



# City of Cambridge

O-9.

IN CITY COUNCIL

September 10, 2001

COUNCILLOR DAVIS  
COUNCILLOR BORN  
COUNCILLOR BRAUDE  
COUNCILLOR DECKER  
MAYOR GALLUCCIO  
VICE MAYOR MAHER  
COUNCILLOR REEVES  
COUNCILLOR SULLIVAN  
COUNCILLOR TOOMEY

ORDERED: That the City Manager be and hereby is requested to transmit the attached information on the "urban heat island effect" to the Assistant City Manager for Community Development, the Commissioner of Public Works and any other appropriate staff for a report back to the City Council with recommendations on possible steps Cambridge can take to avoid the syndrome, such as installing light-colored roofs on municipal buildings and school buildings.

In City Council September 10, 2001.  
Adopted by the affirmative vote of nine members.  
Attest:- D. Margaret Drury, City Clerk.

A true copy;

ATTEST:-

A handwritten signature in black ink that reads "D. Margaret Drury".

D. Margaret Drury  
City Clerk

17D

09

Ordered: That the CM be + hb is requested to transmit the attached information on the "urban heat island effect" to the Assistant City Manager for Community Development, ~~and~~ the Commissioner of Public Works and any other appropriate staff for a report back to the City Council with recommendations on possible steps Cambridge can take to avoid the syndrome, such as installing light-colored roofs on municipal buildings & school buildings.



Davis

Tel: 617-566-1000

Fax: 617-469-4212

# COPLEY

UPHOLSTERING



Commercial — Institutional — Residential

Council order: A H Davis  
~~transmitting info on the~~  
 Asking for investigation  
 into the "urban heat  
 island effect" and  
 asking for recommendations on  
 possible steps Cambridge  
 can take to avoid  
 it by installing  
 light colored roofs on  
 municipal buildings +  
 public schools.

Enclosed is the attached information

2001 JUN 19 11:34  
 RECEIVED CITY CLERK  
 CAMBRIDGE, MASSACHUSETTS

# HOT CITIES = DIRTY AIR

# COOL CITIES = CLEAN AIR

*How To Prevent Killer Heat Waves and Save Money at the Same Time*

## HOT FACTS

- Cities can be 5–10° F warmer than surrounding countryside on hot summer days.
- 1/6 th of total electricity consumed in the U.S. is used for cooling, costing \$40 billion/yr.
- Air quality studies in Los Angeles estimate that a 1° F increase in summer temperatures boosts smog formation by 3%.
- Cooling Los Angeles by 5–7° F can reduce smog formation by 20%—the equivalent of taking all cars out of LA's airshed for one day.

## What is the Urban Heat Island Effect?

**THE PROBLEM:** On hot summer days, cities can be up to 10° F hotter than their suburban and rural surroundings. This phenomenon occurs because urban development results in large amounts of paved and dark colored surfaces like roofs, roads, and parking lots that absorb, rather than reflect, the sun's heat, causing the temperature of surface areas and ambient air to rise.

The good news is that there are simple ways to reduce heat gain in cities, many of which help solve other urban problems.

**WHY SHOULD CITIES AND COUNTIES CARE?** The Urban Heat Island (UHI) Effect can adversely impact a city's public health, air quality, energy demand, and infrastructure costs.

- **Dirty Air:** Hotter air in cities increases the formation of ground-level ozone (the main ingredient in smog) and can push metropolitan areas out of compliance with federal air quality standards. Smog is formed when air pollutants such as nitrogen oxides (NO<sub>x</sub>) and Volatile Organic Compounds (VOCs) are mixed with sunlight and heat. The rate of this chemical reaction increases when temperatures exceed 70° F.
- **Risks To Public Health:** The UHI Effect prolongs and intensifies heat waves, making residents and workers uncomfortable and putting them at increased risk for heat exhaustion and heat stroke. In addition, high concentrations of ground level ozone aggravate respiratory problems such as asthma, putting children and the elderly at particular risk.
- **High Energy Use:** Hotter temperatures increase demand for air conditioning, increasing energy consumption when demand is already high. This in turn contributes to power shortages and raises energy expenditures at a time when energy costs are at their highest.
- **Global Warming:** Global warming is in large part caused by the burning of fossil fuels to produce electricity for heating and cooling buildings. Urban Heat Islands contribute to global warming by increasing the demand for electricity to cool our buildings. Depending on the fuel mix used in producing electricity, each kilowatt hour of electricity consumed can produce up to 2.3 pounds of carbon dioxide (CO<sub>2</sub>), the main greenhouse gas contributing to global warming.

**ICLEI**  
International Council for  
Local Environmental Initiatives



For more information and  
ACCESS TO MODEL POLICIES  
AND ORDINANCES,

see ICLEI's online resource,  
[www.hotcities.org](http://www.hotcities.org)

[www.hotcities.org](http://www.hotcities.org)

# 3 WAYS TO COOL

*Here are three ways your community can mitigate the Urban Heat Island Effect, while cutting energy costs, reducing global warming and air pollution, and preventing conditions that lead to killer heat waves.*

## WHERE ARE COOL ROOFS MOST EFFECTIVE?

• **What Regions?** Cool roofing systems are cost-effective in all but the coldest and cloudiest regions. While these roofing systems do lead to a slight increase in space heating during the winter, the reduced cooling costs in most cases far outweigh the increase in winter heating.

• **Which Buildings?** The best candidates for energy savings from cool roofing are schools, air-conditioned buildings, and commercial office spaces, and higher ceilings than lower.

**For more information and ACCESS TO MODEL POLICIES AND ORDINANCES, see ICLEI's online resource, [www.hotcities.org](http://www.hotcities.org)**

**Cool Roofs** Conventional dark-colored, low-sloped roofs reflect between 10-20% of incoming solar radiation, converting the remainder into heat that is absorbed by the roof. Much of this heat is then transferred into the building, increasing demand for air conditioning. In summer, conventional roofing materials can be 50-60° F hotter than cool roofing alternatives.

