

Mitigating Urban Heat Islands and Responding to Excessive Heat Events



HEAT ISLAND REDUCTION
I N I T I A T I V E

APHA

November 5, 2007

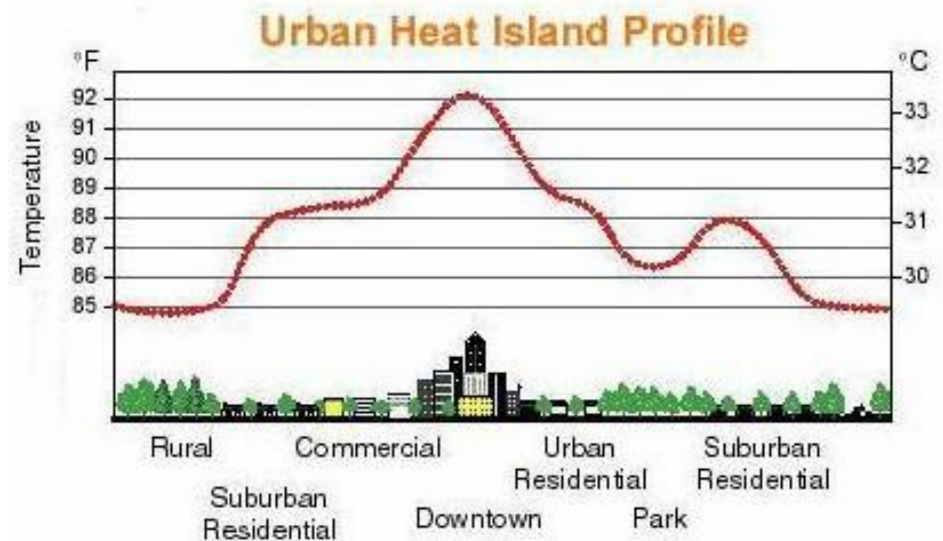
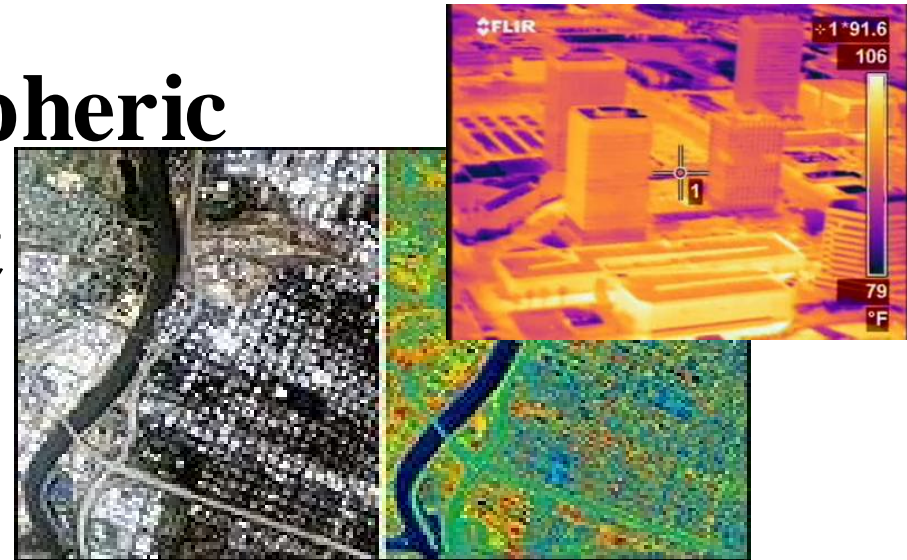
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Urban Heat Island (UHI)

