

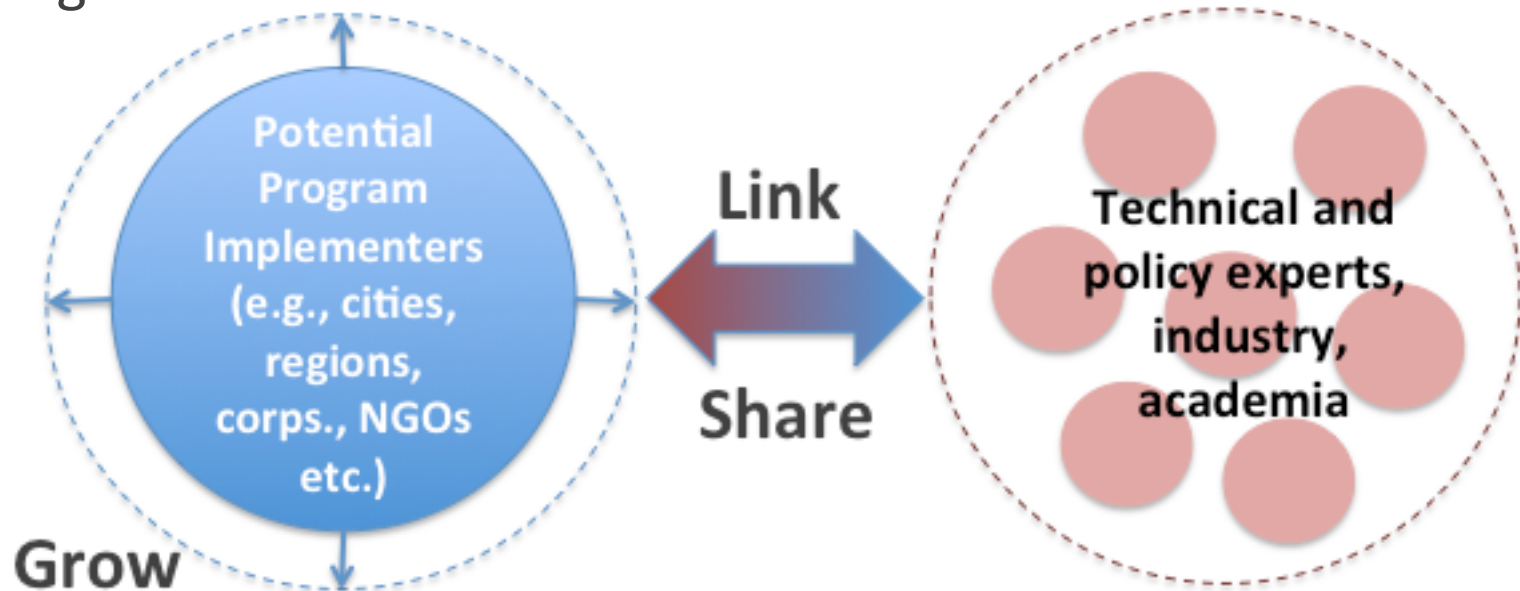


Cool Surfaces: A U.S. Perspective



Global Cool Cities Alliance (GCCA)

The Global Cool Cities Alliance is dedicated to advancing policies and actions that increase the solar reflectance of our buildings and pavements as a cost-effective way to promote cool buildings, cool cities, and to mitigate the effects of climate change through global cooling.



Global Cool Cities Alliance (GCCA)

- Operating Agent for U.S. Department of Energy in the GSEP Cool Roofs and Pavements Working Group.
- Working with 20+ cities through the Cool Cities Network.
- Webinar/discussion series
- Research agenda
 - Cool roofs and reducing mortality during extreme heat events
 - Urban heat island policy survey

U.S. Roofing Market at a Glance

- Residential: ~172 billion sq. ft. of roofs installed
 - Mostly steep sloped roofs
 - 80% covered with asphalt shingles
- Commercial: ~45 billion sq. ft. roofs installed
 - 3-4 billion sq. ft. installed each year (new and existing buildings)
- Overall demand for roofing expected to grow 5.7% per year
- Cool roofs make up about 10 billion sq. ft. (roughly) of the flat roof market and growing.