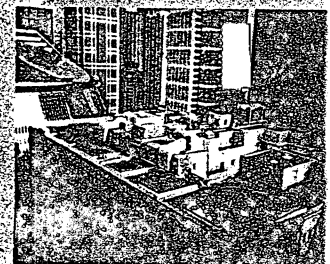
### Cool Roof Strategies:

✓ **Use Cool Roofing Materials:** Florida Solar Energy Center tests on commonly used roofing products revealed that reflectivity ranged from a low of 3% for black shingles to 80% for white roofing materials. Energy savings in buildings with white roofs ranged as high as 32% during peak demand, with a summer average of about 15%. It is important to note that metal-coated and bare metal roofing, while reflective, conducts heat and will not provide cooling benefits.

**Real Results:** An elementary school in Alexandria VA replaced a typical black roof with a reflective roofing system. Energy costs for the school dropped from an average of \$121,000 to \$90,000 per year.<sup>3</sup>

✓ **Green Roofs With Vegetation or Roof-Top Gardens:** Planting vegetation on a roof cools it significantly, while combining energy savings with aesthetic and ecological goals. There are many different types of technologies, commonly used in Western Europe, that will allow the installation of up to 18 inches of soil and planting of no-maintenance vegetation on a roof.

**Case Study:** Chicago has installed a 32,000 square-foot rooftop garden at City Hall. This high profile project covers half the roof with native grasses, shrubs, and trees. Before installation, rooftop temperatures commonly measured 110° F when the surrounding ambient air in Chicago was only 75° F. The city is monitoring rooftop temperatures and energy savings to assess the results of the project.<sup>4</sup>



Chicago City Hall Roof Top Garden

## 2 Lighten Streets and Cool Parking Lots

Streets and parking lots account for the majority of paved surfaces in urban areas. Almost all streets and parking lots are constructed using black asphalt, which greatly contributes to the Urban Heat Island Effect. Dark colored pavements can get up to 40° F hotter than the surrounding air.

### Cool Paving Strategies:

✓ **Use Reflective or Other Cool Paving Materials:** Construct, replace, or reconstruct roads and parking lots with reflective or cool paving materials like portland and flyash cement concrete (see sidebar on "Climate Friendly Cement"), porous concrete, chip-seals, turf-block or porous pavers, and light-colored asphalt emulsion sealcoats.<sup>5</sup>

✓ **Shade Parking Lots:** Planting shade trees in hot spots like parking lots can reduce surface temperatures and the temperature inside parked cars. Cool parking lots also reduce air quality problems. Studies have demonstrated that increasing tree cover in parking lots from 8% to 50% reduces evaporation of hydrocarbons from car fuel tanks and NO<sub>x</sub> emissions from car start-ups.<sup>6</sup>

# YOUR COMMUNITY

**3 Green Your Community** Many scientific studies confirm what we already know from experience: trees and other vegetation make our communities cooler. Studies have found that neighborhoods with plenty of mature trees can be up to 7 degrees cooler than treeless areas nearby.<sup>7</sup>

## Green Community Strategies:

- ✓ **Strategically Select and Site Trees:** Trees placed on the west-, northwest-, and east-facing sides of a building can significantly reduce cooling costs for a typical home or low-rise building during peak summertime demand. Planting deciduous, rather than evergreen, trees will shade buildings in the summer, and allow the sun to warm them in the winter.

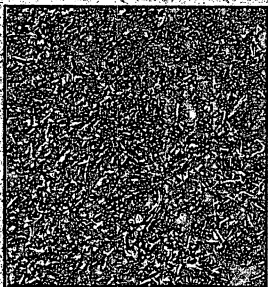
**Scientific Studies:** Simulations of energy saving benefits for Sacramento and Phoenix found that 3 mature trees around homes cut annual air conditioning demand by 25 to 40%.<sup>8</sup>

- ✓ **Preserve and Plant More Trees:** Preserving and increasing urban tree canopies throughout the community have been demonstrated to decrease summer time electric bills.

**Real Results:** Florida Power & Light, in conjunction with Miami-Dade County's Cool Communities Program, studied 20 Miami and Ft. Lauderdale neighborhoods and determined that residents in neighborhoods that had more than 20% tree canopy coverage had summer electric bills 8-12% lower than neighborhoods with less coverage.<sup>9</sup>

- ✓ **De-pave School Yards:** Replacing asphalt playgrounds with green spaces provides children with interesting, safe, and cool places to play at school.

**Case Study:** Los Angeles is eliminating nearly 2 million square meters of pavement at local schools. This "de-paving" project is part of a wider effort of the Trans-Agency Resources for Environmental and Economic Sustainability (TREES) coalition, which includes an extensive strategic tree planting program.



## WHAT IS "CLIMATE FRIENDLY" CEMENT?

Cement is a powder produced from burned limestone, clay and other additives. The process of making cement is extremely energy intensive, and results in large amounts of greenhouse gas emissions – cement processing and production is responsible for 50% of all greenhouse gas emissions coming from the U.S. industrial sector. Local governments can ensure that the cement they use is "climate friendly" by requiring projects made with concrete to use blended cement that includes recycled industrial by-product like fly-ash and blast-furnace slag.

## GOOD TREES – BAD TREES

When it comes to air quality, not all trees are created equal. Some trees, such as weeping willow and eucalyptus, emit volatile organic compounds (VOCs) that combine with nitrogen oxides (NO<sub>x</sub>) to form smog. Other trees, such as ash and maple, are very low emitters. These trees are good candidates for improving air quality because they sequester and filter pollutants such as CO<sub>2</sub> and particulate matter.

# 6 COOL POLICIES FOR LOCAL GOVERNMENTS

*What can local governments do to mitigate the Urban Heat Island Effect?*

*Because city and county governments set and enforce*

*local building standards,*

*operate facilities, build and*

*maintain infrastructure,*

*and provide a variety of*

*services, there are plenty of*

*tools that local governments*

*can use to cool their*

*communities down.*

**Go to ICLEI's online resource**

**to download COOL COMMU-**

**NITY CASE STUDIES, MODEL**

**POLICIES, ORDINANCE LAN-**

**GUAGE, AND RFP LANGUAGE**

**for many of the following local**

**government mechanisms.**

***www.hotcities.org***

## **Use Cool Community Strategies in Public Buildings and in Routine O&M Activities**

Cities and counties can provide leadership in reducing their Urban Heat Island by incorporating cool community strategies in public works projects and routine city operations and maintenance.