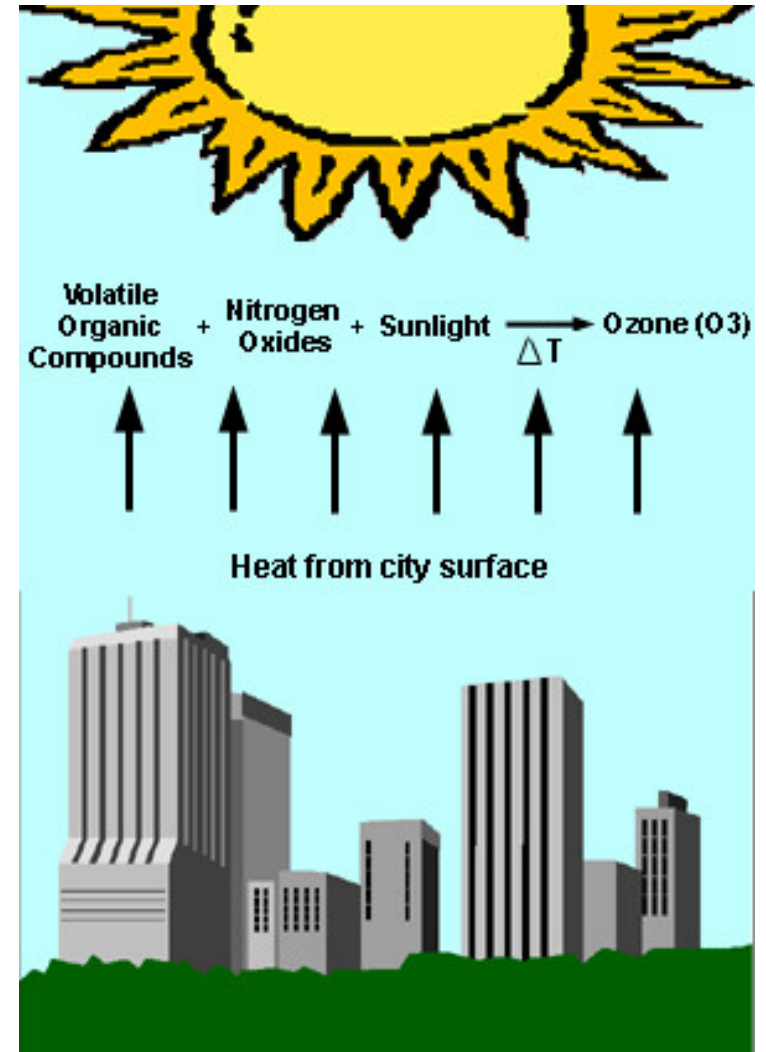
Definition & Causes

- **Surface & Atmospheric**
- **Year-round, night**
- **Causes**
 - Urbanization
 - Urban Form
 - Anthropogenic
- **Influence - weather**



UHI Impacts

- **Energy Demand - A/C**
 - 1.5-2%↑ electr./1°F↑ (LA)
 - Longer peak periods (AZ)
- **Air Pollution**
- **GHG Emissions**
- **Ozone Formation**
- **Water Use & Quality**
- **Human Health**
- *Agriculture & Dairy Impacts*
- *Tourism*
- *LCA of Materials*



Excessive Heat Events (EHE)

Definition & Impacts

- **Summertime weather that is substantially hotter and/or more humid than average for a location at that time of year.**
- **EHEs increase heat-related mortality and morbidity**
 - More deaths from EHE than other natural hazards in U.S.
 - ~700 heat-related deaths annually in U.S. (CDC, 2006)
 - Over 700 deaths in Chicago alone during 1995 heat wave
 - Europe heat wave of 2003: 35K deaths...~15K in France
- **Populations most at risk**
 - Older adults, poor, individuals living alone, very young, people with mental illness and chronic diseases
 - City residents (urban heat islands) in highly variable climates