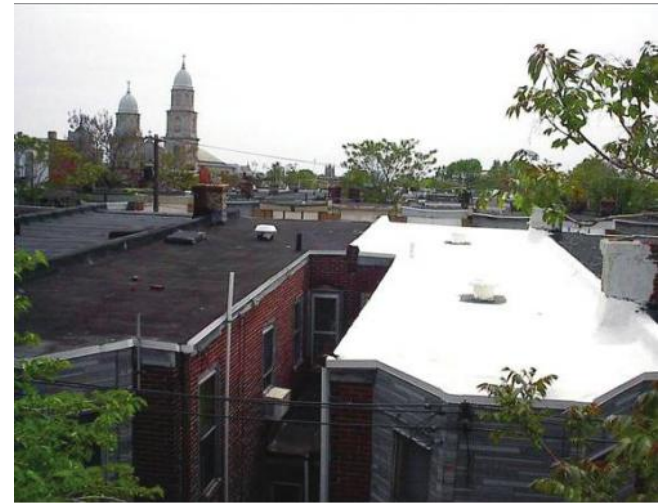
What is Driving the U.S. Cool Surface Market?

- Energy Efficiency
- Building Comfort
- Health Impacts of Urban Heat Islands
- Peak Electricity Reductions
- Global Warming

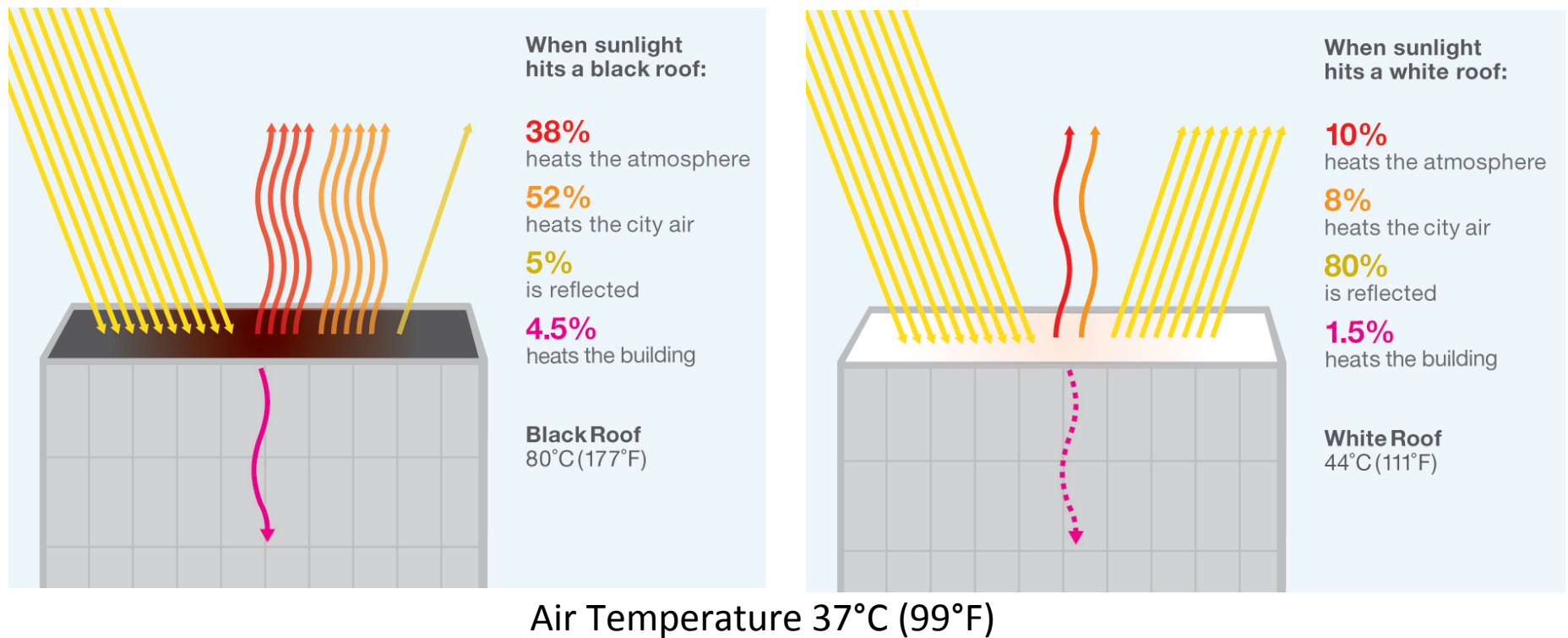


What is a cool surface?