**Chicago Urban Heat Island Reduction Initiative:** The Mayor directed departments to implement a comprehensive Urban Heat Island policy. In addition to installing a high profile rooftop garden at City Hall (see section on "Cool Roofs"), Chicago has also included cool community strategies in other public sector activities:

- The General Services Agency's Building Department created a white roof requirement for all new and replaced roofs on city buildings.
- The Transportation Department adds 4-5 miles of native tree plantings per year along traffic medians
- Four wards were given \$500,000 each to undertake mitigation projects in high profile areas. Pilot projects include installing reflective roofing, developing rooftop gardens, adding greenspace and shade trees, and breaking up large areas of asphalt concrete.

## **Amend Building Codes to Include Reflective Roofing Standards**

There are well accepted standards for reflective roofing systems. Local building departments can amend current codes to include these standards and/or develop incentives to encourage the use of reflective roofing.

**State of Georgia Building Code Standard:** Georgia was the first state to amend its Energy Code for commercial buildings to reduce insulation requirements when a reflective roof is used. Variations of these standards are being considered for inclusion in Chicago's Building Code.

## **Amend Landscape and Development Standards to Include Shade Coverage Requirements**

Most communities have landscape standards, parking lot standards, and/or tree preservation ordinances. The trick is to use these and other development standards to maximize the energy saving and the shading potential of trees.

**Miami-Dade County Landscape Ordinance:** This ordinance includes standards that require three trees per single family dwelling, two of which must be planted in a conceptual "Energy Conservation Zone" that surrounds the dwelling.

**The Sacramento Zoning Code:** The code's "development standards for parking facilities" contain a 50% tree shade coverage requirement for all parking lots. Implementation of a similar requirement in Davis, CA is supported by the *Davis Parking Lot Shading Guidelines and Master Parking Lot Tree List*

**City of Gainesville Tree Preservation Ordinance:** A University of Florida study found that residents of Gainesville had significantly lower energy bills than residents of a nearby town, attributing these savings in part to Gainesville's stricter tree preservation ordinance.<sup>11</sup>

**Continued on next page...**

# 6

# COOL POLICIES FOR LOCAL GOVERNMENTS

CONTINUED

## **Put Cool Community Guidelines in Master Plans and in Agreements with Developers**

All cool community strategies mentioned in this fact sheet can be incorporated into design guidelines, master plans, and design review criteria for high priority areas that are undergoing a planning process. Areas with an Urban Heat Island that are known to be "hot spots" can be targeted for mitigation.

In addition, Planning, Housing, Community Economic Development, and Redevelopment agencies should further pursue the types of Urban Heat Island mitigation goals that are included in planning documents by incorporating them into project agreements with developers.

Highland, UT created design guidelines for developing the Highland Town Center that included the use of light colored paving materials and strategic tree planting for appropriate streets, traffic medians, and parking lots. These guidelines were then incorporated by reference into the Town Center Overlay in the Highland Zoning Code.

## **Create Incentives for Cool Action**

The up-front costs associated with cool roofs, pavements, and tree planting can be higher than traditional hot roofing and paving materials and not having trees at all. Rebates, tax credits, and permit streamlining are some of the incentives that local governments can use to level the playing field and encourage use of cool community strategies.

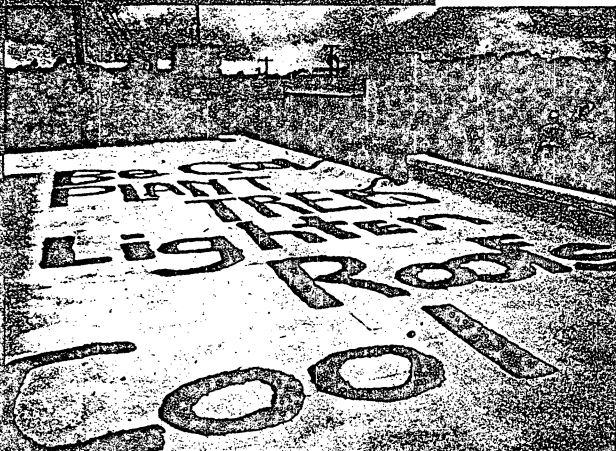
California Energy Commission's Cool Roof Retrofit Program offers rebates to building owners, property managers, schools, and public entities that re-roof using cool products listed by the US EP Energy Star Roofing Products program. Rebates range from \$.05 to \$.15 per square foot of new roofing, depending on existing roof and ceiling insulation. The City of Los Angeles is matching these rebates with an additional \$.025 to \$.075 (or 50% of the state rebate) per square foot.

## **Sponsor Demonstration Projects and Contests**

Public and private sector projects can be used to demonstrate cool community strategies, including their energy savings and aesthetic benefits. This is an excellent way to educate the public, build a local market for cool roofing and paving materials, and gather data on Urban Heat Island mitigation strategies.

Miami-Dade County's Cool Communities program sponsored a contest for a free roof-whitening. The commercial business that won the prize saw a \$100 drop in its electric bill in the first month after the roof was lightened. An educational message about the program was applied to the roof and is seen by 95,000 Metrorail riders every month.

Chicago is demonstrating cool community strategies in four demonstration project areas. The Chicago Department of Environment has issued Requests For Proposals for contractors to install cool roofing on public buildings and to enhance landscaping on city-owned sites. Chicago is also issuing grants to businesses and nonprofit organizations to initiate similar improvements.



The lucky winner of Miami-Dade's Cool Communities Cool Roof contest.

July 11, 2001

**RE: New Tools to Mitigate the Urban Heat Island Effect**

Dear CCP Colleague :

ICLEI's Cities for Climate Protection (CCP) Campaign is pleased to send you this fact sheet on the Urban Heat Island Effect and what local governments can do to **cool their communities down**. Please also find enclosed a sample resolution that you can adapt to introduce Urban Heat Island Mitigation policy in your community.