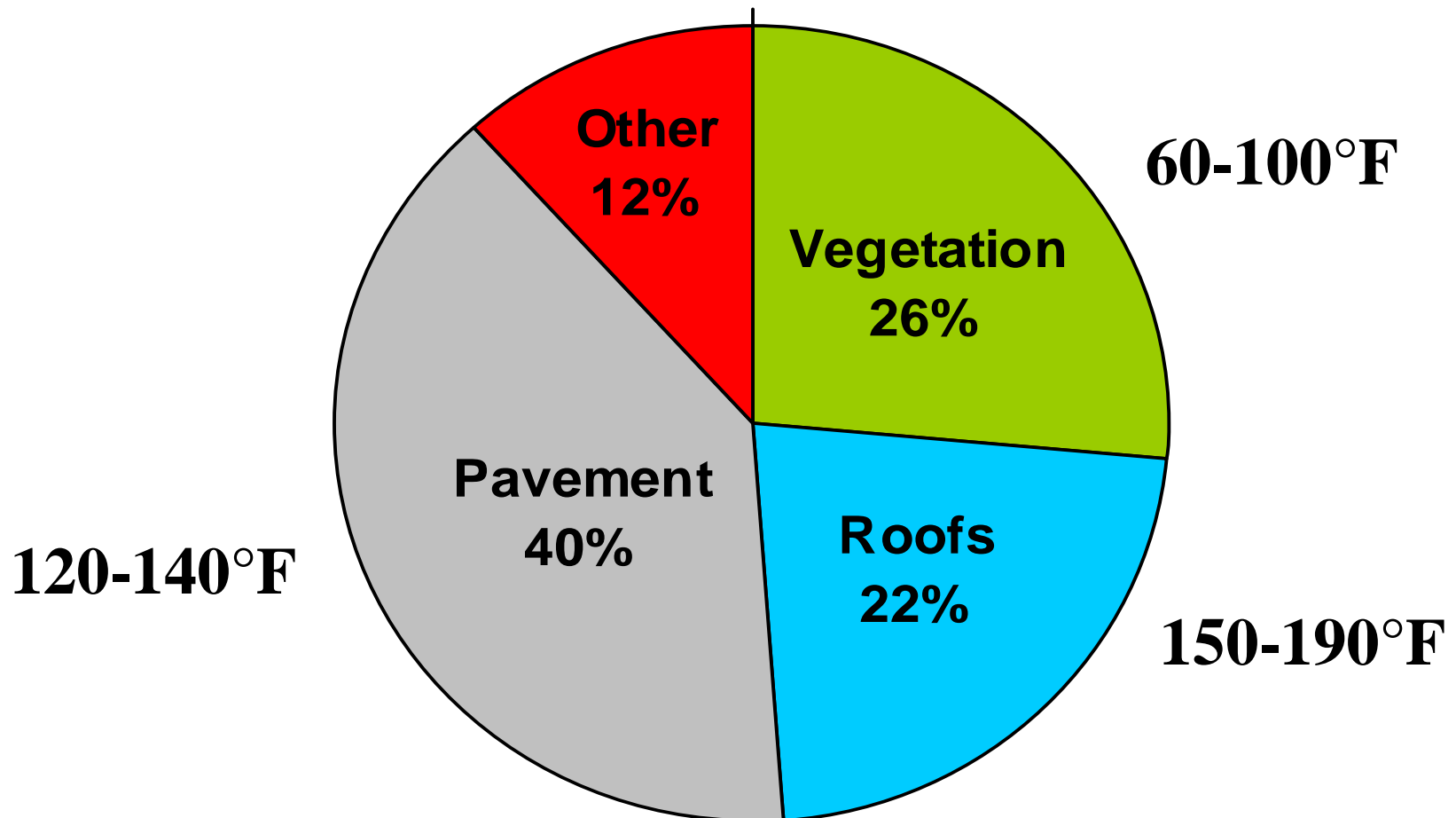
Key Strategies to Reduce UHI

- **Urban Vegetation**
 - **Green Roofs**
- **Cool Roofing**
- **Cool Pavements**



Key Strategies to Reduce Heat Islands

Average Urban Land Cover & Peak Temperatures Ranges



Trees & Vegetation - Technology

- **Trees & Vegetation**
 - **Shading**
 - **Evapotranspiration**



Green Roofs - Technology

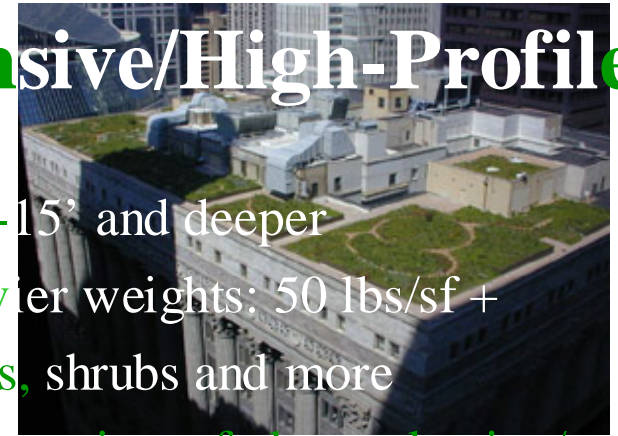
Extensive/Low-Profile



- Low growth media: 2 – 6”
- Lightweight: 13 – 50 lbs/sf
- Low growing plants: 1”– 24” H
- Less variety of plants: Alpine types, succulents, herbs, some grasses and mosses
- Usually non-accessible and non-recreational
- Slopes up to 30° & higher
- Less expensive: \$5-\$25/sf
- Low water requirements
- Low maintenance

vs.

