asphalt and built structures early in the morning, shade structures lower heat retention. Surfaces that receive early shade often stay up to 20ºF cooler later in the day, reducing re-radiated heat and dampening the nighttime UHIE spike [88].

OZONE REDUCTION

Shaded streets remain below the temperature threshold that accelerates ozone formation by limiting the photochemical reactions between nitrogen oxides (NO_x) and volatile organic compounds (VOCs). Additionally, leaves absorb nitrogen dioxide and trap fine soot, improving urban air quality [89].

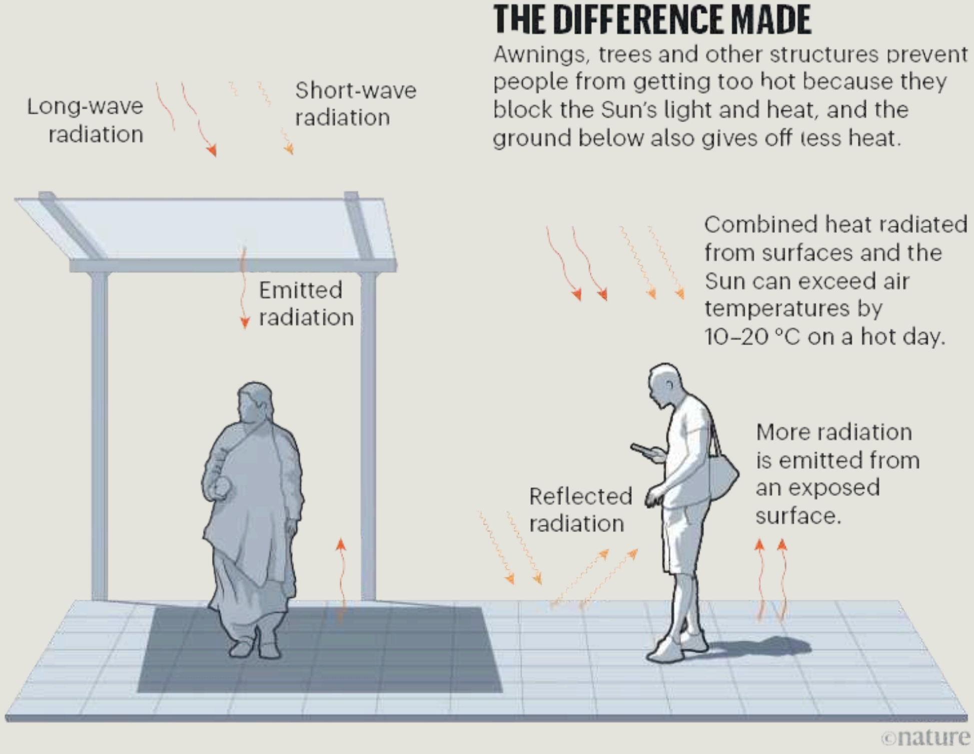


Figure 28. The difference made by shade in reducing heat exposure. Shade structures such as awnings block short-wave solar radiation and reduce emitted long-wave radiation from the ground, lowering heat stress for people underneath. In exposed areas, combined heat from direct sunlight, reflected radiation, and heat emitted from surfaces can raise experienced temperatures by 10-20 °C on hot days.Source: Nature

Materials Comparison

The materials used in shade infrastructure influence its effectiveness, and each material has its distinct benefits:

Vegetation	
Examples	• Trees, vines, green roofs
Pros	• Intercepts up to 90% of direct sunlight. • Provides significant evaporative cooling, promotes airflow, creates habitat corridors, slows stormwater runoff, and improves soil services. • Green roofs maintain temperatures 30-50ºF cooler than black asphalt [90]. • Vine-shaded walls stay 15-25ºF cooler than bare masonry.
Cons	• Requires time to mature (trees), ongoing maintenance (watering, pruning), and can be limited by available soil space.


Figure 29: Vegetation providing shade


Figure 30: Asphalt in front of a city

Metals (Perforated Metal Panels, Polished Metal Panels)	
Pros	• High albedo (polished metal), effective in solar reflection, durable. • Perforated designs can promote cross-breezes.
Cons	• Can absorb and re-radiate heat if not designed with proper ventilation or reflectivity. • Releases absorbed heat at night

Figures 31, 32. AI-generated images representing shade infrastructure for bus stops, featuring designs with perforated metal panels (left) and a green roof system (right). Source: Chat GPT.

Figure 33. Steel walkway covered with shading net. Source: Getty Images.

Fabrics (High-Density Polyethylene - HDPE)	
Pros	• High albedo (bright white HDPE), effective in solar reflection, can lower underlying surface temperatures by 30ºF [91]. • Offers instant daytime relief.
Cons	• Does not provide evapotranspiration benefits or habitat creation.

Figures 34. AI-generated images representing shade infrastructure Source: Chat GPT.

Figure 35: Solar parasol on the Arizona State University campus, providing shade and power.
Source: Grey Gartin, The State Press

Figure 36: Tensile Fabric Shade Structures. Source: Getty Images.

Figure 37: Tensile Fabric Shade Structures. Source: Getty Images.

Types of Shade Infrastructure

Many public spaces—such as transportation hubs, park plazas, and city streets—require shade infrastructure to meet their distinct needs. The SHADE Act promotes a variety of shade infrastructure options:

- **Tree Canopy:** This includes street trees, pocket parks, parking lot plantings, and greenways. They intercept direct sunlight and cool through evapotranspiration.
- **Vine-Covered Trellises & Pergolas:** Fast-growing climbers over lightweight wood or metal frames. They are installed above benches, sidewalks, or building façades. They provide solar interception and evaporative cooling, maturing more quickly than trees.
- **Green Roofs:** Shallow soil pits on flat or low-slope roofs with sedum or drought-tolerant grasses. They intercept sunlight, insulate the roof, and facilitate evapotranspiration.
- **Cool Roof/Cool Pavement Shade Structures:** High-albedo tensile sails, made of HDPE, perforated metal panels, or reflective fiberglass bus shelters. Their primary effect is solar reflection, and open-sided designs promote cross-breezes.
- **Photovoltaic (PV) Canopies / Solar Carports:** Solar panel arrays over parking lots, transit stops, and schoolyards. They block direct sun while generating power, and often include ventilation to prevent heat storage in the underlying asphalt.
- **Mobile or Temporary Shade:** Events or street markets use umbrellas and portable tensile sails. They quickly create shade that blocks heat from reaching the pavement and reduces the mean radiant temperature for pedestrians.