The fact sheet describes how taking action to keep your community cool can:

- **Improve air quality**
- **Decrease the possibility of rolling blackouts and the threat to public health during heat waves**
- **Reduce the pollution the causes global warming**

The fact sheet and sample resolution are part of a comprehensive policy assistance package that ICLEI has developed to assist local governments in mitigating the Urban Heat Island Effect. ICLEI developed these tools with support from the Environmental Protection Agency's Urban Heat Island Initiative.

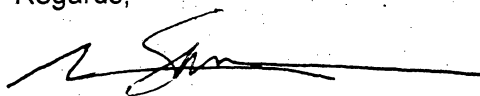
The comprehensive policy package (including this fact sheet and resolution) is available on the web at [www.hotcities.org](http://www.hotcities.org) and includes the following companion pieces:

- Examples of Heat Island mitigation policies currently in place
- Sample ordinance language, standards, product databases, and background documentation for each policy item.

This year, ICLEI will be working with a small group of CCP cities and counties to adopt and implement a variety of Urban Heat Island mitigation measures. Within the next several months, ICLEI will issue a solicitation to all CCP local governments to participate in this innovative technical assistance project, called the **Urban Heat Island Mitigation Policy Adoption Initiative**.

If you wish to get more copies of the fact sheet or more information on the Policy Adoption Initiative, please don't hesitate to contact me.

Regards,



Maria Sanders  
Msanders@iclei.org  
(510) 540-8843

US Office

15 Shattuck Square, Suite 215  
Berkeley, California 94704, US/  
Phone: +1-510/540-8843  
Fax: +1-510/540-4787  
iclei\_usa@iclei.org

World Wide Web

<http://www.iclei.org>

ICLEI is an international association of local governments dedicated to the prevention and solution of local, regional, and global environmental problems through local action.

World Secretariat

Toronto, Canada  
iclei@iclei.org

European Secretariat

Freiburg, Germany  
iclei-europe@iclei-europe.org.

Latin American and Caribbean Secretariat

Rio de Janeiro, Brazil  
iclei-rio@iclei.org

Santiago, Chile  
icleila@cmet.net

Asia Pacific Secretariat

Japan Office  
Tokyo, Japan  
iclei-j@ceres.dti.ne.jp

Australia and New Zealand Office

Melbourne, Australia  
anz@iclei.org

Office of the Africa  
Regional Coordinator

Harare, Zimbabwe  
iclei@zol.co.zw

## Sample Resolution: Urban Heat Island Mitigation

*The following provides sample language for a resolution that can be used to introduce policy to mitigate the Urban Heat Island Effect in private sector and/or public sector projects. The resolution has been constructed so that you may cut-and-paste and adapt it for individual policy items that make the most sense for your jurisdiction.*

*This resolution is a part of a larger policy package that includes the following companion pieces (available on the web at [www.hotcities.org](http://www.hotcities.org)):*

- *Fact sheet describing the Urban Heat Island Effect and what local governments are doing to cool down their communities*
- *Framework for developing a comprehensive Urban Heat Island Mitigation policy*
- *Sample ordinance language, standards, and background documentation for each policy item.*

\*\*\*\*\*

WHEREAS, scientific studies conducted by Lawrence Berkeley National Laboratory and others have shown that urban areas may have peak summer-time air temperatures of up to ten degrees Fahrenheit hotter than their suburban and rural surroundings, a phenomenon that is commonly known as the Urban Heat Island Effect; and

WHEREAS, these studies have shown that this additional urban heat is primarily the result of large areas of dark colored surfaces such as roofs, roads and parking lots that absorb rather than reflect the sun's heat, causing surface and ambient air temperatures to rise; and

WHEREAS, this effect is exacerbated by the lack of vegetation in urban areas. Vegetation not only provides cooling shade, but also naturally cools the atmosphere; and

WHEREAS, the Urban Heat Island Effect may lead to many adverse impacts on a city's public health, air quality, and energy supplies, including: intensification of heat waves that can put people at risk for heat exhaustion and heat stroke; more rapid formation of ground-level ozone (which accelerates at higher temperatures); aggravation of respiratory problems such as asthma that are caused by poor air quality; higher risk for power shortages and blackouts due to increased demand for air conditioning; and greater emissions of air pollutants and greenhouse gases (which cause global warming) due to the burning of fossil fuels for electricity production; and

WHEREAS, there are currently available cost-effective technologies and practices -- such as incorporating reflective roofing and paving materials into the built environment, and strategically planting shade trees -- that can mitigate the increased temperatures associated with the Urban Heat Island Effect; and

WHEREAS, mitigating urban heat islands improves air quality, cuts energy costs, and decreases the impacts of severe heat waves; and

[CONTINUED - SEE REVERSE SIDE]

WHEREAS, using urban heat island mitigation technologies and practices increases the life of roofing and paving materials, thereby decreasing maintenance costs; and

WHEREAS, pedestrians and other vehicles are more visible on lighter roadways and parking lots, thereby increasing safety and reducing the need for as many streetlights and security lights; and

WHEREAS, using urban heat island mitigation technologies and practices will contribute to the achievement of goals under *[if appropriate, insert applicable policy -- such as participation in Cities for Climate Protection or other types of sustainability initiatives -- passed by your jurisdiction]* .

THEREFORE, BE IT RESOLVED, that *[governing body]* declares that in the interest of the health, safety, and quality of life of *[city/county]* residents and businesses, it is the goal of *[city/county]* to mitigate the effects of heat-absorbing materials that contribute to the Urban Heat Island Effect within its jurisdictional boundaries.

BE IT FURTHER RESOLVED, that *[name implementing agency: e.g., Procurement, Public Works or Environmental Services]* be directed to develop within nine months a comprehensive Urban Heat Island Mitigation policy for *[governing body]* approval that promotes the use of cool community strategies and that includes the following elements:

- Designation of divisions or agencies that will be responsible for implementing and monitoring elements of the policy; and
- Action steps for ensuring that cool community strategies – such as shade tree standards for parking lots and heat-reducing alternatives to traditional hot roofing and paving systems – are used in all facilities owned, operated and maintained by *[city/county]*, and in private projects receiving funding from the jurisdiction; and
- Action steps for encouraging use of heat-reducing strategies and technologies by the private sector through education, incentives, and regulation.

