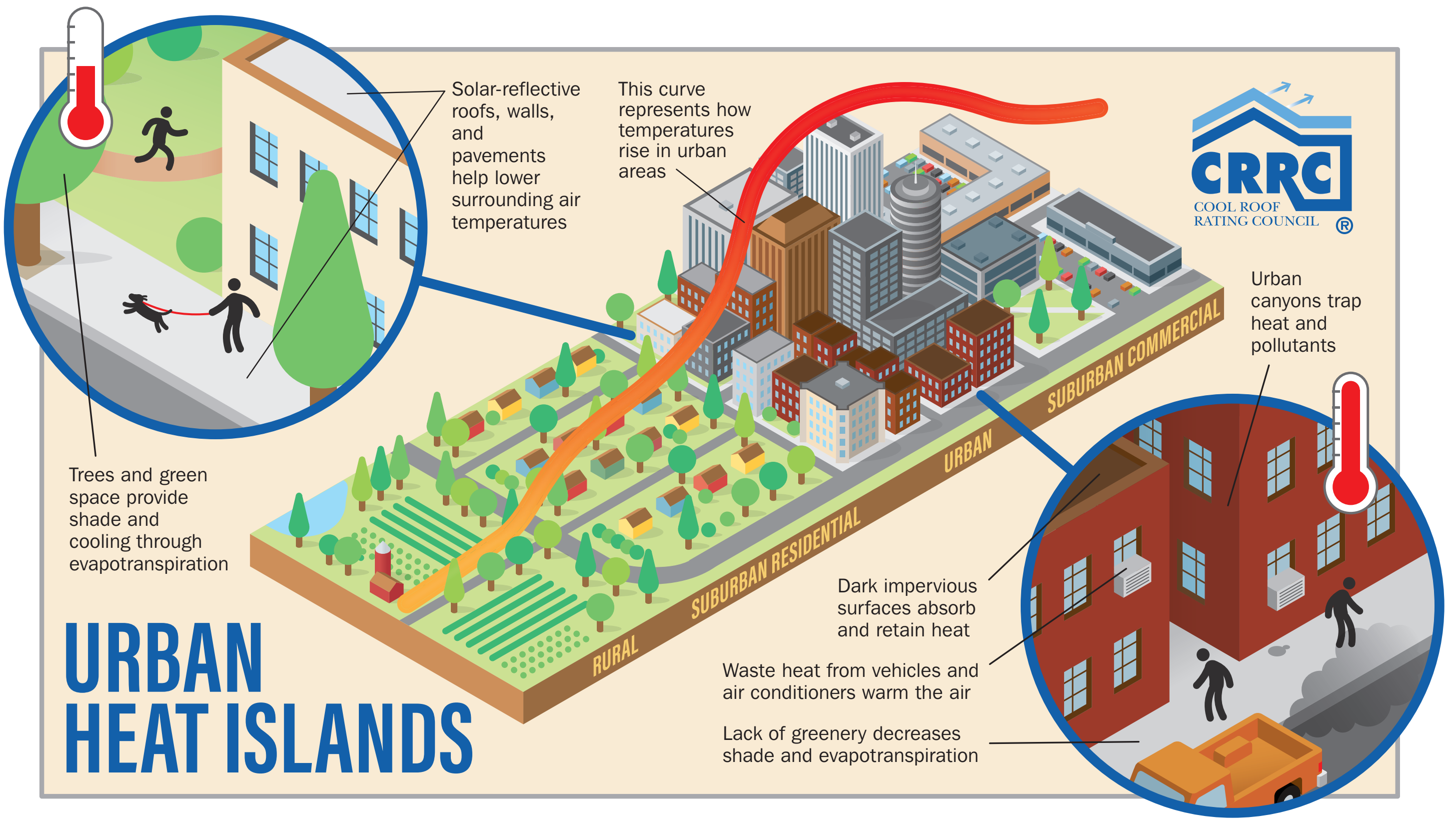
Reducing Urban Heat with Cool Roofs and Solar-Reflective Walls

Rising temperatures threaten our communities. High heat negatively affects our health and well-being, productivity, energy use, school performance, and more. These challenges are more frequently borne by low-income communities and communities of color.[1]

What is the Urban Heat Island Effect?