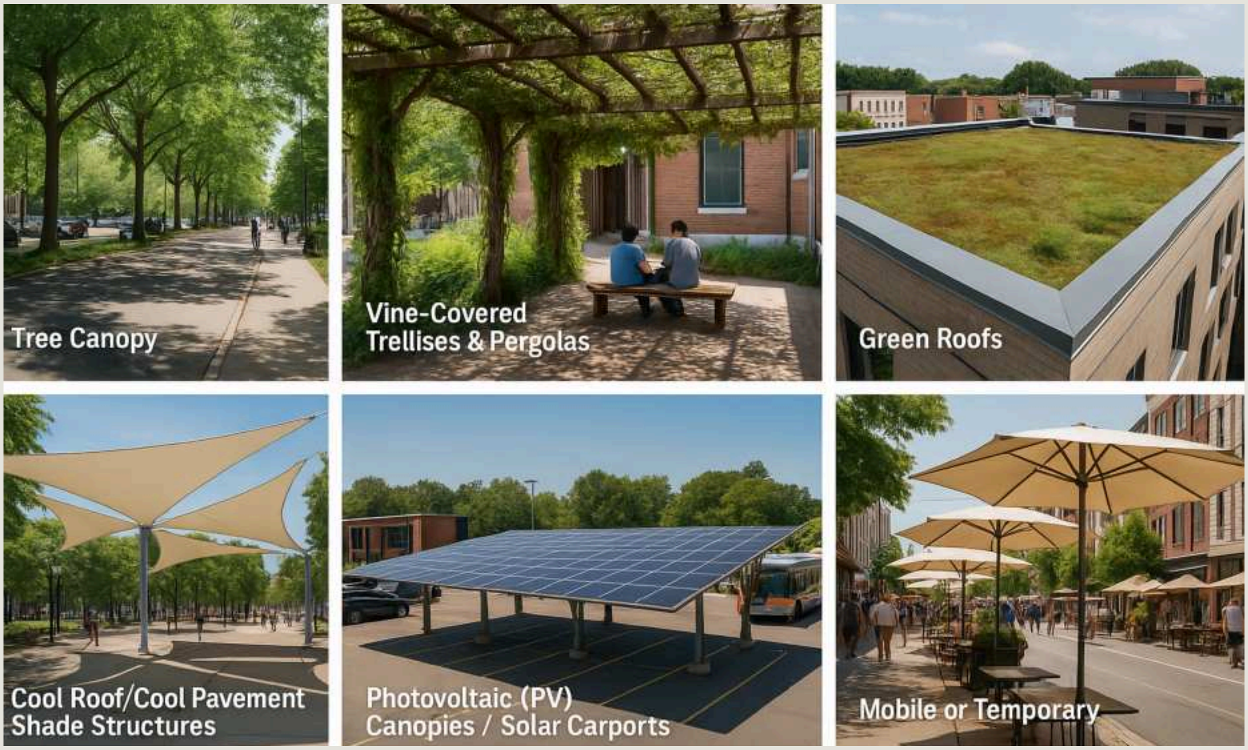


Figure 38. AI-generated images representing different types of shade infrastructure. Source: Chat GPT.

How the SHADE Act Addresses the Problem

Health Benefits Associated with Shade Infrastructure

Shade infrastructure's cooling effect has a direct and measurable impact on public health. Researchers modeled data from Los Angeles County's most heat-vulnerable residents and found that increasing urban tree cover by 25 to 40 percent could significantly reduce heat-related emergency department (ER) visits [92]. Additionally, urban tree canopy of at least 40% results in 7-9°F of cooling [93].

Vulnerable populations such as children, seniors, low-income residents, and transit users face a higher risk of heat-related illness and may experience worsening of existing physical and mental health conditions. A study found an 8% increase in mental health-related emergency department visits on the hottest summer days compared to the coolest [94]. Heat worsened conditions such as substance use disorders, anxiety, mood disorders, schizophrenia, self-harm, and childhood behavioral disorders [95]. Additionally, research shows that shade reduces thermal stress on the human body, improving outdoor thermal comfort and lowering health risks [96]. By investing in shade infrastructure, SHADE Act supports climate adaptation efforts that aim to reduce heat-related illness, hospitalizations, deaths, and the overall burden on the healthcare system.

Drives Economic Vitality Through Outdoor Accessibility

Studies show that shaded areas increase pedestrian presence and dwell time, which in turn boosts retail activity, dining, and social engagement in local economies [97]. In hot weather, people avoid unshaded streets and open-air venues, meaning that shaded infrastructure not only improves comfort but also functions as an economic stimulant. Researchers found that outdoor leisure begins to decline around 90°F, and higher temperatures lead to larger, statistically significant drops.

Daily maximum temperatures over 100˚F reduce outdoor leisure by 22 minutes compared to days between 76˚F and 80˚F [98]. Additionally, a study found that people are 5% less likely to visit public parks when hourly temperatures reach 86°F, and 13% less likely when temperatures reach 95°F [99]. By expanding access to cooled outdoor zones, the SHADE Act encourages safe outdoor activity and transforms public infrastructure into a community asset.

By reducing temperatures, shade can also lower surrounding cooling demands and ease pressure on the power grid. Lower temperatures reduce the amount of energy buildings require to maintain a comfortable indoor temperature, via air conditioning or other cooling methods. Buildings face overheated interiors, roof damage, and increased air conditioning use, which adds stress to power grids and adds risk of blackouts. Heatwaves increase air conditioning demand while also reducing the grid's ability to transmit electricity efficiently, placing greater pressure on the energy system. Heat also raises demand on water systems, strains pipes, and raises the likelihood of sewage overflows. A 2023 report from the New York State Energy Research & Development Authority (NYSERDA) developed climate change projections, categorizing them as mild, moderate, and severe [100]. The report found that electricity system costs increase significantly in the moderate and reference cases and severe and reference cases, increasing by 7% and 15% respectively. In the severe scenario, annual cost impacts more than double between 2050 and 2100.

These impacts highlight the need for cooling infrastructure in the built environment, especially in developed and heat-vulnerable areas.

Empowering Municipalities to Tailor Solutions

A key strength of the SHADE Act is that it encourages municipalities to identify, design, and implement shade projects tailored to their specific environmental, social, and geographic contexts. The SHADE Act helps municipalities reject one-size-fits-all mandates and instead fosters creativity, accountability, and climate-responsive planning.

Case Studies

Successful implementations in various locations demonstrate the effectiveness of shade infrastructure in various locations, including NYC.

ARIZONA STATE UNIVERSITY, PHOENIX

Arizona State University (ASU) has increased shade on its Tempe campus using tree canopies and solar structures like PowerParasols [101]. These structures, equipped with 1,380 solar panels, provide shade and generate energy, significantly reducing surface temperatures and making outdoor spaces more usable [102] [103].

- To enable planning ahead, ASU has developed a web tool, ASU Cool Routes, which combines Light Detection and Ranging (LiDAR) surface models with MRT forecasts and data to compare walking paths' thermal comfort [104].
- ASU actively works to alleviate thermal stress, as Tempe's average yearly temperature reaching over 70ºF [105]. ASU has an urban climate research group, the SHaDE lab, which has developed multiple tools relating to shade, heat, and temperature [106]. WebMRT is a online Machine Learning based tool that can predict summertime MRT using air temperature, shade status, and built environment features [107]. Similarly, another tool is PanoMRT which can calculate thermal exposure and comfort using panoramic infrared thermography [108].
- The same lab conducted a project that built shade performance curves, by evaluating the effectiveness of different forms of shade along the campus [109]. The study found that during the day, shade from urban structures (like building overhangs, tunnels, canyons, etc) had the most effective decrease in surface temperature and MRT, followed by trees and lightweight structures. All shade types had a daytime cooling impact on the three thermal metrics, with varying degrees of success.

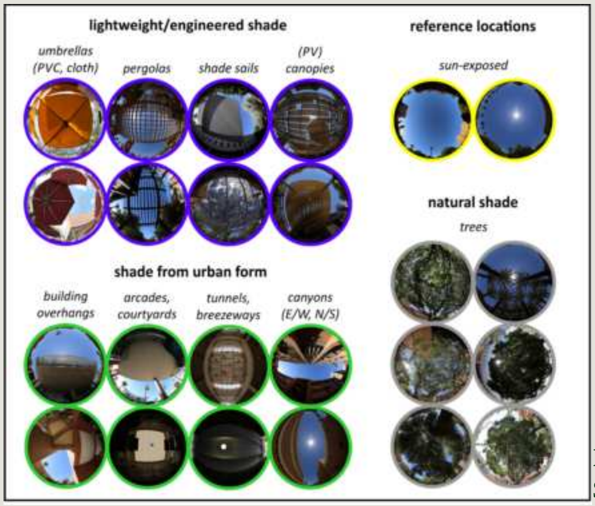


Figure 39: Forms of shade.
Source: Building and Environment

NEW YORK CITY BUS STOP HEAT SCAN STUDY BY TRANSPORTATION ALTERNATIVES & NASA, 2024

A study revealed that four out of five NYC bus stops lack adequate shade shelters and can be up to 14.5ºF hotter than shaded stops. Lower-income municipalities contain many of these stops. The study also found that green-roof shelter installed in a high-vulnerability community reduced its temperature by nearly 15ºF on a 96ºF afternoon, highlighting the immediate cooling benefits of targeted shade [110].

SINGAPORE

Urban planners in Singapore have created an extensive network of tree-lined streets, shaded walkways, and vertical greenery. Research indicates that shaded areas in Singapore consistently remain several degrees cooler than exposed zones, showcasing the broad impact of integrated shade solutions. Singapore's strategic use of architectural shading devices, such as canopies and covered linkways, complements its natural greenery to form a continuous cooling network throughout the city. These features not only enhance pedestrian comfort but also reduce UHIE by limiting direct solar exposure on pavements and buildings.