# 3

# WAYS TO COOL

*Here are three ways your community can mitigate the Urban Heat Island Effect, while cutting energy costs, reducing global warming and air pollution, and preventing conditions that lead to killer heat waves.*

## WHERE ARE COOL ROOFS MOST EFFECTIVE?

- **What Regions?** Cool roofing systems are cost-effective in all but the coldest and cloudiest regions. While these roofing systems do lead to a slight increase in space heating during the winter, the reduced cooling costs in most cases far outweigh the increase in winter heating.
- **Which Buildings?** The best candidates for energy savings from cool roofing are low-rise, air-conditioned buildings that have large roof surface areas and higher cooling than heating costs.

For more information and  
ACCESS TO MODEL POLICIES  
AND ORDINANCES,  
see ICLEI's online resource,  
[www.hotcities.org](http://www.hotcities.org)

**1 Cool Roofs** Conventional dark-colored, low-sloped roofs reflect between 10-20% of incoming solar radiation, converting the remainder into heat that is absorbed by the roof. Much of this heat is then transferred into the building, increasing demand for air conditioning. In summer, conventional roofing materials can be 50-60° F hotter than cool roofing alternatives.

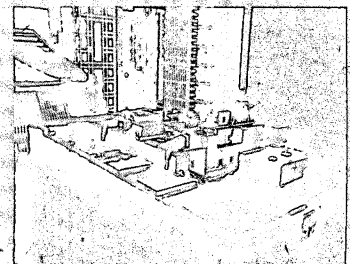
### Cool Roof Strategies:

- ✓ **Use Cool Roofing Materials:** Florida Solar Energy Center tests on commonly used roofing products revealed that reflectivity ranged from a low of 3% for black shingles to 80% for white roofing materials. Energy savings in buildings with white roofs ranged as high as 32% during peak demand, with a summer average of about 15%. It is important to note that metal-coated and bare metal roofing, while reflective, conducts heat and will not provide cooling benefits.

**Real Results:** An elementary school in Alexandria VA replaced a typical black roof with a reflective roofing system. Energy costs for the school dropped from an average of \$121,000 to \$90,000 per year.<sup>3</sup>

- ✓ **Green Roofs With Vegetation or Roof-Top Gardens:** Planting vegetation on a roof cools it significantly, while combining energy savings with aesthetic and ecological goals. There are many different types of technologies, commonly used in Western Europe, that will allow the installation of up to 18 inches of soil and planting of no-maintenance vegetation on a roof.

**Case Study:** Chicago has installed a 32,000 square-foot rooftop garden at City Hall. This high profile project covers half the roof with native grasses, shrubs, and trees. Before installation, rooftop temperatures commonly measured 110° F when the surrounding ambient air in Chicago was only 75° F. The city is monitoring rooftop temperatures and energy savings to assess the results of the project.<sup>4</sup>



Chicago City Hall Roof Top Garden

## 2 Lighten Streets and Cool Parking Lots

Streets and parking lots account for the majority of paved surfaces in urban areas. Almost all streets and parking lots are constructed using black asphalt, which greatly contributes to the Urban Heat Island Effect. Dark colored pavements can get up to 40° F hotter than the surrounding air.

### Cool Paving Strategies:

- ✓ **Use Reflective or Other Cool Paving Materials:** Construct, replace, or reconstruct roads and parking lots with reflective or cool paving materials like portland and flyash cement concrete (see sidebar on "Climate Friendly Cement"), porous concrete, chip-seals, turf-block or porous pavers, and light-colored asphalt emulsion sealcoats.<sup>5</sup>
- ✓ **Shade Parking Lots:** Planting shade trees in hot spots like parking lots can reduce surface temperatures and the temperature inside parked cars. Cool parking lots also reduce air quality problems. Studies have demonstrated that increasing tree cover in parking lots from 8% to 50% reduces evaporation of hydrocarbons from car fuel tanks and NO<sub>x</sub> emissions from car start-ups.<sup>6</sup>

# HOT CITIES = DIRTY AIR

# COOL CITIES = CLEAN AIR

*How To Prevent Killer Heat Waves and Save Money at the Same Time*

## HOT FACTS<sup>1</sup>

- Cities can be 5–10° F warmer than surrounding countryside on hot summer days.
- 1/6 th of total electricity consumed in the U.S. is used for cooling, costing \$40 billion/yr.
- Air quality studies in Los Angeles estimate that a 1° F increase in summer temperatures boosts smog formation by 3%.
- Cooling Los Angeles by 5–7° F can reduce smog formation by 20%—the equivalent of taking all cars out of LA's airshed for one day.

## What is the Urban Heat Island Effect?

**THE PROBLEM:** On hot summer days, cities can be up to 10° F hotter than their suburban and rural surroundings. This phenomenon occurs because urban development results in large amounts of paved and dark colored surfaces like roofs, roads, and parking lots that absorb, rather than reflect, the sun's heat, causing the temperature of surface areas and ambient air to rise.<sup>2</sup>

The good news is that there are simple ways to reduce heat gain in cities, many of which help solve other urban problems.

**WHY SHOULD CITIES AND COUNTIES CARE?** The Urban Heat Island (UHI) Effect can adversely impact a city's public health, air quality, energy demand, and infrastructure costs.

- **Dirty Air:** Hotter air in cities increases the formation of ground-level ozone (the main ingredient in smog) and can push metropolitan areas out of compliance with federal air quality standards. Smog is formed when air pollutants such as nitrogen oxides (NO<sub>x</sub>) and Volatile Organic Compounds (VOCs) are mixed with sunlight and heat. The rate of this chemical reaction increases when temperatures exceed 70° F.
- **Risks To Public Health:** The UHI Effect prolongs and intensifies heat waves, making residents and workers uncomfortable and putting them at increased risk for heat exhaustion and heat stroke. In addition, high concentrations of ground level ozone aggravate respiratory problems such as asthma, putting children and the elderly at particular risk.
- **High Energy Use:** Hotter temperatures increase demand for air conditioning, increasing energy use when demand is already high. This in turn contributes to power shortages and raises energy expenditures at a time when energy costs are at their highest.
- **Global Warming:** Global warming is in large part caused by the burning of fossil fuels to produce electricity for heating and cooling buildings. Urban Heat Islands contribute to global warming by increasing the demand for electricity to cool our buildings. Depending on the fuel mix used in producing electricity, each kilowatt hour of electricity consumed can produce up to 2.3 pounds of carbon dioxide (CO<sub>2</sub>), the main greenhouse gas contributing to global warming.