- Surfaces that reflect lots of solar energy and release lots of stored heat energy (i.e., white roofs, light-colored pavements)
- Vegetated surfaces that provide shade or cooling through evapotranspiration (i.e., green roofs, urban canopy, permeable/pervious pavement)

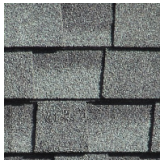


How cool, reflective roofs work



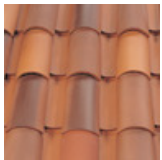
Cool surfaces are measured by how much light they reflect (solar reflectance) and how long they hold heat (thermal emittance).

Almost all roofs have a cool option



Asphalt Shingle (predominant residential roof type in U.S.)

- Lasts 15-30 years
 - Cool Options: white or light grey shingles
-



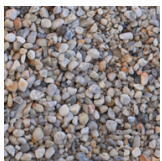
Clay or Concrete Tiles (clay shown)

- Lasts 30 – 50+ years
 - Cool Options: terracotta, cool colored pigment or white
-



Metal Roofs (often found on commercial, industrial and some low-income residential)

- Lasts 20 – 50+ years
 - Cool Options: white/cool coated or painted metal (factory or on-site)
-



Built-Up Roof (multiple layers covered by ballast or smooth membrane)

- Lasts 10 – 30 years
 - Cool Options: white gravel ballast or white smooth membrane
-

See Page 24 and 25 of the Toolkit for more details and examples

Not just white – there are cool colors too!

Cool color options exist to suit nearly any aesthetic requirement.



Standard Concrete Tiles (SR)

0.04

0.18

0.24

0.33

0.17

0.12

With Cool Coating Applied (SR)