Intensive/High-Profile



- > 6”-15’ and deeper
- Heavier weights: 50 lbs/sf +
- Trees, shrubs and more
- Huge variety of plant selection/ architectural features depending on loads, design & budget
- Designed for human recreation: gardening, socializing, etc.
- Relatively flat
- More expensive: \$25-\$40/sf +
- Irrigation usually necessary
- Higher maintenance

Source: Linda Valezquez, Greeroofs.com

Urban Vegetation – Benefits

- **Energy Savings**
 - On average 5-10% a/c savings
- **Temperature Reduction – Heat-health**
 - Up to 45°F surface temp reduction
 - 10% increase in canopy ♦ up to 3.5 °F decrease in midday temps



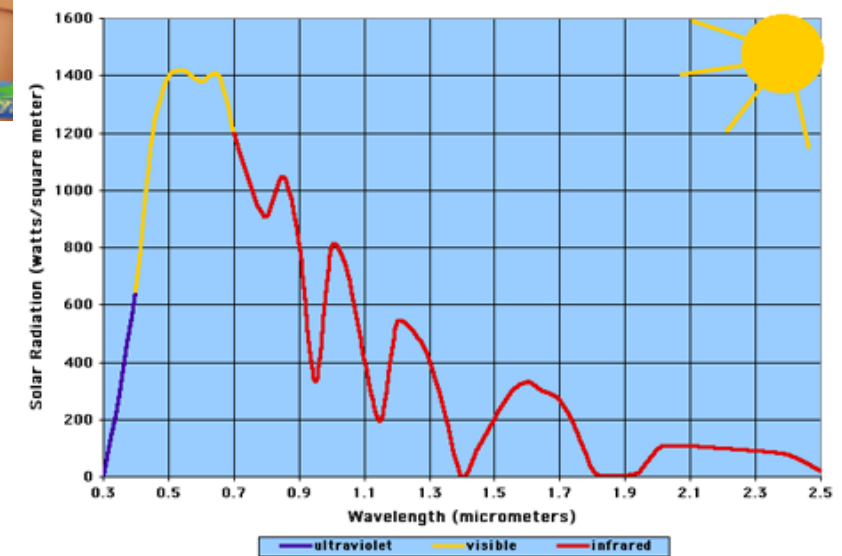
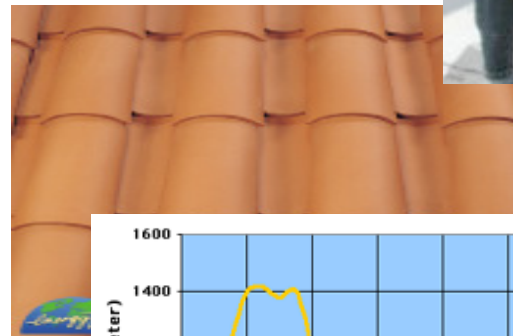
- **Air Pollution**
 - Removal
 - VOC reductions - shading parking lots
 - CO2 sequestration and storage



- **Stormwater Management**
- **Beautification, Biodiversity, Property Value Increases**

Cool Roofing - Technology

- **Flat or Low-Sloped Roofs (Commercial)**
 - Coatings
 - Single-ply
- **Sloped Roofs (Residential)**
 - Tiles
 - Metal roofs
 - *Asphalt shingles?*