ICLEI  
International Council for  
Local Environmental Initiatives



For more information and  
ACCESS TO MODEL POLICIES  
AND ORDINANCES,  
see ICLEI's online resource,  
[www.hotcities.org](http://www.hotcities.org)

[www.hotcities.org](http://www.hotcities.org)

# YOUR COMMUNITY

**3 Green Your Community** Many scientific studies confirm what we already know from experience: trees and other vegetation make our communities cooler. Studies have found that neighborhoods with plenty of mature trees can be up to 7 degrees cooler than treeless areas nearby.<sup>7</sup>

## Green Community Strategies:

✓ **Strategically Select and Site Trees:** Trees placed on the west-, northwest-, and east-facing sides of a building can significantly reduce cooling costs for a typical home or low-rise building during peak summertime demand. Planting deciduous, rather than evergreen, trees will shade buildings in the summer, and allow the sun to warm them in the winter.

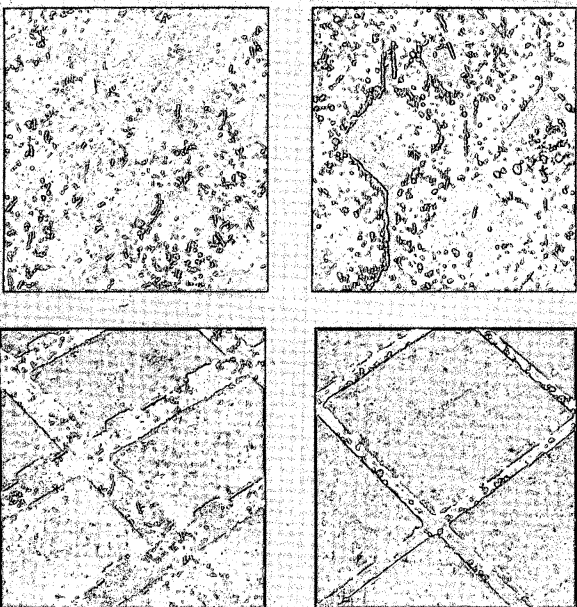
**Scientific Studies:** Simulations of energy saving benefits for Sacramento and Phoenix found that 3 mature trees around homes cut annual air conditioning demand by 25 to 40%.<sup>8</sup>

✓ **Preserve and Plant More Trees:** Preserving and increasing urban tree canopies throughout the community have been demonstrated to decrease summer time electric bills.

**Real Results:** Florida Power & Light, in conjunction with Miami-Dade County's Cool Communities Program, studied 20 Miami and Ft. Lauderdale neighborhoods and determined that residents in neighborhoods that had more than 20% tree canopy coverage had summer electric bills 8-12% lower than neighborhoods with less coverage.<sup>9</sup>

✓ **De-pave School Yards:** Replacing asphalt playgrounds with green spaces provides children with interesting, safe, and cool places to play at school.

**Case Study:** Los Angeles is eliminating nearly 2 million square meters of pavement at local schools. This "de-paving" project is part of a wider effort of the Trans-Agency Resources for Environmental and Economic Sustainability (TREES) coalition, which includes an extensive strategic tree planting program.



Examples of porous pavers.

## WHAT IS "CLIMATE FRIENDLY" CEMENT?

Cement is a powder produced from burned limestone, clay and other additives. The process of making cement is extremely energy intensive, and results in large amounts of greenhouse gas emissions – cement processing and production is responsible for 50% of all greenhouse gas emissions coming from the U.S. industrial sector. Local governments can ensure that the cement they use is "climate friendly" by requiring projects made with concrete to use blended cement that includes recycled industrial by-products like fly-ash and blast-furnace slag.

## GOOD TREES – BAD TREES

When it comes to air quality, not all trees are created equal. Some trees, such as weeping willow and eucalyptus, emit volatile organic compounds (VOCs) that combine with nitrogen oxides (NO<sub>x</sub>) to form smog. Other trees, such as ash and maple, are very low emitters. These trees are good candidates for improving air quality because they sequester and filter pollutants such as CO<sub>2</sub> and particulate matter.<sup>10</sup>

## Resources for Urban Heat Island Reduction

Below is a list of the most helpful web sites for information on implementing urban heat island reduction strategies. Links to these sites—as well as a model framework for developing a comprehensive Urban Heat Island mitigation policy, and backup documentation for many of the policy items mentioned in this fact sheet—can be found on ICLEI's online resource, [www.hotcities.org](http://www.hotcities.org).