0.41

0.44

0.44

0.48

0.46

0.41

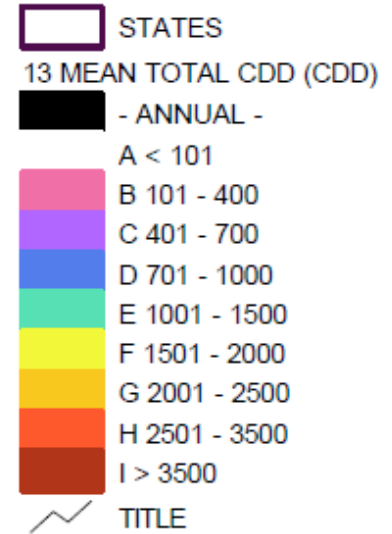
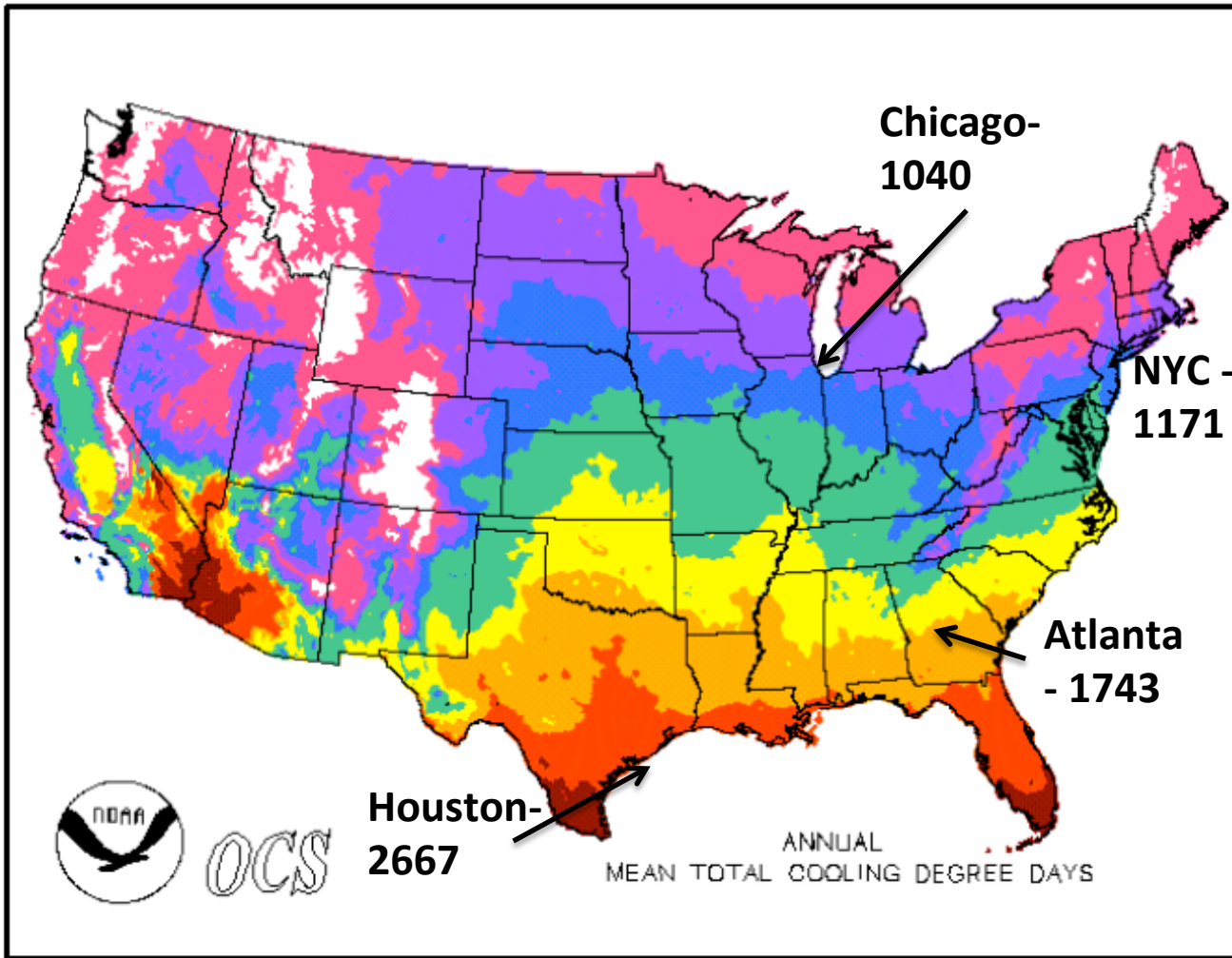
Source: Adapted from data from American Rooftile Coatings.

Cool roof costs are comparable to dark roofs

Roof Materials	Typical Non-Cool Surface	Cool Alternative	Price Premium (US\$ per ft ²)				
Built-Up Roof	Mineral aggregate embedded in flood coat	Light-colored aggregate, like marble chips, gray slag	0.00	Shingles	Mineral granules	White granules	0.00
						Cool-colored granules	0.35-0.75
	Asphaltic emulsion	Field-applied coating on top of emulsion	0.80-1.50	Sprayed Polyurethane Foam	Liquid applied coating	Most coatings are already cool to protect the foam	0.00
Mineral surfaced cap sheet	White mineral granules	0.50	Aggregate		Light colored aggregate	0.00	
Metal	Unpainted metal	May already be cool	0.00	Thermoplastic Membranes	White, colored, or dark surface	Choose a white or light colored surface	0.00
		Factory-applied white paint	0.20			ThermoSet Membranes	Dark membrane, not ballasted (adhered or mechanically attached)
	Painted metal	Cool-colored paint	0.00-1.00+			Factory cool ply or coating on dark EPDM	0.50
Modified Bitumen	Mineral surface cap sheet	Factory-applied coating, white mineral granules	0.50	Tiles	Non-reflective colors	Clay, slate (naturally cool)	0.00
	Gravel surface in bitumen	Light colored gravel	0.00			Cool colored coatings	0.00
	Metallic foil	May already be cool	0.00				
		Field-applied coating	0.80-1.50				
Asphalt coating	Field-applied coating on top of asphaltic coating	0.80-1.50					

The Benefits: More efficient buildings

- Cool roofs can cut AC energy use by up to 20 percent on the top floor of conditioned buildings – often avoiding cooling loads at the most expensive times of the day.
 - *\$735 million in annual energy costs savings in U.S. commercial buildings*
- Cooler surface temperatures may help the roof and the equipment on it last longer.
- Cooler intake air means AC works less, and EE contributes to downsizing the AC units.