This holistic approach to shade infrastructure demonstrates how thoughtful design can significantly improve thermal comfort in dense urban environments. Research shows that urban greenery in Singapore can reduce surrounding temperatures by up to 9°F, and combining vegetation with built shading can lower surface temperatures by as much as 20°F [111] [112].

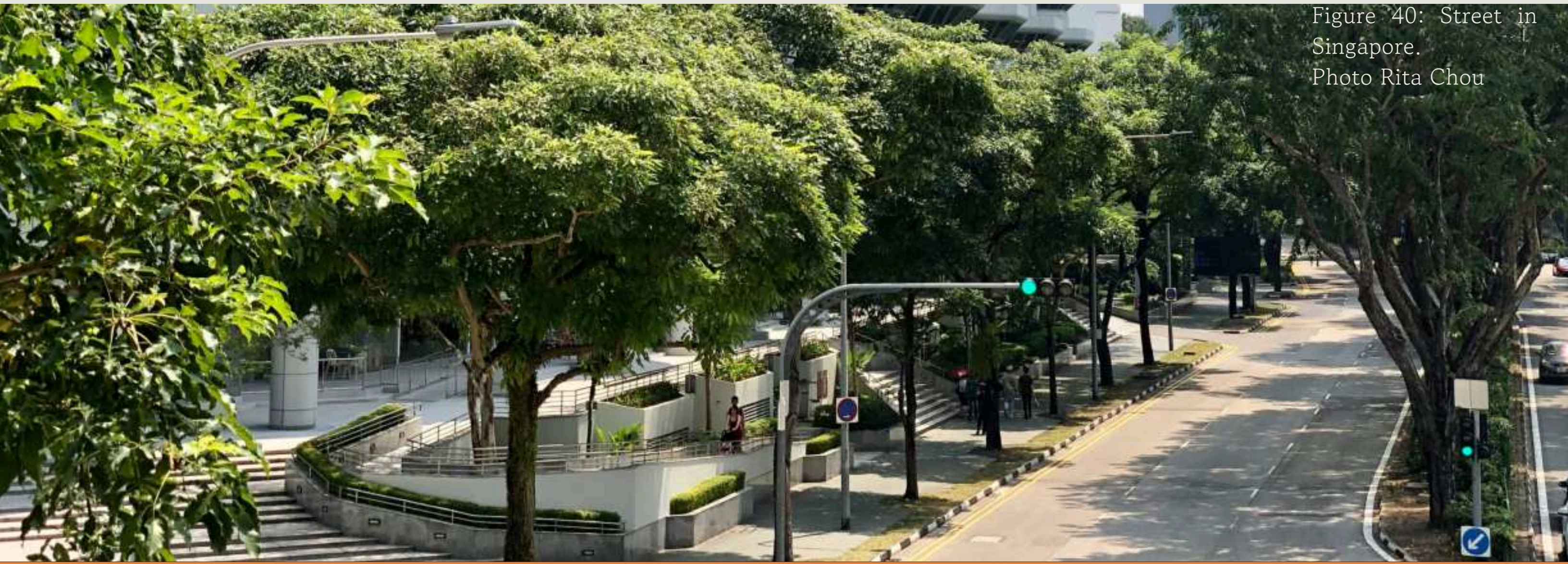


Figure 40: Street in Singapore.
Photo Rita Chou

LOS ANGELES URBAN COOLING PROJECT

- Los Angeles (LA) launched the Cool Streets LA program in 2019, demonstrating how municipal leadership can successfully implement comprehensive shade and cooling infrastructure [113]. The program exemplifies the type of innovative, multi-strategy municipal project that the SHADE Act aims to support through its competitive grant structure [114].
- The initiative deployed 60 miles of cool pavement and nearly 2,000 shade trees across vulnerable neighborhoods including Pico-Union, Westlake South, North Hollywood, and the San Fernando Valley [115]. This demonstrates how municipalities can successfully scale shade infrastructure across diverse urban environments - exactly the type of comprehensive approach the SHADE Act encourages.
- LA's success came from combining the same shade infrastructure types promoted by the SHADE Act:
  - Vegetative shade: Strategic tree planting in heat-vulnerable areas
  - Structural shade: Bus shelters and shade structures at transit points
  - Cool surface materials: High-albedo pavements that reflect rather than absorb solar radiation
  - Community-focused placement: Targeting neighborhoods with the greatest heat vulnerability
- The program achieved measurable cooling benefits, with cool pavement surface temperatures up to 11°F cooler than regular asphalt [116] [117]. This success story proves that municipal shade infrastructure projects can deliver the quantifiable mean radiant temperature reductions that the SHADE Act requires for grant eligibility.

Figure 41: Los Angeles

Defining Success

Figure 42: Upstate New York

Introduction

ESD will track the success of SHADE Act projects by measuring two primary outcomes: reduced temperatures and increased public use of shaded areas. These success metrics allow ESD to assess whether each project improves thermal comfort, expands access to public space, and delivers economic and health benefits. This section outlines how ESD will measure progress using quantifiable data, site-level monitoring, and reporting milestones across six core performance areas.

Defining the SHADE Act's Success Metrics

ESD will evaluate shade infrastructure projects based on two main criteria: measurable reductions in MRT and the number of residents or events served. These serve as the SHADE Act's core success metrics. By focusing on these metrics, ESD ensures that selected projects advance the six intended outcomes outlined below. ESD will also assess the economic implications of each metric, consistent with its broader framework for evaluating grant programs through impact on revitalization of underused areas and economic growth.

Mean Radiant Temperature (MRT)

MRT measures the average temperature of surrounding surfaces such as pavement, buildings, and other structures that radiate heat toward a person [118]. It captures how the human body gains or loses heat through radiation rather than just through the air, making it a key factor in how people experience thermal comfort outdoors.

Inputs	
Baseline Data Collection	Field readings using globe thermometers or black globe sensors in both shaded and unshaded areas during peak heat periods (June - September); • Surface material descriptions; • Nearby structure / material reflectivity
Modeling	• MRT before installation; • Solar exposure and site-specific shadow modeling; • Seasonal weather station data
Project Design	• Materials used; • Shading angles, structure height, and area covered; • Location context

Outputs:	
Thermal Performance Metrics	• Cost per degree of MRT reduction; • Cost per square foot of effectively cooled area; • Reduction in solar exposure per user
Secondary Temperature Metrics	• Surface temperature beneath shade structures; • Ambient air temperature at pedestrian height
Localized Heat Island Impact	• Localized urban heat island intensity

Residents and Events Served

This metric serves as a proxy for public benefit by estimating how many residents will use or benefit from shaded infrastructure in public gathering spaces such as bus stops, sidewalks, plazas, or parks. It helps ESD evaluate both reach and equity of project impact.

Inputs	
Baseline Data Collection	• Pedestrian counts at proposed sites; • Public transit boarding and alighting data; • Census or American Community Survey (ACS) population data within a quarter mile radius.

Outputs:	

Quantified Impact	• Number of daily or weekly users / foot traffic
	  ◦ Observational or sensor-based counts of users
	  ◦ Self-reported usage via surveys, quick-response (QR) code check-ins, or intercept interviews
	• Average duration of use per person in shaded areas;
	• Attendance at shaded events and number of programmed activities.

Cost Efficiency	• Cost per person served; • Cost per user per visit

.

Targets for Each Success Metric

Different types of shade infrastructure will yield different levels of impact based on the materials used, the design approach, and the site in which they are installed. As a result, success metrics will vary across infrastructure types. The table below outlines feasible target ranges for each type of shade intervention under the SHADE Act.