- **American Forests:** Non-profit association that provides a variety of tools and regional tree guides to help develop appropriate tree lists and to measure the economic benefits of trees in urban settings. [www.americanforests.org/trees\\_cities\\_sprawl](http://www.americanforests.org/trees_cities_sprawl).
- **EPA Energy Star Program:** US Environmental Protection Agency voluntary labeling program designed to identify and promote energy-efficient products, including reflective roofing products. Information on Energy Star rated roofing products can be found online: [www.energystar.gov/products](http://www.energystar.gov/products).
- **EPA Heat Island Reduction Initiative (HIRI):** Multi-agency collaboration that works with state and local governments to reduce the impact of the Urban Heat Island Effect. HIRI supports heat island research including efforts to quantify the energy, health, and air quality benefits of reducing city temperature. The program also involves a wide range of stakeholders in the promotion of policy options to achieve these benefits. Contact: Niko Dietsch—phone (202) 564-3479, e-mail: [dietsch.niko@epa.gov](mailto:dietsch.niko@epa.gov) and Eva Wong—phone (202) 564-3528, e-mail: [wong.eva@epa.gov](mailto:wong.eva@epa.gov).
- **International Council for Local Environmental Initiatives:** ICLEI hosts the [www.hotcities.org](http://www.hotcities.org) web site, containing information specifically tailored for local governments in adopting and implementing cool community strategies. Contact: Maria Sanders, Cities for Climate Protection Program, (510) 540-8843. [www.hotcities.org](http://www.hotcities.org).
- **Lawrence Berkeley National Laboratory's Cool Roofing Database:** A database that provides a comparison of the reflectivity and emissivity of various roofing products. <http://EETD.LBL.gov/CoolRoofs/>.
- **Lawrence Berkeley National Laboratory's Urban Heat Island Group:** Its home page contains a good tutorial on the Urban Heat Island Effect, results of its heat island and cool roof research, links to other web sites containing pertinent research, and a database that compares roofing materials. <http://eandc.lbl.gov/HeatIsland/>.
- **NASA's Urban Climatology and Air Quality Group:** Home page for NASA's investigations in how the rapid growth of urban areas impacts regional climate and air quality. This site details the results of NASA's remote sensing of hot spots in five pilot cities. [www.ghcc.msfc.nasa.gov/urban](http://www.ghcc.msfc.nasa.gov/urban).
- **Selectree Database:** A tree species database that contains a "biogenic emissions" search criterion, as one of many important tree selection criteria. Especially useful for southern California cities. <http://selectree.cagr.calpoly.edu/>.
- **USDA Forest Service Western Center for Urban Forest Research and Education:** Its home page provides information on its research and products, such as California urban forest guidelines, a comprehensive study of the Sacramento urban forest, air quality and energy reduction benefits of urban forests, and evaluations of parking lot shade tree ordinances. <http://wcufr.ucdavis.edu/>.

## Notes

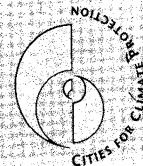
- <sup>1</sup> Rosenfeld, Arthur, Romm, Joseph, Akbari, Hashem and Lloyd, Alan. "Painting the Town White—and Green." *Technology Review*. Cambridge, MA, Feb/Mar 1997. For more information also see <http://eandc.lbl.gov/heatisland>
- <sup>2</sup> Ibid.
- <sup>3</sup> "Reflective Roofs Return Multiple Dividends." *Building Operation Management*. pp. 105-116. May, 2000.
- <sup>4</sup> City of Chicago website [www.ci.chi.il.us/Environment/AirToxPollution/UrbanIslands.html](http://www.ci.chi.il.us/Environment/AirToxPollution/UrbanIslands.html).
- <sup>5</sup> Ting, Michael; Koomey, Jonathan; and Pomerantz, Melvin. "Preliminary Evaluation of the Lifecycle Costs and Market Barriers of Reflective Pavements." Lawrence Berkeley National Laboratory, Energy Analysis Department. December 2000. <http://enduse.lbl.gov/Projects/pavements.html>.
- <sup>6</sup> Scott, K.I.; Simpson, James; and McPherson, Gregory. "Effects of Tree Cover on Parking Lot Microclimate and Vehicle Emissions." *J. Arboric.* 25(3), pp. 129-142. 1999. Also see <http://wcufr.ucdavis.edu/>
- <sup>7</sup> Simpson, James. "Urban Forest Impacts on Regional Cooling and Heating Energy Use: Sacramento County Case Study." *J. Arboric.* 24(4), pp. 201-214. 1998.  
Nowak, David. "The Effects of Urban Trees on Air Quality." USDA Forest Service, Northeast Research Station. Syracuse NY. [www.fs.fed.us/ne/syracuse](http://www.fs.fed.us/ne/syracuse)
- <sup>8</sup> McPherson, Gregory and Simpson, James. *Carbon Dioxide Reduction Through Urban Forestry*. Gen Tech Rep PSW-GTR-171. Pacific Southwest Research Station, USDA, US Forest Service. Albany, CA 1999.
- <sup>9</sup> Miami-Dade County Cool Communities Program.
- <sup>10</sup> Benjamin, Michael T.; Sudol, Mark; Bloch, Laura; and Winer, Arthur M. "Low-Emitting Urban Forests: A Taxonomic Methodology for Assigning Isoprene and Monoterpene Emission Rates." *Atmospheric Environment*. Vol.30, No.9, pp.1437-1452, 1996.
- <sup>11</sup> Jensen, Ryan. University of Florida Department of Geography. *University of Florida News*. July 6, 2000. [www.napa.ufl.edu/2000news/tree.htm](http://www.napa.ufl.edu/2000news/tree.htm).

• I • C • L • E • I

International Council for  
Local Environmental Initiatives

The International Council for Local Environmental Initiatives is an association of local governments dedicated to the prevention of and solution to local, regional, and global environmental problems through local action.

The Urban Heat Island Policy Project of ICLEI's Cities for Climate Protection is made possible by funding from the US EPA Heat Island Reduction Initiative, State and Local Capacity Building Branch, Office of Air and Radiation.



ICLEI's Cities for Climate Protection® (CCP) Campaign is a global effort to reduce the emissions of greenhouse gases from urban areas and to improve local air quality and urban livability. More than 400 local governments, including over 100 US cities and counties, are currently participating in CCP. The Campaign operates training and technical assistance projects that focus on reducing emissions through energy efficiency, renewable energy, waste management, and transportation improvements.

• I • C • L • E • I

International Council for  
Local Environmental Initiatives

15 Shattuck Square, Suite 215  
Berkeley, CA 94704

Phone: 510.540.8843 Fax: 510.540.4787  
E-mail: [iclei\\_usa@iclei.org](mailto:iclei_usa@iclei.org)

# 6

# COOL POLICIES FOR LOCAL GOVERNMENTS

*What can local governments do to mitigate the Urban Heat Island Effect?*

*Because city and county governments set and enforce local building standards, operate facilities, build and maintain infrastructure, and provide a variety of services, there are plenty of tools that local governments can use to cool their communities down.*

*Go to ICLEI's online resource to download COOL COMMUNITY CASE STUDIES, MODEL POLICIES, ORDINANCE LANGUAGE, AND RFP LANGUAGE for many of the following local government mechanisms.*

*[www.hotcities.org](http://www.hotcities.org)*

**1 Use Cool Community Strategies in Public Buildings and in Routine O&M Activities** Cities and counties can provide leadership in reducing their Urban Heat Island by incorporating cool community strategies in public works projects and routine city operations and maintenance.