Cooling Degree Days

Cape Town – 1048

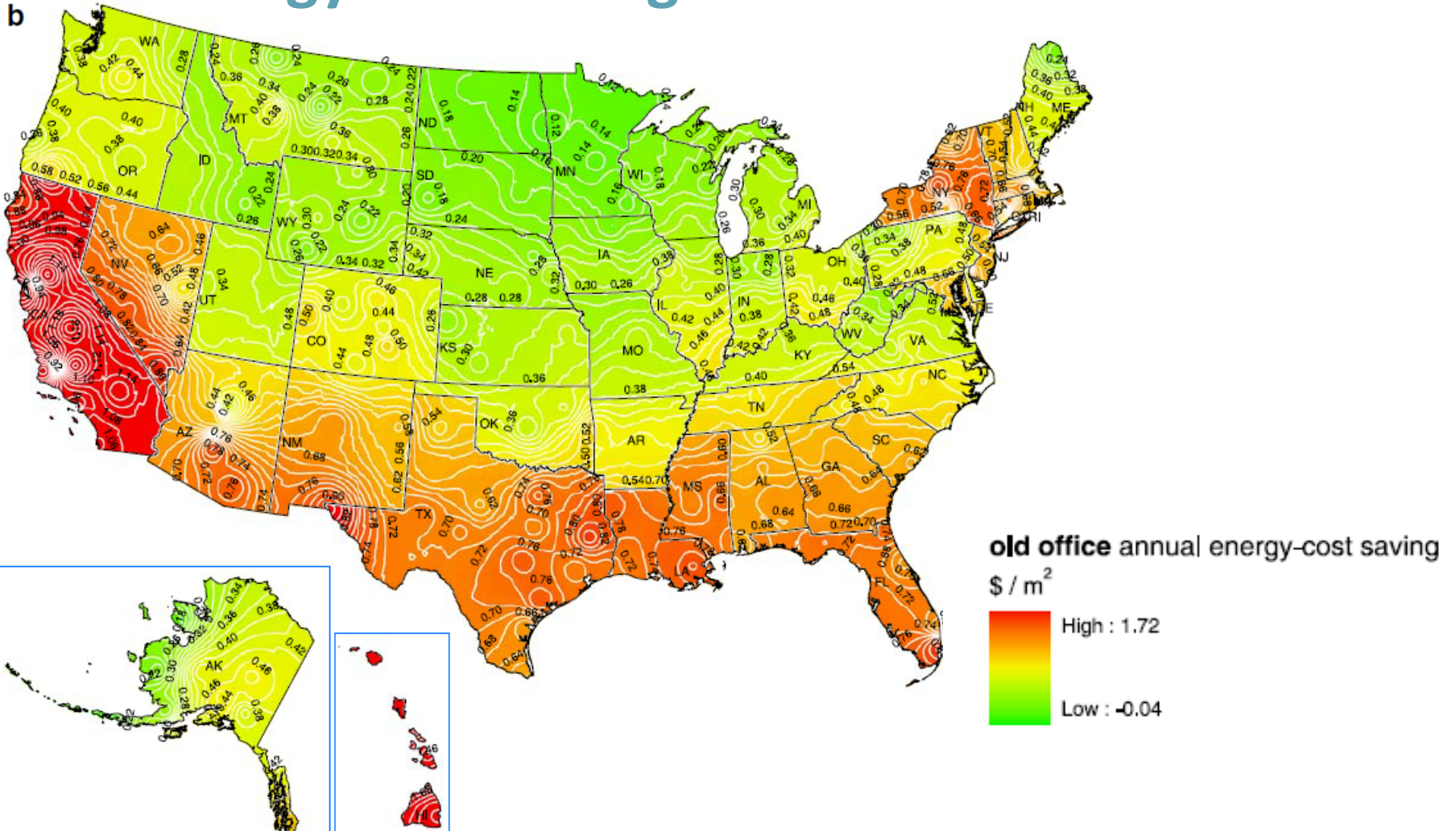
Pretoria – 1845

Durban – 2254

Kimberly – 2001

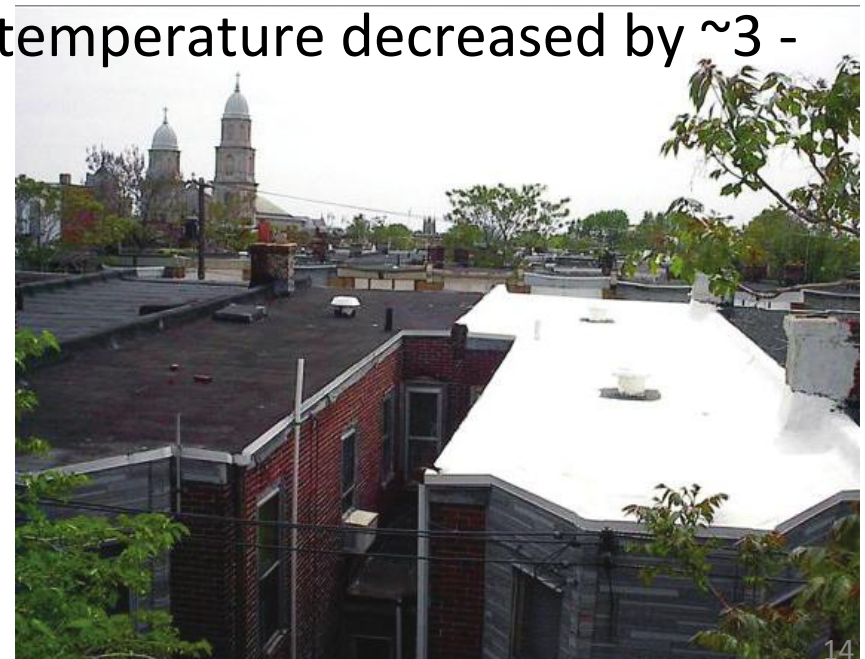
Polokwane – 1477

Net energy cost savings



The Benefits: More comfortable buildings

- Cool roofs allow less heat into the building, making unconditioned homes, warehouses, and other buildings much cooler.
- India pilot study: internal “felt” temperature decreased by ~3 - 4 degrees Celsius with cool roof.