Type of Shade Infrastructure	Mean Radiant Temperature (MRT) Reduction Target (°F)	People/Events Served Target (Percentage Increase %)
Tree Canopy	12-20°F	15-30%
Vine-Covered Trellises & Pergolas	8-15°F	10-25%
Green Roofs	5-10°F	5-10%
Cool Roof/Cool Pavement Shade Structures	6-12°F	10-20%
Photovoltaic Canopies	8-15°F	15-30%
Mobile / Temporary Shade	3-10°F	5-15%

Table 2: The ranges in the table are based on peer-reviewed studies that document the observed impacts of different types of shade infrastructure. They represent infrastructure-specific performance targets rather than location-specific benchmarks. Each location, such as a bus stop, park, or plaza, has different conditions that will affect performance. Most studies do not separate results by location type, so these ranges are based on the type of infrastructure rather than the setting. The SHADE Act acknowledges that not all projects can be evaluated in the same way so these ranges allow for flexibility based on site context. [119] [120] [121] [122] [123] [124] [125] [126]

Figure 43: New York State Capitol.

Defining Success Metrics

KEY PERFORMANCE INDICATORS TO TRACK PROGRESS AND EVALUATE SUCCESS

Key Performance Indicator 1:

Temperature

Intended Outcome: Achieve measurable temperature reductions and improve thermal comfort at shade infrastructure sites for New York State residents.

MONITORING FREQUENCY:

- Conduct MRT field measurements on at least 2 non-consecutive days per week during peak summer months (June - September)
- Take measurements during standardized peak heat hours (12 - 5 p.m.) using globe thermometers or black globe sensors
- Monitor both shaded and unshaded comparison zones to track relative improvement

REPORTING SCHEDULE:

- Submit quarterly monitoring updates summarizing collected data and any anomalies
- Submit a full temperature impact report at Years 1, 3, and 5, including baseline comparisons and interpretation of thermal comfort outcomes

Figure 44. Hot Summer Day

Key Performance Indicator 2:

Public Access and Utilization

Intended Outcome: Increase the number of people who access and utilize shaded public gathering spaces during the months of extreme heat.

MONITORING FREQUENCY:

- Conduct monthly pedestrian counts from June through September using infrared counters, manual tallies, or QR code surveys
- Monitor on at least two non-consecutive days per week
- Collect estimates of average duration of use per person through observation or short surveys

REPORTING SCHEDULE:

- Submit quarterly summaries of user volume and average time spent at the site
- Submit comprehensive access and utilization reports at Years 1, 3, and 5, showing trends in foot traffic, engagement, and user behavior across seasons

Figure 45: Little Island NYC

Key Performance Indicator 3:

Economic Development

Intended Outcome: Support nearby businesses and drive local economic activity by increasing foot traffic and dwell time in shaded commercial areas.

MONITORING FREQUENCY:

- Track business activity quarterly using local business surveys, commercial occupancy trends, or foot traffic patterns in commercial areas
- Conduct 2 business interviews or surveys per year (pre- and post-summer)

REPORTING SCHEDULE:

- Submit quarterly economic summaries including any observed shifts in customer volume or duration
- Submit detailed economic development reports at Years 1, 3, and 5

Figure 46: NYC street

Key Performance Indicator 4:

Resource Efficiency

Intended Outcome: Maximize cost-effectiveness by measuring the temperature reduction and public benefit achieved per dollar spent.

MONITORING FREQUENCY:

- Track costs and usage estimates annually
- Calculate cost per degree of cooling, cost per user, and cost per square foot shaded

REPORTING SCHEDULE:

- Submit Year 1 and Year 5 cost-effectiveness reports detailing all unit cost metrics and comparisons across infrastructure types

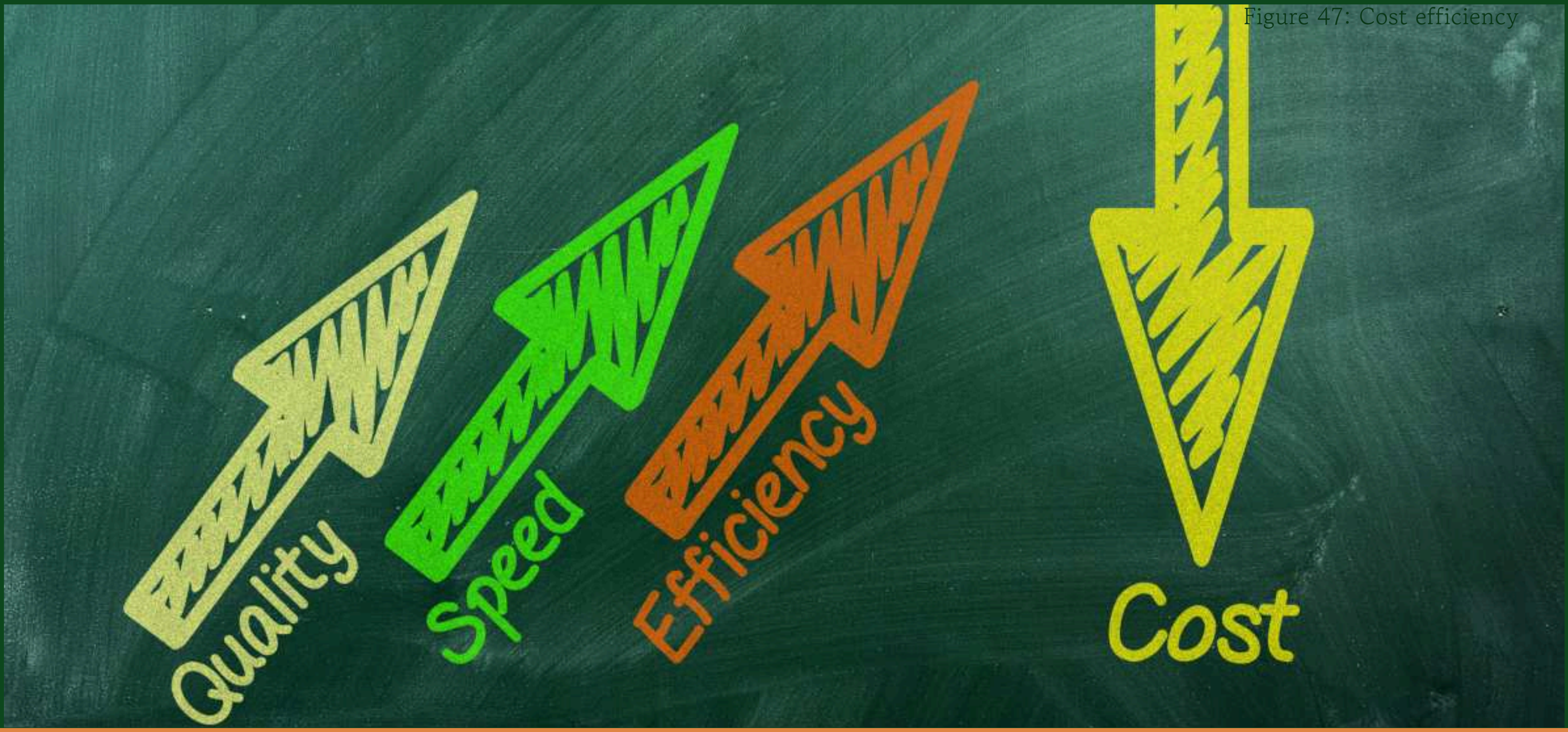


Figure 47: Cost efficiency

Key Performance Indicator 5:

Public Health

Intended Outcome: Reduce exposure to extreme heat and heat-related illness. These interventions aim to lower rates of heat-related emergency room visits and reduce strain on the public health system during peak summer months.

