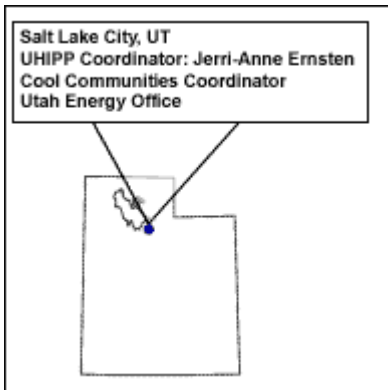


# EPA Urban Heat Island Pilot Project City Profile: Salt Lake City (Archived Page)

This document is an archive of webpages from EPA's Urban Heat Island Pilot Project, which ran from 1998-2002. EPA no longer updates these pages but is maintaining them for historical purposes. Please visit the [Where You Live](#) to find up-to-date information on heat island activities in communities throughout the United States.



Salt Lake City is located in the high-desert terrain of northwestern Utah. The city has a population of approximately 182,000 people and covers over 109 square miles. The Salt Lake City Metropolitan Statistical Area includes over 1.3 million people and covers approximately 1,617 square miles.

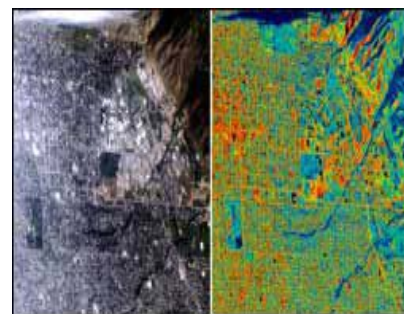
## Salt Lake City's Heat Island

In September 1998, the National Aeronautics and Space Administration took (NASA) aerial photos of Salt Lake City using Advanced Thermal and Land Applications Sensor aircraft data. These flyover photos represent a typical, visible view of the city and a thermal infrared readout of metropolitan hot spots.

The white areas in the visible photo, mostly rooftops, are about 160°F (71°C). The dark areas, primarily vegetative areas or water, are approximately 85-96°F (29-36°C).

In the thermal image, red and yellow areas indicate "hot spots" and generally correspond with urban development, while blue and green areas are cool and generally correspond to the natural environment. (These images have not been calibrated. Absolute temperatures will change after calibration, but the relative temperature differences between surface types will not.)

Before determining how heat island reduction strategies impact an area, researchers need to evaluate existing surface characteristics. Aerial photos are useful for estimating the proportions of vegetative, roofed, and paved surface cover relative to the total urban surface in a city. Having this urban fabric information can help researchers simulate the meteorological and air quality impacts of heat island reduction strategies.



Aerial view of Salt Lake City (courtesy of NASA-Marshall Space Flight Center-Global Hydrology and Climate Center).

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Surface cover data also help scientists determine an area's heat island. The Department of Energy's Lawrence Berkeley National Laboratory (LBNL) modeled Salt Lake City's near surface heat island, which represents near ground air temperatures as opposed to surface temperatures measured by thermal images.

LBNL conducted this modeling over a large area, several times larger than the city center. They found that topography greatly influences Salt Lake City's heat island with higher elevations having consistently lower temperatures than the lower elevations. LBNL simulations indicate that Salt Lake City's heat island can reach 7.2°F (4°C) at night and about 3.6°F (2°C) during the afternoon. The aerial extent of Salt Lake City's heat island is greater in the afternoon compared to earlier in the day.

## **Salt Lake City's Climate**

Salt Lake City's climate is characterized by hot, dry summers, and cold, mild winters. The Great Salt Lake, which lies to the northwest of the city, greatly influences the climate. The average summer temperature in Salt Lake City is 92.2°F (33.4°C), and the average winter temperature is 36°F (2.2°C). Salt Lake City receives most of its rain in the spring and heavy snow in the winter. Average annual rainfall for the City is about 15.7 inches per year.

Salt Lake City has an average relative humidity of 68% in the morning and 43% in the afternoon. The area's summer daytime relative humidity averages less than 30%. Salt Lake City receives 67% annual sunshine. Based on 1961-1990 National Climatic Data Center data, Salt Lake City has, on average, 1,047 cooling degree days and 5,765 heating degree days.