Urban heat islands (UHI) are areas where surface and/or air temperatures are higher than surrounding areas.[2] This could be an entire city or areas within a city. A UHI forms in an area with:

- Dark, impervious surfaces (e.g., roofs, walls, industrial areas, and roads)
- Relative lack of vegetation and tree canopy
- Buildings that block or slow air movement and trap solar and thermal radiation
- Vehicles and air conditioning units that release waste heat



This illustration describes the factors that contribute to urban heat islands (UHI), as well as factors that help mitigate UHI. Urban heat islands occur when the temperature in urban environments is higher than surrounding areas. High surface temperatures lead to elevated air temperatures, especially at night. Heat islands increase heat-related discomfort, illness, and death. They also cause greater air conditioner use, which increases energy costs and air pollution. Urban heat has a disproportionate impact on disadvantaged communities (Hsu et al., 2021; Hoffman et al., 2020; and Wilson, 2020).

IMAGE CREDIT: COOL ROOF RATING COUNCIL

1. Hsu, A., Sheriff, G., Chakraborty, T. et al. Disproportionate exposure to urban heat island intensity across major US cities. *Nat Commun* 12, 2721 (2021). https://doi.org/10.1038/s41467-021-22799-5

2. U.S. EPA. Learn About Heat Islands. https://www.epa.gov/heatislands/learn-about-heat-islands

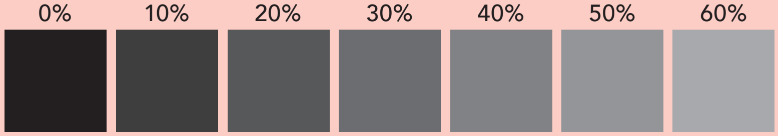
ILLUSTRATION REFERENCES

Hoffman, J.S., Shandas, V., and Pendleton, N. The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas. *Climate* 8(1):12 (2020). https://doi.org/10.3390/cli8010012

Wilson, B. Urban Heat Management and the Legacy of Redlining. *Journal of the American Planning Association* 86:4, 443-457 (2020). https://doi.org/10.1080/01944363.2020.1759127

How Can We Mitigate Urban Heat Islands?

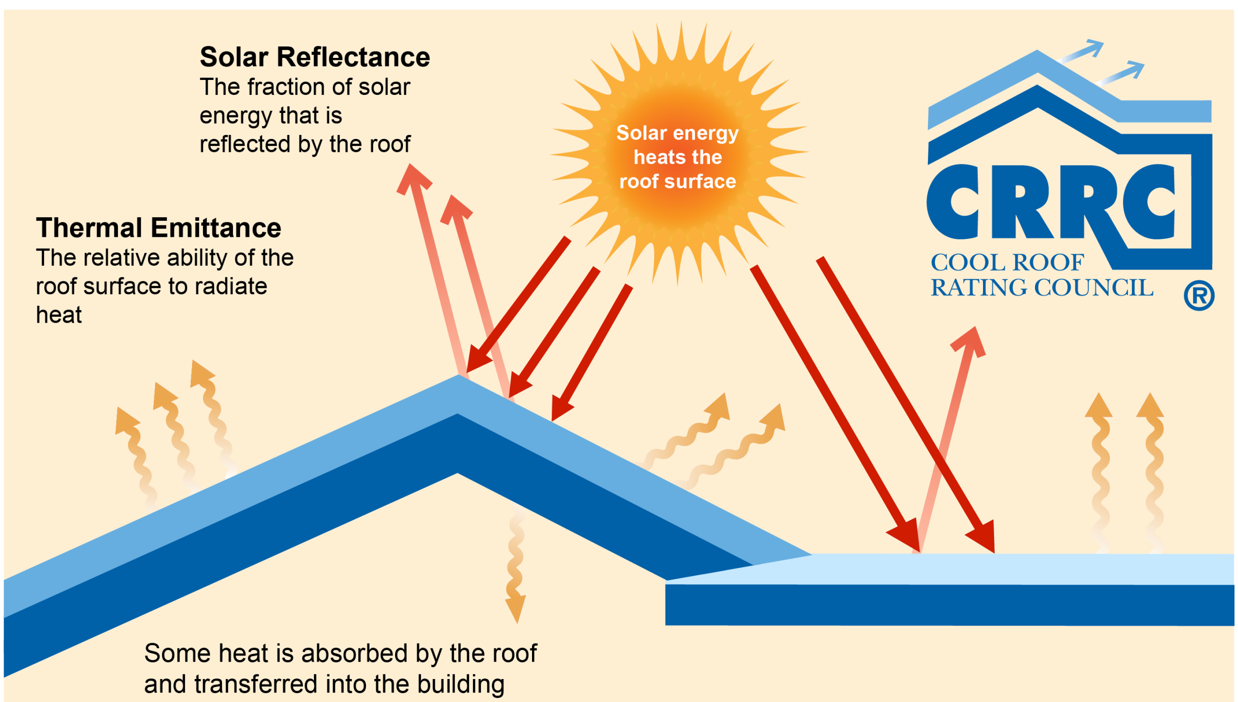
Increasing the solar reflectivity of our roofs and exterior walls is a cost-effective means of reducing high heat and urban heat islands. These "cool" surfaces reflect more of the sun's energy. The result is substantially lower building surface temperatures and outdoor air temperatures, in addition to inside temperature reductions of up to 5°F or more on the floor below the roof.[3] Increasing the solar reflectivity of our cities by 0.1 (each lighter block in the image below represents a 0.1 improvement) could result in an average surface temperature reduction of more than 10°F and a corresponding air temperature reduction of up to 1°F.[4] Each degree of cooling leads to increased thermal comfort, health, and economic benefits.