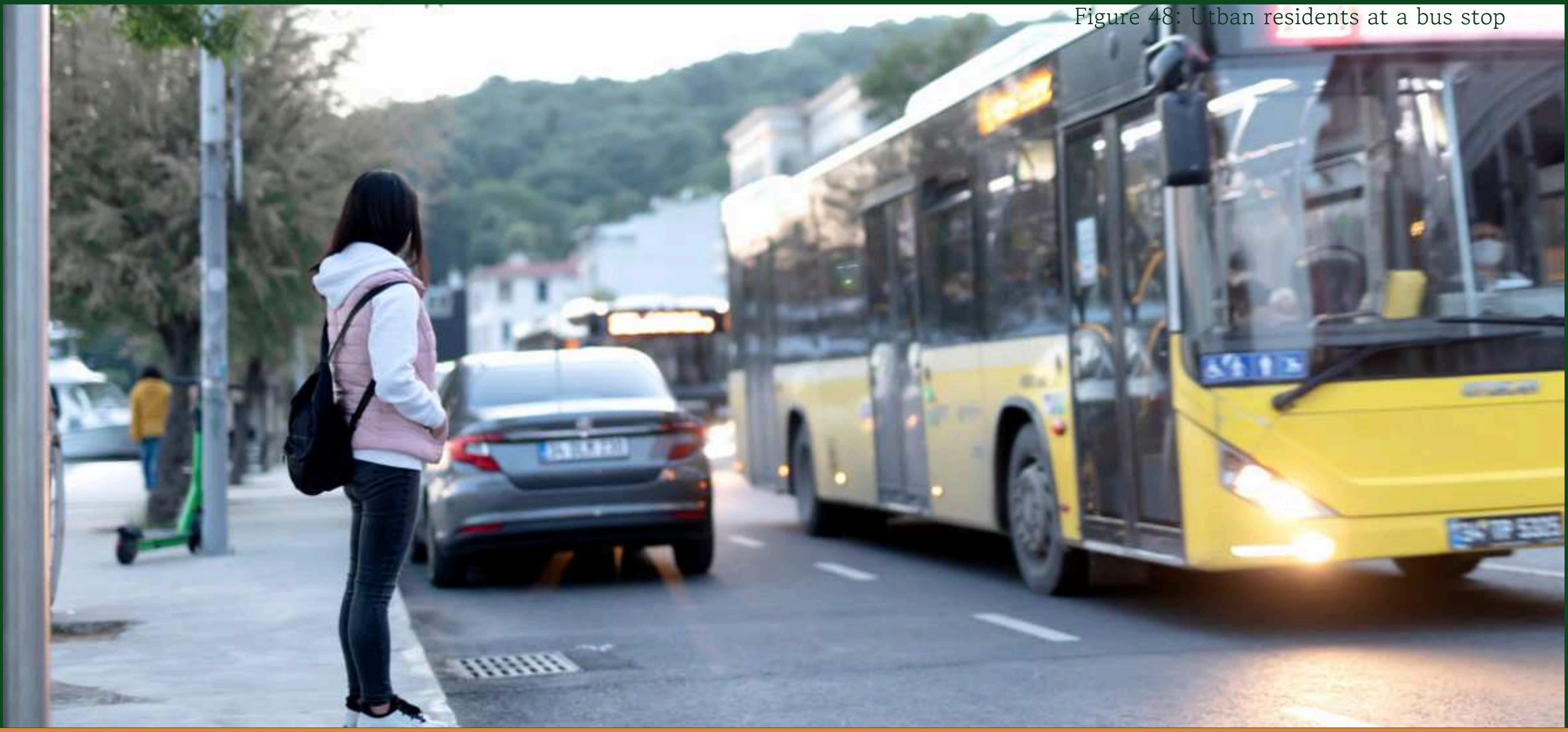
MONITORING FREQUENCY:

- Coordinate with local or county health departments to obtain annual data on heat-related illnesses and ER visits
- Conduct one community health survey each year (preferably post-summer) to gauge perceived safety, comfort, and access to cooling infrastructure

REPORTING SCHEDULE:

- Submit health impact reports at Years 1, 3, and 5, including quantitative data and qualitative data

Figure 48: Urban residents at a bus stop



Key Performance Indicator 6:

Infrastructure

Intended Outcome: Reduce strain on critical infrastructure systems during extreme heat events. Mitigate stress on roads, transit systems, buildings, and utilities/power grid by cooling the built environment and reducing localized heat intensity.

MONITORING FREQUENCY:

- Track indirect indicators such as reductions in energy demand, pavement damage, or system maintenance reports in shaded zones seasonally

REPORTING SCHEDULE:

- Submit quarterly infrastructure condition logs
- Submit full infrastructure performance reports at Years 1, 3, and 5, including observations on physical resilience, asset longevity, and potential co-benefits such as reduced cooling load or avoided maintenance costs

Figure 49: Cooling methods

Defining Success Metrics

Figure 50: People enjoying outside shaded areas

Conclusion

Through these success metrics and key performance indicators, ESD will translate shade infrastructure investments into measurable public outcomes. ESD will verify whether projects lower heat exposure, increase equitable access to outdoor spaces, and strengthen local economies.

Measuring success requires a combination of scientific, social, and economic data. ESD will use temperature readings, pedestrian counts, surveys, and business activity reports to reflect these dimensions, while recognizing that results will vary based on site conditions and project scale. Shade serves multiple purposes, so its impact must be evaluated through multiple lenses.

Scientific + Political Controversies

Figure 51: Air pollution

Introduction

Climate change is increasing extreme heat risks for health, infrastructure, and the economy. The SHADE Act seeks to expand shade infrastructure across NYS, representing an important adaptive measure. However, the SHADE Act is not the most effective stand-alone solution for mitigating the UHIE or for achieving substantial, city-wide temperature reductions. As an infrastructure-focused policy, it raises scientific, socioeconomic, and political challenges, including material effectiveness, climate limitations, governance complexities, equity concerns, and ongoing maintenance issues These are grouped into: (1) Scientific Issues and (2) Socioeconomic and Political Controversies.

Material Effectiveness Comparison

Different shade materials offer varying levels of effectiveness in temperature reduction and Ultraviolet(UV) protection. Shade structures can reduce UV radiation exposure by up to 75%, but effectiveness varies by material type. Severe weather conditions impact infrastructure durability, which vary by material [127].

Metal:

- Metal shades are durable and can provide full physical coverage, blocking UV radiation. However, metal surfaces can absorb and conduct heat especially when exposed to direct sunlight. Metal structures store and gradually emit heat, particularly at night. Without design features like reflective coating or ventilation, metal structures can create hot microclimates underneath, reducing thermal comfort and increasing heat exposure despite providing UV protection.
- Shade effectiveness depends on the specific materials selected, such as steel or aluminum. Steel's strength and durability make it ideal for large-scale structures that must withstand wind or snow. However, steel's heaviness and tendency to rust mean it needs regular treatment, like galvanization or powder-coating to prevent corrosion from acid rain. Aluminum is lightweight and corrosion-resistant, offering strength and durability, but at a higher cost.

Figure 52: Metal

Polymer

- Polyester shade structures are used because of their flexibility, stiffness, heat reduction, and UV resistance. Structures with about 70% shade coverage have shown temperature reduction of 15-22°F [128]. Different polymers give shade structures distinct characteristics. High-Density Polyethylene (HDPE) blocks up to 98% of harmful UV rays, is durable, requires low maintenance, and is cost effective [129]. However, this material is less effective during the rainy season. Polytetrafluoroethylene (PTFE) is a flexible, durable, weather resistant, long lasting, and low maintenance material.It can reflect 85-97% of UV radiation and lower surface temperatures by 2-12°F [130]. These materials balance heat mitigation and UV protection well, hence their popularity for urban shade infrastructure.

Method of Shade Infrastructure

Nature-based solutions (NBS) harness the natural functions of healthy ecosystems to provide environmental protection, while providing economic and social benefits. These methods provide urban resilience to heat and UV exposure by integrating green infrastructure into the built environment. NBS not only reduces ambient temperatures but also improves air quality, promotes biodiversity and supports community well-being.

Figure 53: Trees providing shade
Source: Minneapolis 2040

Vegetation

- Natural shading, such as tree canopies, provides cooling benefits. Unlike direct UV protection, trees provide cooling through evapotranspiration [131]. Studies show that each 1% increase in canopy cover aligns with an approximate 0.17°C reduction in local daytime air temperature [132].

