



## Heat Island Effect

<http://www.epa.gov/heatisland/about/index.htm>  
Last updated on Monday, February 09, 2009

You are here: [EPA Home](#) [Heat Island Effect](#) Basic Information

## Basic Information

You will need the free Adobe Reader to view some of the files on this page. See [EPA's PDF page](#) to learn more.

### What Is an Urban Heat Island?

As urban areas develop, changes occur in their landscape. Buildings, roads, and other infrastructure replace open land and vegetation. Surfaces that were once permeable and moist become impermeable and dry.<sup>1</sup> These changes cause urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures in the landscape.

Heat islands occur on the surface and in the atmosphere. On a hot, sunny summer day, the sun can heat dry, exposed urban surfaces, such as roofs and pavement, to temperatures 50–90°F (27–50°C) hotter than the air,<sup>2</sup> while shaded or moist surfaces—often in more rural surroundings—remain close to air temperatures. Surface urban heat islands are typically present day and night, but tend to be strongest during the day when the sun is shining.

In contrast, atmospheric urban heat islands are often weak during the late morning and throughout the day and become more pronounced after sunset due to the slow release of heat from urban infrastructure. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F (1–3°C) warmer than its surroundings.<sup>3</sup> On a clear, calm night, however, the temperature difference can be as much as 22°F (12°C).<sup>3</sup>

To view images of surface and atmospheric heat islands, and to learn more about how scientists measure them, visit the [Measuring Heat Islands](#) page.

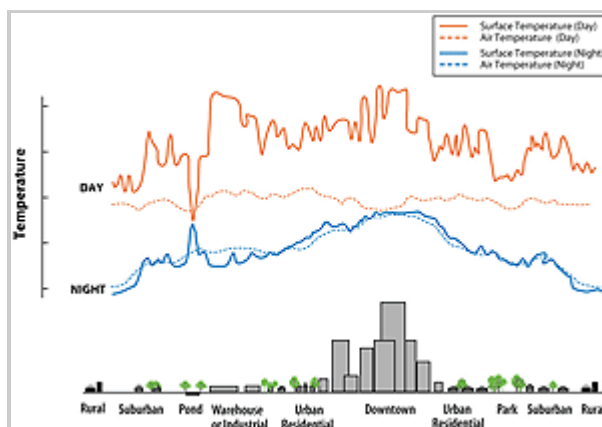
The heat island sketch pictured here shows how urban temperatures are typically lower at the urban-rural border than in dense downtown areas. The graphic also shows how parks, open land, and bodies of water can create cooler areas within a city.

For additional information on urban heat islands:

- read the [Heat Island Basics chapter \(PDF\)](#) (22 pp, 1.5MB) from EPA's *Reducing Urban Heat Islands: Compendium of Strategies*, which

### More Information on Urban Heat Islands

- Heat Island Basics Chapter from EPA's *Reducing Urban Heat Islands: Compendium of Strategies* (PDF) (22 pp, 1.5MB)
- Measuring Heat Islands
- Heat Island Video Segments



[view a larger version of this image](#)

Surface and atmospheric temperatures vary over different land use areas. Surface temperatures vary more than air temperatures during the day, but they both are fairly similar at night. The dip and spike in surface temperatures over the pond

explains the different types of urban heat islands and their causes, describes the impacts of heat islands, and provides resources for more information;

- learn [how heat islands are measured](#); and
- watch two short [video segments](#) that EPA developed in partnership with The Weather Channel cable television network.

show how water maintains a fairly constant temperature day and night, due to its high heat capacity.

\* Note: The temperatures displayed above do not represent absolute temperature values or any one particular measured heat island. Temperatures will fluctuate based on factors such as seasons, weather conditions, sun intensity, and ground cover.

## Why Do We Care About Heat Islands?

Elevated temperature from urban heat islands, particularly during the summer, can affect a community's environment and quality of life. While some heat island impacts seem positive, such as lengthening the plant-growing season, most impacts are negative and include:

- *Increased energy consumption:* Higher temperatures in summer increase energy demand for cooling and add pressure to the electricity grid during peak periods of demand. One study estimates that the heat island effect is responsible for 5–10% of peak electricity demand for cooling buildings in cities.<sup>3</sup>
- *Elevated emissions of air pollutants and greenhouse gases:* Increasing energy demand generally results in greater emissions of air pollutants and greenhouse gas emissions from power plants. Higher air temperatures also promote the formation of ground-level ozone.
- *Compromised human health and comfort:* Warmer days and nights, along with higher air pollution levels, can contribute to general discomfort, respiratory difficulties, heat cramps and exhaustion, non-fatal heat stroke, and heat-related mortality.
- *Impaired water quality:* Hot pavement and rooftop surfaces transfer their excess heat to stormwater, which then drains into storm sewers and raises water temperatures as it is released into streams, rivers, ponds, and lakes. Rapid temperature changes can be stressful to aquatic ecosystems.

For more information on the effects of heat islands, visit the [Heat Island Impacts](#) page.

## What Can Be Done?

Communities can take a number of steps to reduce the heat island effect, using four main strategies:

- increasing [tree and vegetative cover](#);
- creating [green roofs](#) (also called "rooftop gardens" or "eco-roofs");
- installing [cool—mainly reflective—roofs](#); and
- using [cool pavements](#).

Typically heat island mitigation is part of a community's energy, air quality, water, or sustainability effort. Activities to reduce heat islands range from voluntary initiatives, such as cool pavement demonstration projects, to policy actions, such as requiring cool roofs via building codes. Most mitigation activities have multiple benefits, including cleaner air, improved human health and comfort, reduced energy costs, and lower greenhouse gas emissions.

For more information on heat island mitigation strategies and activities:

- visit the [Urban Heat Island Mitigation](#) page;
  - read the [Heat Island Reduction Activities](#) chapter (PDF) (23 pp, 2.7 MB) from EPA's *Reducing Urban Heat Islands: Compendium of Strategies*;
  - use the [Community Actions Database](#) to see what communities around the United States are doing to reduce the urban heat island effect; and
  - learn about [EPA's Clean Energy-Environment State and Local Program](#).
- 

## Footnotes and References

1. This change in landscape may differ in regions such as deserts, where moisture may increase in urban areas if development introduces grass lawns and other irrigated vegetation.
2. Berdahl P. and S. Bretz. 1997. Preliminary survey of the solar reflectance of cool roofing materials. *Energy and Buildings* 25:149-158.
3. Akbari, H. 2005. [Energy Saving Potentials and Air Quality Benefits of Urban Heat Island Mitigation](#) (PDF) (19 pp, 251K). Lawrence Berkeley National Laboratory.