**Chicago Urban Heat Island Reduction Initiative:** The Mayor directed departments to implement a comprehensive Urban Heat Island policy. In addition to installing a high profile rooftop garden at City Hall (see section on "Cool-Roofs"), Chicago has also included cool community strategies in other public sector activities:

- The General Services Agency's Building Department created a white roof requirement for all new and replaced roofs on city buildings.
- The Transportation Department adds 4-5 miles of native tree plantings per year along traffic medians.
- Four wards were given \$500,000 each to undertake mitigation projects in high profile areas. Pilot projects include installing reflective roofing, developing rooftop gardens, adding greenspace and shade trees, and breaking up large areas of asphalt concrete.

**2 Amend Building Codes to Include Reflective Roofing Standards** There are well accepted standards for reflective roofing systems. Local building departments can amend current codes to include these standards and/or develop incentives to encourage the use of reflective roofing.

**State of Georgia Building Code Standard:** Georgia was the first state to amend its Energy Code for commercial buildings to reduce insulation requirements when a reflective roof is used. Variations of these standards are being considered for inclusion in **Chicago's Building Code**.

**3 Amend Landscape and Development Standards to Include Shade Coverage Requirements** Most communities have landscape standards, parking lot standards, and/or tree preservation ordinances. The trick is to use these and other development standards to maximize the energy saving and the shading potential of trees.

**Miami-Dade County Landscape Ordinance:** This ordinance includes standards that require three trees per single family dwelling, two of which must be planted in a conceptual "Energy Conservation Zone" that surrounds the dwelling.

**The Sacramento Zoning Code:** The code's "development standards for parking facilities" contain a 50% tree shade coverage requirement for all parking lots. Implementation of a similar requirement in Davis, CA is supported by the *Davis Parking Lot Shading Guidelines and Master Parking Lot Tree List*.

**City of Gainesville Tree Preservation Ordinance:** A University of Florida study found that residents of Gainesville had significantly lower energy bills than residents of a nearby town, attributing these savings in part to Gainesville's stricter tree preservation ordinance.<sup>11</sup>

**Continued on next page...**

# 6

# COOL POLICIES FOR LOCAL GOVERNMENTS

CONTINUED...

## 4 Put Cool Community Guidelines in Master Plans and in Agreements with Developers

All cool community strategies mentioned in this fact sheet can be incorporated into design guidelines, master plans, and design review criteria for high priority areas that are undergoing a planning process. Areas with an Urban Heat Island that are known to be "hot spots" can be targeted for mitigation.

In addition, Planning, Housing, Community Economic Development, and Redevelopment agencies should further pursue the types of Urban Heat Island mitigation goals that are included in planning documents by incorporating them into project agreements with developers.

Highland, UT created design guidelines for developing the Highland Town Center that included the use of light colored paving materials and strategic tree planting for appropriate streets, traffic medians, and parking lots. These guidelines were then incorporated by reference into the Town Center Overlay in the Highland Zoning Code.

## 5 Create Incentives for Cool Action

The up-front costs associated with cool roofs, pavements, and tree planting can be higher than traditional hot roofing and paving materials and not having trees at all. Rebates, tax credits, and permit streamlining are some of the incentives that local governments can use to level the playing field and encourage use of cool community strategies.

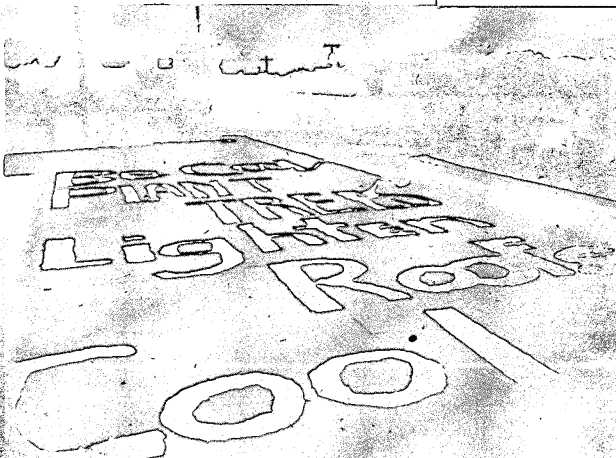
California Energy Commission's Cool Roof Retrofit Program offers rebates to building owners, property managers, schools, and public entities that re-roof using cool products listed by the US EPA Energy Star Roofing Products program. Rebates range from \$.05 to \$.15 per square foot of new roofing, depending on existing roof and ceiling insulation. The City of Los Angeles is matching these rebates with an additional \$.025 to \$.075 (or 50% of the state rebate) per square foot.

## 6 Sponsor Demonstration Projects and Contests

Public and private sector projects can be used to demonstrate cool community strategies, including their energy savings and aesthetic benefits. This is an excellent way to educate the public, build a local market for cool roofing and paving materials, and gather data on Urban Heat Island mitigation strategies.

Miami-Dade County's Cool Communities program sponsored a contest for a free roof-whitening. The commercial business that won the prize saw a \$100 drop in its electric bill in the first month after the roof was lightened. An educational message about the program was applied to the roof and is seen by 95,000 Metrorail riders every month.

Chicago is demonstrating cool community strategies in four demonstration project areas. The Chicago Department of Environment has issued Requests For Proposals for contractors to install cool roofing on public buildings and to enhance landscaping on city-owned sites. Chicago is also issuing grants to businesses and nonprofit organizations to initiate similar improvements.



The lucky winner of Miami-Dade's Cool Communities Cool Roof contest.



# City of Cambridge

O-9.

**IN CITY COUNCIL**

September 10, 2001

COUNCILLOR DAVIS

**ORDERED:** That the City Manager be and hereby is requested to transmit the attached information on the "urban heat island effect" to the Assistant City Manager for Community Development, the Commissioner of Public Works and any other appropriate staff for a report back to the City Council with recommendations on possible steps Cambridge can take to avoid the syndrome, such as installing light-colored roofs on municipal buildings and school buildings.

2440m

**Order #9**

Recommendation on steps that the  
City of Cambridge can take to  
avoid the "urban heat island effect."

**Councillor Davis**

**In City Council September 10, 2001**

**ORDER ADOPTED**