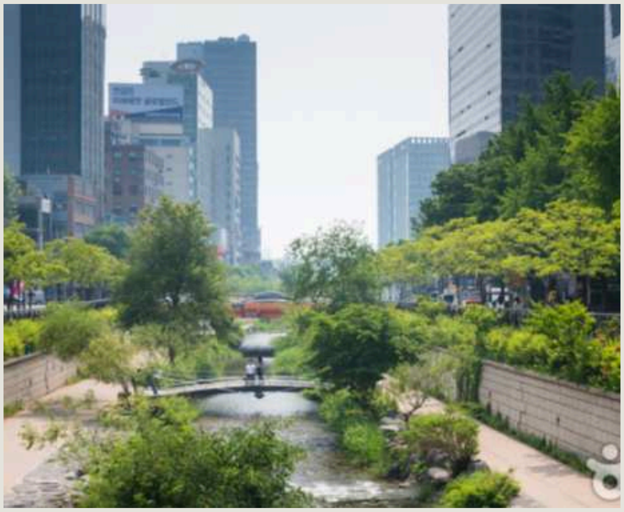


Figure 54: Trees providing shade along Cheonggyecheon in South Korea, a stream running through the center of Seoul's skyscrapers
Source: Visit Korea

However, vegetation presents several challenges:

- Some tree species release large amounts of pollen, triggering asthma and seasonal allergies for people.
- Tree canopies provide shade and cooling during the day, but they can also trap heat at night, especially in areas with dense vegetation and limited airflow through nighttime.
- Dense tree canopies may cause increasing radiative cooling by limiting sky exposure. Raising nighttime temperatures by up to 4°F compared to less vegetated areas [133].
- Meaningful cooling effects require extensive canopy coverage-typically more than 40% over contiguous areas of 60 to 90 square meters [134].

Figure 55. Central Park, NYC

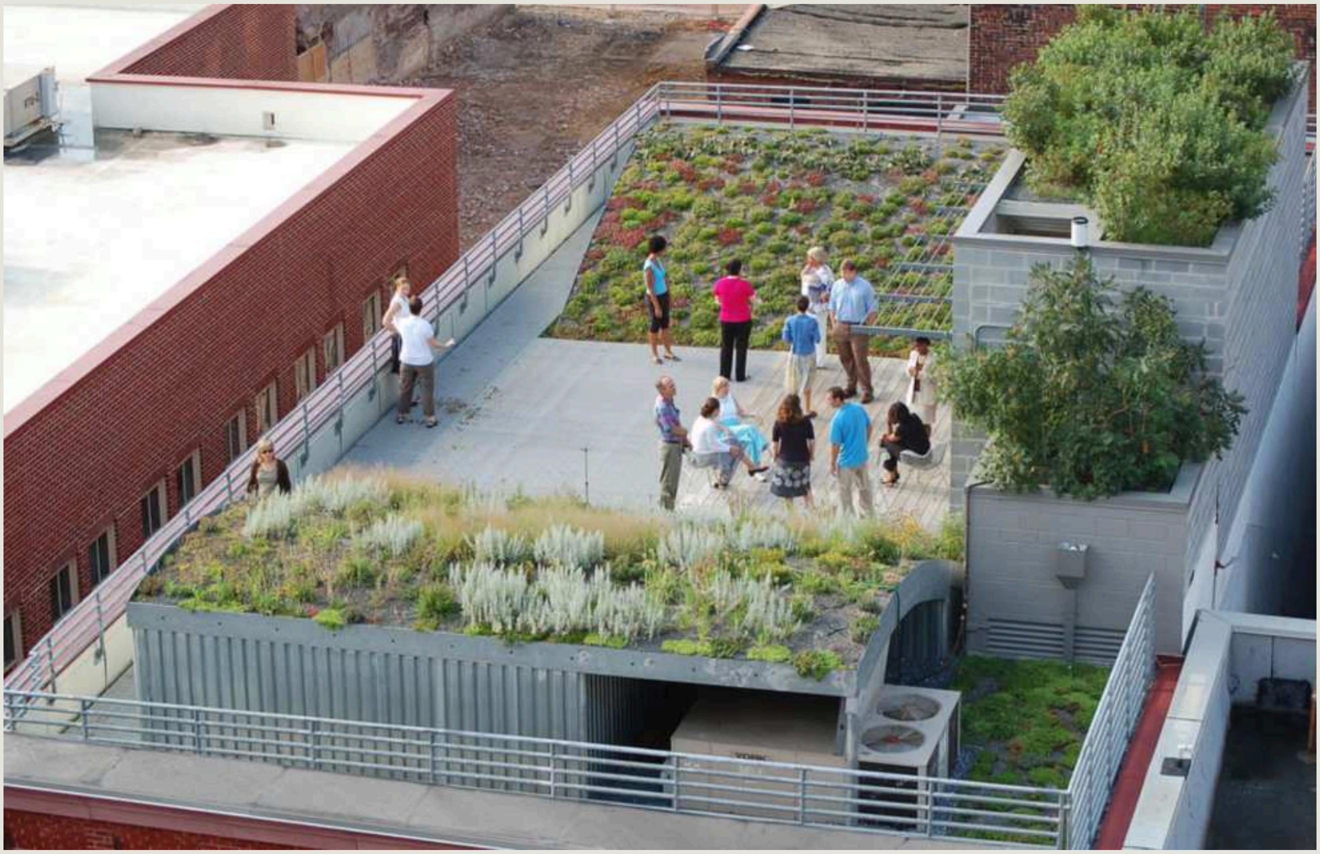


Figure 56: Green roof at American Society of Landscape Architects (ASLA) Headquarters Green Roof, Washington, D.C.
Source: ASLA

Green roofs and walls

Urban planners promote green roofs and vertical green walls for their ability to reduce heat absorption and thus mitigate the UHIE. Covering buildings with vegetation insulates structures, lowers surface temperatures, and helps manage stormwater. Studies show green roofs reduce roof surface temperatures by 36-72°F, sometimes up to 86°F compared to conventional roofs [135]. The actual cooling benefits vary based on plant species, building design, irrigation, and maintenance practices. Some studies question green roof scalability, especially in cities with older infrastructure or limited rooftop load-bearing capacity.

The high installation and maintenance costs raise debates on cost-effectiveness and equity, especially if wealthier neighborhoods are the primary adopters of these technologies, reinforcing inequity in heat resilience [136]. In Manhattan, one of the largest green roofs in the United States covers 6.75 acres. A study found that the roof increased biodiversity, retained substantial rainwater, and improved insulation, resulting in measurable energy savings. However, after expansion, the roof developed leaks and required ongoing maintenance to maintain long-term performance [137].

Urban forestry and tree planting

Urban forestry initiatives and strategic tree planting are among the most effective nature-based interventions to combat urban heat and UV exposure [138]. Trees provide extensive canopy cover that shades streets, buildings and public spaces, while their evapotranspiration cools the surrounding air [139]. Trees contribute to carbon sequestration, air purification, and enhanced mental health for residents.

However, urban forestry programs often focus on selecting species adapted to local climate conditions to maximize cooling benefits and minimize maintenance challenges, such as water use and pollen production [140]. Successful implementation requires long-term planning, adequate funding, and community engagement to ensure tree survival and equitable canopy distribution. In 2007, the NYC Department of Parks & Recreation and the New York Restoration Project (NYRP) launched MillionTreesNYC as a joint venture, with the goal of planting 1 million trees in NYC. Many trees died due to insufficient watering, poor maintenance, and vandalism. A recent report found that only 76% of street trees survived after five years [141].

Broader Environmental Considerations

Combating urban heat requires evidence-based solutions, including the growth of tree canopies/green roofs, the replacement of dark asphalt with high-albedo pavement, and the installation of permeable surfaces. Although shade lowers local temperatures, it has not significantly reduced broader urban temperatures. The SHADE Act aims to lower urban temperatures, but its current strategies are not the most effective. These strategies need to account for the limitations of shade infrastructure.

Greenhouse Gas (GHG) Emissions and Long-Term Climate Change

Although shade infrastructure alleviates localized heat stress, it does not address the true cause of climate change. GHG emissions, particularly from fossil fuel combustion, are the primary contributors to global temperature rise and intensify the UHIE. New York State has experienced a temperature increase of approximately 2.6°F (from an average of 45.4°F in 1895-1924 to 48.0°F in 1991-2020) over the past century. Projections indicate a further rise of 4-6°F by 2050 and 5-9°F by 2080 compared to 1981-2010 baselines. Summer temperatures that now average 73°F could reach 78-82°F by the end of the century. While the SHADE Act is a valuable short-term adaptation tool, it must be paired with long-term GHG mitigation policies to address the underlying causes of urban warming [142].