Local climate data, such as cooling and heating degree days, can help researchers estimate the potential energy savings and air quality impacts from implementing heat island mitigation strategies. For example, areas with long, sunny, hot summers and high cooling degree day values generally can achieve substantial energy savings.

Information on an area's local climate can also help communities focus on heat island reduction activities that best suit their region. For example, cities with predominantly dry climates may achieve greater benefits from increasing vegetation than would cities in humid climates. Dry-climate cities more effectively capture the cooling benefits of evapotranspiration – or evaporation of water from leaves. However, dry-climate cities also need to consider the availability and cost of water to maintain vegetation.

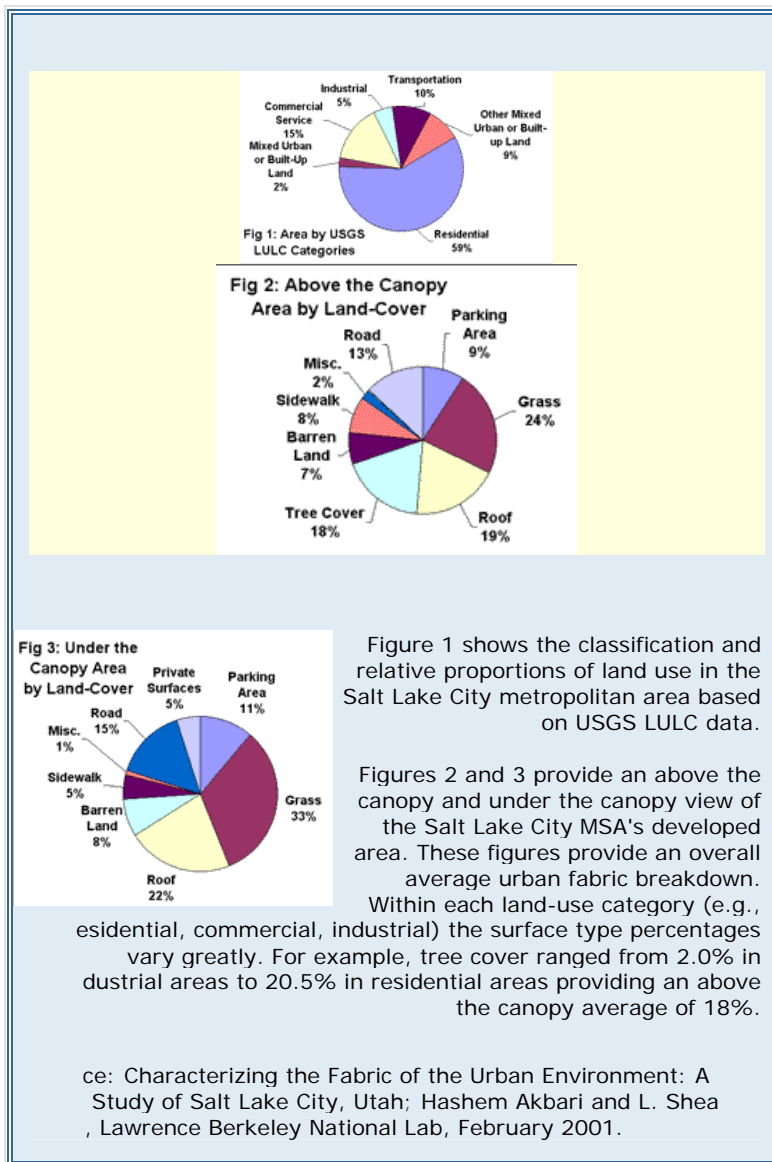
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## **Salt Lake City's Urban Fabric**

In 2000, Department of Energy's Lawrence Berkeley National Laboratory (LBNL) conducted an urban fabric analysis to determine the proportions of vegetative, roofed, and paved surface cover relative to the total urban surface in the city. LBNL used digital aerial photos covering 13 square miles of Salt Lake City, which represented a variety of neighborhoods (e.g., industrial, commercial, residential).