Cool Roofing - Benefits

- **Energy Savings**
 - ENERGY STAR® - peak cooling demand reductions 10–15 %
 - Field monitoring in CA, TX, FL resulted in annual cooling energy savings from 10 - 70%
- **Temperature Reductions**
 - ENERGY STAR® - surface temp reductions up to 100°F
 - Recent modeling in NYC cool roof scenario found ~0.5°F reduction in air temperatures
- **Reduced Air Pollution and GHG Emissions**
- **Indoor Comfort – Heat-health impact**
- *Durability and Waste Minimization*

Cool Pavements – Technology

- **Current Technology Options**

- Increase solar reflectance
- Increase evaporation
- Increase porosity/change thermal properties



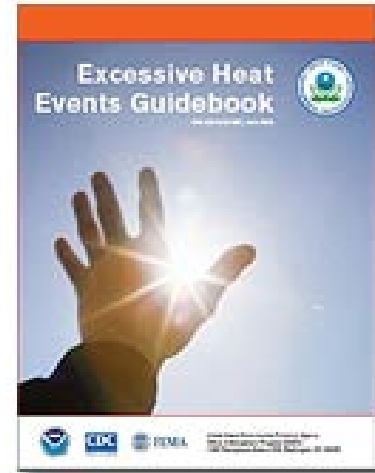
- **Challenges**

- Multiple functions requiring multiple technologies
- Each pavement individually specified – not “off the shelf.”
- Current options may have much higher first costs
- Many unanswered questions
- Main industries very competitive



Responding to EHE

- **UHI Reduction – Long-Term**
- **EHE Guide - 5 Recommendations**
 - **EHE definition and forecasting**
 - **Public education**
 - **Response preparation**
 - **Understand local constraints and opportunities**
 - **Develop plan w/critical service providers (e.g., public health dept., emergency medical services, county aging offices, homeless shelters/advocates, utilities, community leaders, etc.)**
 - **Response actions**
 - **Facilitate access to a/c – cooling centers w/transportation**
 - **Phone hotlines, Direct outreach – buddy system**
 - **Suspend utility shut-offs**
 - **EHE program review and evolution**



UHI – EHE Research

- **Dr. Jay Golden, ASU, “Role of Climate and Urban Morphology with Human Health Vulnerability.” Empirical research and development of a model to Predict Incidents, Allocate Resources & Examine Mitigation Strategies – Multiple cities (Chicago, King County, Phoenix, London, New York etc.)**