Ozone Formation

High urban temperatures accelerate the formation of ground-level ozone through photochemical reactions involving sunlight and pollutants from vehicles and industry. Shaded environments can reduce surface temperatures and slow these reactions, but shade does not filter or remove airborne pollutants. In NYC, ground-level ozone often exceeds the Air Quality Index threshold of 100, prompting health warnings [143]. Poor air quality causes approximately 2,400 deaths annually in NYC. While increased shade may encourage outdoor activity, it also raises concerns about ongoing exposure to polluted air in shaded but high-traffic environments [144].

Socioeconomical and Political Controversies

Figure 57:Climate protest

The SHADE Act's funding model presents structural barriers that limit equitable access to shade infrastructure across NYS. Key issues include financial requirements that disproportionately burden low-income communities and result in uneven distribution of resources. These inequities often leave historically underserved neighborhoods more exposed to extreme heat, with limited access to the long-term benefits of tree canopy and shade infrastructure.

Dollar-for-Dollar Match Funding Requirement

A significant obstacle to fair access under the SHADE Act comes from requiring local municipalities or entities to provide matching funds equal to the grant amount, a structure ESD commonly uses in its programs. Although the policy aims to promote local investment and accountability, this dollar-for-dollar match benefits wealthier municipalities with stronger financial capacity and institutional infrastructure [145].

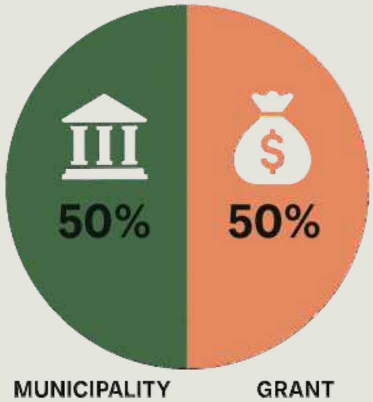


Figure 58: Visual representation of a dollar for dollar match fund

Unequal and Geographic Distribution

When it comes to impacting vulnerable communities, disparities in access to shade and heat risk are widespread across New York State. Areas with higher poverty rates often have 30-40% less tree canopy cover than wealthier areas, leading to urban heat disparities of up to 7°F during summer months [146]. Upstate cities including Albany, Syracuse, and Buffalo prioritize indoor solutions, such as air conditioning, over shade infrastructure [147].

Limited funding and competing infrastructure priorities present challenges for investment in shade projects, such as those for public schools. For example, less than 25% of schools in upstate districts have fully functioning air conditioning systems, often due to budget constraints and urgent repair needs [148]. These challenges limit equitable access to heat relief for vulnerable populations.

Oversight and Transparency Concerns

ESD manages and directs shade infrastructure initiatives. While ESD prioritizes economic growth, business investment, and job creation, critics question its suitability to lead efforts in public health. The watchdog group Reinvent Albany has highlighted ESD's political favoritism, limited accountability, and a lack of transparency in decision-making processes. It is doubtful that ESD prioritizes heat relief in the most vulnerable communities [149][150].

Sustainability and Long-Term Maintenance

Figure 59: Heat has forced us to reevaluate how unnatural this is, long-term.
Source: Photo © Shivangi Shrivastava

Shaded structures provide temporary relief but degrade in the sunlight and require ongoing maintenance. Infrastructure like trees or solar panels require long-term maintenance and sustainability. Deputy Commissioner Licata, New York City Department of Environment Protection, spoke to the council about the challenges of maintaining rain gardens in high traffic areas where litter accumulation requires frequent, data-driven maintenance while balancing other priorities [151]. Requiring a dollar-for-dollar match to get substantial investment and maintenance in infrastructure can be difficult, and municipalities often can't produce the funds.

The case study of Re-Tree Buffalo exemplifies the problems with long-term maintenance of shade structures. Re-Tree Buffalo is a community-driven program launched after the 2006 snowstorm to restore urban tree canopy. While it has planted over 30,000 trees, long-term maintenance is a challenge, especially in low-income neighborhoods. Relying heavily on volunteers and public-private partnerships, the program shows the broader need for sustained funding and long-term stewardship across New York's shade and cooling infrastructure projects [152].

Figure 60: Walkway covered with shading net

Final Conclusion

The Safe Havens for All Day Enjoyment Act (Bill S1028) seeks to address pressing heat-related environmental issues across the NYS, which are compounded by urbanization and land use changes. Rising urban temperatures due to anthropogenic climate change are exacerbated by the ubiquitous use of heat-absorbing materials such as asphalt and concrete in urban areas, increasing the UHIE and making large populations vulnerable to heat stress. This poses not only risks to public health, but also places an immense burden on the power grid due to increased cooling demand, and decreases economic vitality as people become more restricted indoors.

The bill aims to mitigate these issues through a competitive grant program designed to support local municipalities in building shade infrastructure for their communities, with a focus on public transit areas and gathering spaces.

Administered by the ESD Corporation, the program prioritizes proposals that demonstrate the greatest potential to reduce mean radiant temperatures and serve the largest number of people. Program success can be measured through observed temperature reductions and increased public use of shaded spaces.

However, the SHADE act faces both scientific and socioeconomic challenges. The bill is not aimed at tackling the issue of urban heat island itself, but offers a smaller, more localized solution aimed at public transportation hubs and gathering spaces. Material choices for shade structures can vary in effectiveness, and the bill does not explicitly target heat-related vulnerabilities in marginalized communities. Addressing these gaps will be essential to ensuring equitable, long-term solutions for building cooler and more resilient cities.

Glossary

Albedo: The proportion of the incident light or radiation that is reflected by a surface [1]

Built environment: The man-made structures that provide people with living, working, and recreational spaces. [2]

Climate change: Long-term shifts in temperatures and weather patterns caused by human activities since the 1800s, primarily due to the burning of fossil fuels like coal, oil, and gas. [3]

Empire State Development Corporation (ESDC): A public benefit corporation with a mission to promote a strong and growing state economy, encourage business investment and job creation, and support diverse local economies in NYS [4]

Energy burden: Percentage of gross household income spent on energy costs [5]

Evapotranspiration: The Process where water is transferred from the Earth's surface to the atmosphere, primarily through the processes of evaporation (water turning to vapor from soil and plant surfaces) and transpiration (water released as vapor from plant leaves). Evapotranspiration cools the air by using heat from the air to evaporate water. [6]

Green roofs: Vegetated layers installed on top of a building's roof, and also known as living roofs or eco-roofs [7]

Greenhouse effect: A natural process where greenhouse gases in the atmosphere trap heat and warm the Earth's surface, making it habitable [8]

Greenhouse gas (GHG): Gases that trap heat in the Earth's atmosphere and can contribute to climate change if they exceed their natural concentrations, which include carbon dioxide, methane, and nitrous oxide [9]

Glossary

Heat-related illnesses: Illnesses caused by the body's inability to regulate temperature in response to heat and include heat stroke, heat exhaustion, rhabdomyolysis, heat syncope, heat cramps, and heat rash [10]

Heat Vulnerability Index (HVI): The Heat Vulnerability Index shows neighborhoods whose residents are more at risk for dying during and immediately following extreme heat. It uses a statistical model to summarize the most important factors of neighborhood heat risk: surface temperature, green space, home air conditioning, and income. [11]

Heat-vulnerable populations: Groups who are at higher risk of heat due to compromised ability to regulate their body temperature, which include older adults, young children, people with chronic conditions (like heart or lung disease, diabetes, kidney disease, or mental health conditions), those living alone or in care facilities, outdoor workers, and people with disabilities or limited access to resources [12]

Heat wave: consecutive days where the heat was above a certain threshold [13]

High-density polyethylene (HDPE): A thermoplastic polymer made from petroleum, used widely for plastic bottles, milk jugs, shampoo bottles, bleach bottles, cutting boards, and piping. [14]

Municipality: Any county, city, town, or village with a local government [15]

Permeable surfaces: materials that allow water to pass through them and into the ground [16]