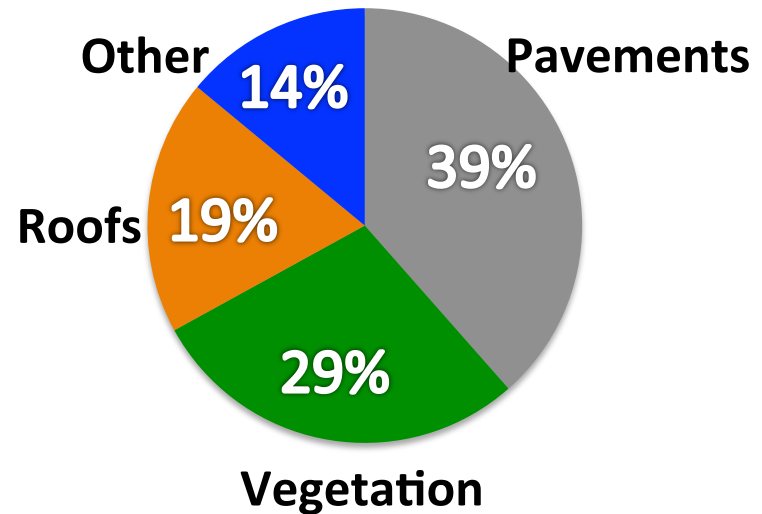
The Benefits: Cooler cities

- Cooling effect will vary by city, but studies indicate a cooling potential of 2 to 4°C.
- Peak load reductions, particularly on critical heat days
 - *UHI accounts for 5 – 10% of U.S. peak electricity demand for A/C*
- Better air quality.
 - *A study of Los Angeles found that cooler surfaces and shade trees could cut unhealthy air by up to 12 percent – a \$104M opportunity.*
- Greater resiliency to extreme heat and improved quality of life