This bar illustrates the effect in the visible spectrum of increasing a surface's solar reflectance.

How do Cool Roofs and Solar-Reflective Walls Work?

The effectiveness of cool surfaces is measured as the fraction of solar energy (represented as solar reflectance or SR) that is reflected from the building surface. The effectiveness of cool surfaces is also measured by how efficiently they shed absorbed heat. A surface that absorbs solar radiation releases some heat into the building and the outdoor surroundings through conduction, convection, and radiation (represented as thermal emittance or TE). A cool surface is both highly reflective and highly thermally emissive.



This illustration describes the flow of radiant energy as heat between the sun, roof surface, building interior, sky, and surroundings. The higher the solar reflectance, the more solar energy is reflected away from the roof surface. Some of the solar energy is absorbed by the roof as heat. The higher the thermal emittance, the more of this absorbed heat is radiated away from the roof surface.
Image Credit: Cool Roof Rating Council

3. Blasnik, M. Impact Evaluation of the Energy Coordinating Agency of Philadelphia's Cool Roof Program. *M. Blasnik & Associates* (2004). https://coolrooftoolkit.org/wp-content/uploads/2012/04/Blasnik-2004-Eval-coolhomes_Philly-EAC.pdf
4. Krayenhoff, E. S., Broadbent, A. M., Zhao, L., et al. Cooling hot cities: a systematic and critical review of the numerical modelling literature. *Environ. Res. Lett.* 16, 053007 (2021). https://doi.org/10.1088/1748-9326/abdcf1

How do Cool Surfaces Help Protect My Community?

Reducing indoor and outdoor temperatures improves comfort and lowers cooling energy demands (air conditioning), especially during peak electricity demand periods. Lowering peak demand can be critical on hot days when power grids and distribution are most at risk of power interruptions. In the event of a power outage, buildings with cool roofs and solar-reflective walls will stay cooler longer than similar buildings with darker, less reflective surfaces.[5]

What are the Economic Benefits of Mitigating the UHI Effect?

Investing in cool roofs and solar-reflective walls presents an economic opportunity while cooling our communities. Reduced energy use helps lower utility bills, and home and building owners can use cool surfaces to qualify for financial incentives in some cities. At the community level, a cost-benefit analysis of UHI mitigation strategies for over 1,600 cities worldwide found that one dollar invested in cool roofs, along with a much smaller investment in green roofs and cool pavements, would return twelve dollars worth of benefits.[6]

WANT TO LEARN MORE?

- US EPA Heat Island Reduction Program
- Global Cool Cities Alliance (GCCA) Key Initiatives
- Lawrence Berkeley National Laboratory Heat Island Group

WHERE CAN I FIND COOL ROOF AND WALL PRODUCTS?

- Search for products on the CRRC Rated Products Directory

ADDITIONAL RESOURCES

- ACEEE UHI Mitigation State and Local Policy Database
- Database of State Incentives for Renewables & Efficiency (DSIRE)

CONTACT US

Visit the CRRC website at **www.coolroofs.org** or contact us directly:

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Email: **info@coolroofs.org**

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5. Baniassadi, A. and Sailor, D.J. Synergies and trade-offs between energy efficiency and resiliency to extreme heat – a case study. *Building and Environment* 132, 263-272 (2018). https://doi.org/10.1016/j.buildenv.2018.01.037

6. Estrada, F., Wouter Botzen, W. J., and Tol, R. S. J. A global economic assessment of city policies to reduce climate change impacts. *Nature Clim Change* 7, 403-406 (2017). https://doi.org/10.1038/nclimate3301