Glossary

Safe Havens for All-Day Enjoyment (SHADE) Act: Develops a competitive grant program, administered from the Empire Development Corporation, designed to assist municipalities with establishing shaded public gathering spaces and public transportation areas to enhance the enjoyment and use of such spaces where there is no existing or insufficient sun protection [17]

Shade: Shade is any overhead cover, natural or man-made, that blocks some portion of sunlight before it can reach people, pavement, or buildings [18]

Solar canopy: An elevated structure that hoists solar panels in overhead locations such as parking lots or other paved areas [19]

Temperature, Air: The temperature of the air around us and is most commonly measured at a height of 6.5 feet above the surface. [20]

Temperature, Mean radiant: The average temperature of surrounding surfaces such as pavement, buildings, and other structures that radiate heat toward a person, and it captures how the human body gains or loses heat through radiation [20]

Temperature, Surface: How hot the surface of the Earth would feel to the touch in a particular location. [21]

Tree canopy: Layer of leaves and branches from trees that cover the ground from a bird's-eye view [22]

Urban Heat Island Effect (UHIE): the effect that developed areas have hotter temperatures compared to rural areas [23]

Urbanization: The concentration of human populations into discrete and densely populated areas [24]

MEET OUR TEAM

This final report is part of a workshop in the Master of Public Administration in Environmental Science and Policy program at Columbia University's School of International and Public Affairs (SIPA). Guided by our faculty advisor, Louise Rosen, we have spent the summer of 2025 conducting an in-depth analysis of the SHADE Act, examining its potential impacts and opportunities.

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She earned her B.A. in Public Policy Analysis and Environmental Analysis from Pomona College. Her experience spans environmental consulting, startups, Congress, non-profits, and sustainability program management. She has led projects on cleantech innovation, groundwater and food systems research, and urban development, with the aim to develop science-based, actionable solutions that advance climate resilience, equity, and sustainable innovation.

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He has experience in climate policy, having worked at one of India's leading think tanks, focused on climate change mitigation across diverse areas. He primarily worked on energy systems modeling to chart net-zero pathways for India, and was also closely involved in stakeholder engagement with various state governments in India. He holds a Master's degree in Physics from the University of Cologne, Germany, where he specialized in Atmospheric Physics and worked at a leading research center.

MEET OUR TEAM

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She has over five years of experience working at the intersection of research, climate change communication, policy, and innovation. Her background spans academia, government engagement, and industry collaboration, enabling her to combine technical expertise with policy insight. She focuses on developing evidence-based, actionable solutions for climate goals, with a particular interest in leveraging technology and communication to advance inclusive and impactful environmental policies.

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She received her BA in Foreign Affairs from University of Virginia and has professional experience in ESG investing, green bonds trading, and sustainability consulting across China and the US. As a former analyst at investment firms and consulting companies, she is passionate about leveraging finance as a tool for environmental impact and sustainable development in emerging markets, with expertise spanning startup ESG analysis and carbon accounting.

MEET OUR TEAM

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He received his Bachelor's degree from Gettysburg College in 2020. Since then, he has worked in New York City, primarily working in affordable housing as a Senior Associate at Habitat for Humanity NYC and Westchester. While at Habitat for Humanity, he worked on a Net Zero housing development that inspired him to pursue sustainable urban development. He grew up in New York, so the SHADE Act hits close to home.

Abubakar Suleonibo | Documentation Lead

He is a Petroleum Engineer, Project Manager, and Data Analyst with over a decade of experience in the energy industry. As a petroleum engineer, consultant, project manager, data analyst, and sustainability advocate, he leverages a multidisciplinary skill set to manage multiple projects simultaneously with multinational energy companies like Chevron, BP, and other independent operators, while fostering strong stakeholder relationships worldwide

Louise Rosen | Faculty Advisor

We would like to extend our profound gratitude to Professor Rosen for being our advisor. With her wisdom, guidance, and anecdotes, she was an invaluable resource.

Appendix

Safe Havens for All Day Enjoyment Act

STATE OF NEW YORK

1028

2025-2026 Regular Sessions

IN SENATE

(Prefiled)

January 8, 2025

Introduced by Sen. MAY -- read twice and ordered printed, and when printed to be committed to the Committee on Corporations, Authorities and Commissions

AN ACT to amend the urban development corporation act, in relation to enacting the "safe havens for all-day enjoyment (SHADE) act"

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

Section 1. This act shall be known and may be cited as the "safe havens for all-day enjoyment (SHADE) act".

§ 2. Section 1 of chapter 174 of the laws of 1968, constituting the New York state urban development corporation act, is amended by adding a new section 16-bb to read as follows:

§ 16-bb. Safe havens for all-day enjoyment grant program. (1) Program established. There is hereby established a "safe havens for all-day enjoyment grant program" under the purview of the empire state development corporation. Such program shall be a competitive grant program designed to assist municipalities in the state with establishing shaded public gathering spaces and public transportation areas to enhance the enjoyment and use of such spaces where there is no existing or insufficient sun protection, as provided under this section.

(2) Definitions. For the purposes of this section, the following terms shall have the following meanings:

(a) "Eligible project" shall mean a project proposed by a municipality to enhance shade in the following areas within such municipality:

(i) public gathering spaces, including but not limited to public parks, plazas, squares, or trails; and/or

(ii) public transportation areas, including but not limited to bus stops, city blocks, or bicycling corridors.

(b) "Grant recipients" shall mean municipalities selected to receive grant awards under the program pursuant to subdivision one of this section.

(c) "Program" shall mean the safe havens for all-day enjoyment grant program established under this section.

EXPLANATION--Matter in italics (underscored) is new; matter in brackets [-] is old law to be omitted.

LBD03097-01-5

Appendix

Safe Havens for All Day Enjoyment Act

S. 1028 2

(3) Selection of grant recipients. Grant recipients shall be selected by the corporation based on the strength of their proposals, including evaluation of eligible projects highlighted within such proposals. The following criteria shall be considered by the corporation in evaluating such proposals:

(a) Eligible projects shall be high impact in the number of people or events they will serve, as determined by the corporation by evaluating a history of events taking place at the location of such eligible projects, traffic studies, and any other evidence of regular use deemed relevant by the corporation;

(b) The corporation shall favor selection of eligible projects that will serve the largest number of people; and

(c) Eligible projects shall demonstrate an impact on mean radiant temperature, with a focus on reducing or providing relief from heat enhanced by the urban heat island effect, as determined by the corporation, who shall develop standards for demonstrating such impacts.

(4) Grants awarded and matching funds. (a) The corporation shall determine amounts to be awarded to grant recipients on an individual basis, based on the financial needs of the eligible projects proposed by such grant recipients. Criteria for such determinations shall be established by the corporation by rules and regulations.

(b) Grant recipients shall match the value of funds awarded to such grant recipients under paragraph (a) of this subdivision on a dollar-for-dollar basis for each eligible project.

(5) Funding. The corporation is authorized, within available appropriations in the empire state development fund established pursuant to section sixteen-m of this act or from other funds appropriated, to make grant awards available to grant recipients pursuant to the provisions of this section.

§ 3. Subdivision 1 of section 16-m of section 1 of chapter 174 of the laws of 1968, constituting the New York state urban development corporation act, is amended by adding a new paragraph (p) to read as follows:

(p) Grant awards to grant recipients as set forth under section sixteen-bb of this act to support the safe havens for all-day enjoyment grant program to assist municipalities in the state with establishing shaded public gathering spaces and public transportation areas to enhance the enjoyment and use of such spaces where there is no existing or insufficient sun protection.

§ 4. Rules and regulations. The empire state development corporation is authorized to promulgate rules and regulations in accordance with the state administrative procedure act that are necessary to fulfill the purposes of this act. Such rules and regulations shall be completed within one hundred eighty days after the effective date of this act.

§ 5. This act shall take effect on the one hundred eightieth day after it shall have become a law; provided, however, that the amendments to subdivision 1 of section 16-m of section 1 of chapter 174 of the laws of 1968, constituting the New York state urban development corporation act, made by section three of this act shall not affect the expiration of such section and shall be deemed to expire therewith. Effective immediately, the addition, amendment and/or repeal of any rule or regulation necessary for the implementation of this act on its effective date are authorized to be made and completed on or before such effective date.

References

Background

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