LBNL used the aerial photos to characterize the area fraction of various surface types (e.g., roofs, sidewalks, etc.) and vegetative cover. LBNL then used United States Geological Survey land use/landcover (LULC) data to extrapolate detailed surface characteristic findings to the entire Salt Lake City Metropolitan Statistical Area.

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LBNL concluded that although Salt Lake City is a fairly vegetated city, the potential for additional urban vegetation is large. Considering that trees potentially can shade 20% of the roof area, 20% of roads, 50% of sidewalks, and 30% of parking areas, Salt Lake City could increase additional tree cover by approximately 13%.

LBNL also found that with 49% of Salt Lake City's surfaces being impermeable (roofs and pavement), the metropolitan area has a large potential for solar reflectance – or albedo – modification, starting with the impermeable surfaces.

## Salt Lake City's Energy Savings Analysis

Salt Lake City has a June through September cooling season and a long heating season beginning in September and ending in May. Most residential buildings are one story and commercial buildings are low-rises. Air conditioning saturation in the Salt Lake City Metropolitan Statistical Area (MSA) is high (with the exception of older residential buildings) with a total air conditioned roof area in 1998 of 120 million (M)ft<sup>2</sup> residential, 15 Mft<sup>2</sup> office, and 21 Mft<sup>2</sup> retail.

### Modeling Methodology

The Department of Energy's Lawrence Berkeley National Laboratory (LBNL) analyzed the energy savings potential (direct and indirect effects) of heat island reduction measures on cooling energy use in Salt Lake City. Determining direct energy impacts involved modeling the effects from placing eight mature deciduous shade trees around residential buildings, eight shade trees around office buildings, and four shade trees around commercial buildings to provide 10% summertime (April - October) transmittance and 90% transmittance for the remainder of the year.

In addition, determining direct impacts involved modeling the effects from increasing solar reflectance— or albedo— on residential and commercial roofs from 0.2 to 0.5 and 0.6, respectively, using an infrared emittance of 0.9, to calculate savings. (Emittance is the percentage of energy a material can radiate away in the form of heat.) This modeling was performed using DOE-2 building energy software, which is an advanced computer program that simulates hourly building energy use.

The indirect impacts were modeled by analyzing the ambient cooling from the placement of four or eight shade trees per building and from the reduced rooftop temperatures due to the albedo changes discussed above. LBNL captured these indirect effects by using the Colorado State Urban Meteorological Model (CSUMM). The CSUMM outputs were used to modify the typical meteorological year 2, which were fed into the DOE-2 building energy model.

### Modeling Results

LBNL calculated the following annual results for the total Salt Lake City MSA:

- \$3.6M energy savings in 1997 dollars (\$7.3M in annual electricity savings less a natural gas deficit, or heating penalty of \$3.7M);
- 85 megawatts of peak power avoided (65% from residential, 17% from office, and 18% from retail); and
- 20,000 tons of carbon emission reductions.

## Salt Lake City's Air Quality

Salt Lake City's active effort to reduce the impact of heat islands and improve air quality may have contributed to its redesignation in 1997 from a nonattainment area for ground-level ozone to an attainment area in 1997.

### Modeling Methodology

In 1999-2000, the Department of Energy's Lawrence Berkeley National Laboratory (LBNL) used the Colorado State Urban Meteorological Model (CSUMM) and the Urban Airshed Model (UAM-IV) to estimate the impacts of heat island reduction activities in Salt Lake City on the area's local meteorology and ozone air quality.

LBNL used a modeling domain of 37,840 km<sup>2</sup> or 14,781 square miles, which is several times larger than the Metropolitan Statistical Area.

LBNL determined that the solar reflectance – or albedo– in the Salt Lake City modeling domain ranges from 0.05 for water (the Great Salt Lake) to 0.45 in areas with abundant exposed rocks, sand, or sand flats. Most of the urban area had an albedo of 0.14-0.18.

LBNL found the vegetative cover near the city to be between 0.15-0.20. Within the modeling domain, the vegetative cover ranged from nearly zero in urban areas to 55-60% east of the lake and on the southern and eastern elevations and forests. Overall, only 20% of the modeling domain had a vegetative cover greater than 40%.