Heat Waves

Power Outages

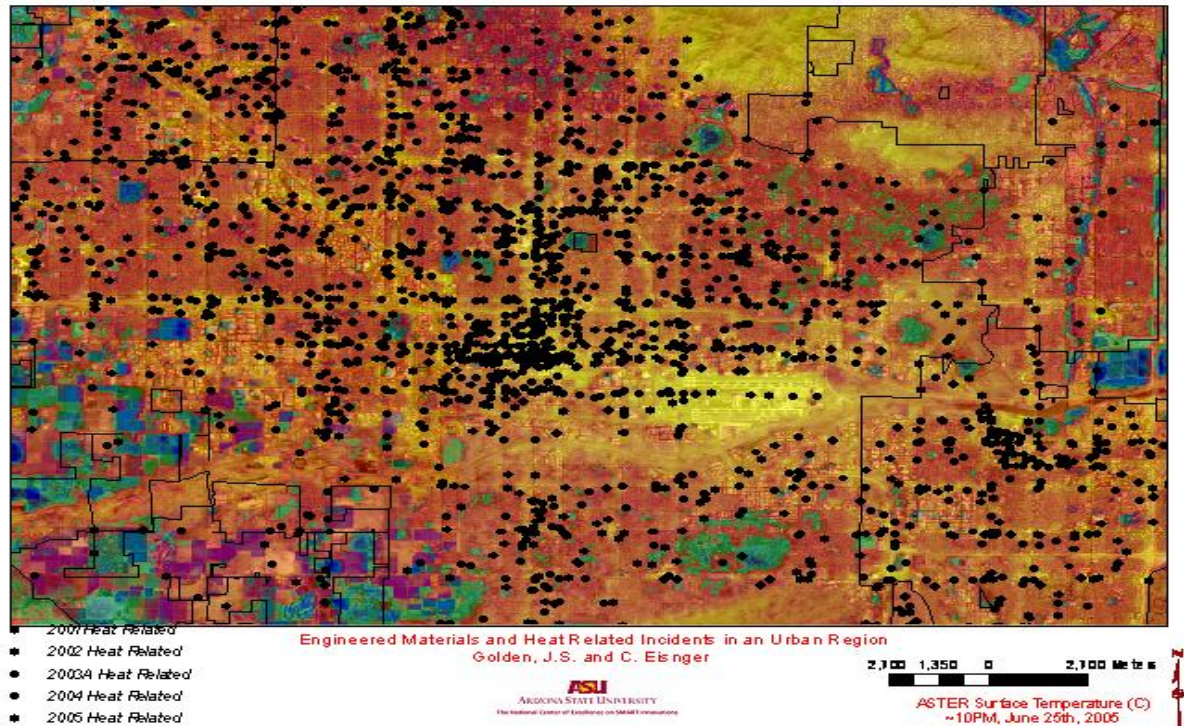
Heat Stress

Premature Births

Respiratory

By Age & Income

**By Vegetation &
Materials**



- **Jason Samenow, EPA**
- **University of Michigan**

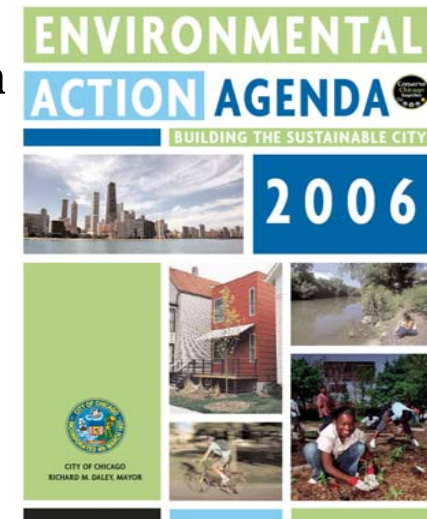
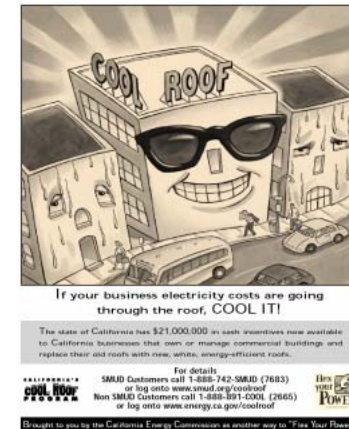
Efforts to Advance UHI Reduction Strategies

- Labeling Programs
- Demonstration Projects
- Weatherization Programs
- Education
 -  *Earth Gauge*™
- Incentives
- Green Building Programs
- Ordinances
- Standards and Energy Codes



Examples of Local Action

- **Philadelphia – Health Driver**
 - Excessive Heat Event program – HHWWS+
 - Weatherization – Cool roof component**Results: Heat-health study, Replicable program**
- **Sacramento – Energy & AQ Driver**
 - CEC and SMUD – Cool Roofs
 - Multiple urban forestry efforts**Result: CA Title 24 and Urban Forestry in AQ Plan**
- **Chicago – Sustainability Driver**
 - Greening Strategies – Green Roofs
 - Cool Roofs in Energy Code
 - Permeable Pavements**Result: Comprehensive Approach - Leaders**



EPA's HIRI Program



HEAT ISLAND REDUCTION
INITIATIVE

- **Build Capacity**
 - **Share best practices**
 - Data where available
 - Case studies
 - **Educate – website, workshops**
 - **Foster networks**
 - **Translate research into tools**
- **Fill Gaps**
 - **Stay engaged with emerging research and S&L needs to direct research priorities**
 - Cool pavement and ASU
 - Holistic approach



National Center of Excellence
on SMART Innovations for Urban Climate + Energy

Resources

EPA's Heat Island Website www.epa.gov/heatisland

ENERGY STAR® www.energystar.gov

EPA's Clean Energy Programs www.epa.gov/cleanenergy

EPA's Aging Initiative www.epa.gov/aging

National Center of Excellence www.asusmart.com

LBNL - Heat Island Group <http://eetd.lbl.gov/heatisland/>

ICLEI www.hotcities.org

Cool Colors Project <http://coolcolors.lbl.gov/>

Cool Roof Rating Council www.coolroofs.org