LBNL simulated heat island reduction measures by increasing the solar reflectance and vegetative cover inputs into the meteorological model, CSUMM. LBNL increased solar reflectance levels and vegetative cover in the city center area by approximately 0.13 and 0.16, respectively.

### Modeling Results

Using an August 11-12, 1996 modeling period, LBNL found ground-level ozone and temperature decreases up to four parts per billion and 3.6°F (2°C), respectively. LBNL's modeling resulted in ozone increases as well as decreases. Within the entire modeling domain there were net ozone decreases, in general.

Thus, LBNL's modeling indicates that there is potential for heat island reduction strategies to lower air temperatures and improve air quality in Salt Lake City. Urban fabric and energy savings studies also indicate that Salt Lake City can reduce energy use and carbon emissions through strategies to lower urban temperatures.

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## Salt Lake City's Heat Island Reduction Activities

Currently, state and local leaders are working to reduce the impact of heat islands. EPA's Salt Lake City Urban Heat Island Pilot Project Coordinator has been leading a [Cool Communities Program](#) through the Utah Office of Energy Services. Salt Lake City has launched several demonstration projects, including installing reflective and green roofs, planting shade trees, and showcasing cool pavements – all in an effort to educate the community about urban heat islands and strategies to reduce them.

### Kool Kids Program

The Cool Communities' [Kool Kids Program](#) educates students about the urban heat island phenomenon and the resulting energy consumption, carbon dioxide emissions, and air quality ramifications. The Kool Kids program is a hands-on way for students to learn about many issues, including energy, climate science, and map reading.

To assist teachers, the Utah Office of Energy Services assembled a Kool Kids Box containing lesson plans and tools for activities. This box includes an infrared analyzer, thermometers, thermal maps, and two model houses – one with a light roof and one with a dark roof. The lesson plans were written to follow the state curricula for various subjects.

To make the Kool Kids Box easier to use, the Utah Office of Energy Services will soon post these written materials on its website. In the meantime, educators can borrow the box from the office.

### Winter Olympics



The Salt Lake Organizing Committee partnered with local groups to mitigate heat islands.

For the 2002 Winter Olympics, the Utah Cool Communities group partnered with the Salt Lake Organizing Committee (SLOC) and Utah Power to implement SLOC's Cool Spaces 2002™ tree planting program. Utah Power, a SLOC's Environmental Champion, grew and donated approximately 500 trees for the project. Cool Community volunteers and other partners planted these trees in various communities throughout Utah, including in the Olympic Village at the University of Utah.

To insure species diversity, Utah Power donated approximately 20 different species. Among other goals, this project aimed to: reduce localized hot spots, energy consumption, and air

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pollution by strategically planting trees in selected communities; and comply with Utah Power's motto "The Right Tree in the Right Place," which helps people to grow healthy trees with energy and electric safety in mind.

## **Envision Utah**

The Utah Cool Communities group has been working with [Envision Utah](#), a nongovernmental organization that focuses on growth issues including preserving critical lands, conserving water, and improving housing and transportation options. Envision Utah developed a toolbox to offer state and local decision-makers information on community development options. The second edition of the toolbox will contain a chapter on energy efficiency and will address the importance of urban heat island reduction. This toolbox and cooperative effort provide a great way to educate communities about Smart Growth strategies, heat islands, and energy savings.

TreeUtah and other organizations in Utah and Salt Lake City are also taking actions that reduce heat island impacts via the co-benefits that their programs provide.

## **Tree Utah**

[Tree Utah](#) is a statewide nonprofit organization that aims to improve Utah's quality of life by enhancing the environment through planting, stewardship, and education. It partners with a variety of state and national groups, including American Forests, American Express, EPA, the National Aeronautics and Space Administration, the Utah Cooperative Extension Service, Habitat for Humanity, the Utah Office of Energy Services, and the Department of Natural Resources.

Since 1995, TreeUtah has been focusing on educating communities about urban forestry, particularly maintenance. Some examples of TreeUtah projects include planting 300 large trees along the main highway into Park City and planting 6,000 tree seedlings along the Jordan River to augment the 8,000 previously planted in "Centennial Trees," a project encouraging every city and town in the state to plant at least one tree in honor of Utah's 100th birthday.