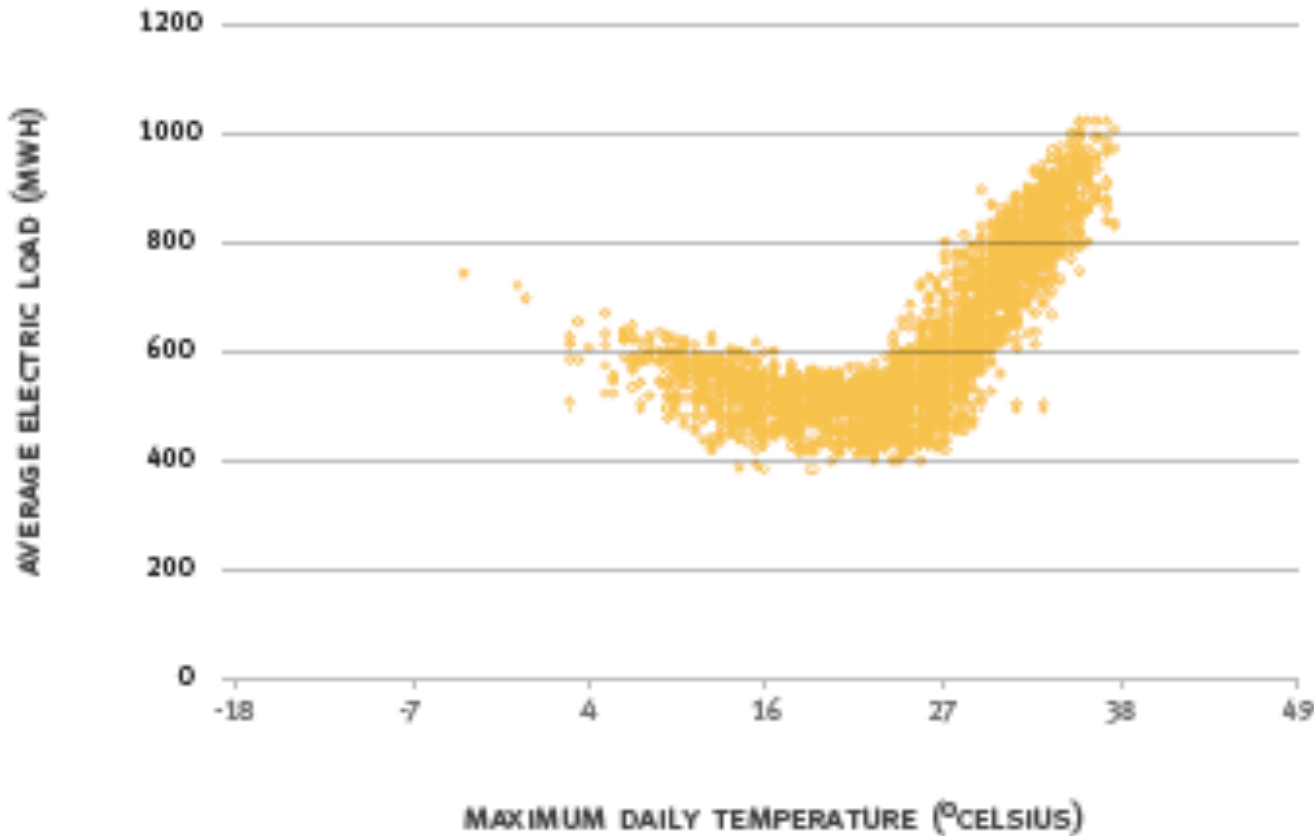
Cities are especially hot, thanks to the urban heat island effect

- Human activity, combined with dark roofs and pavements, make cities hotter than surrounding rural areas.
- Higher temperatures lead to greater energy use, lower air quality, and a reduced quality of life in urban areas.

Urban Fabric above tree canopy

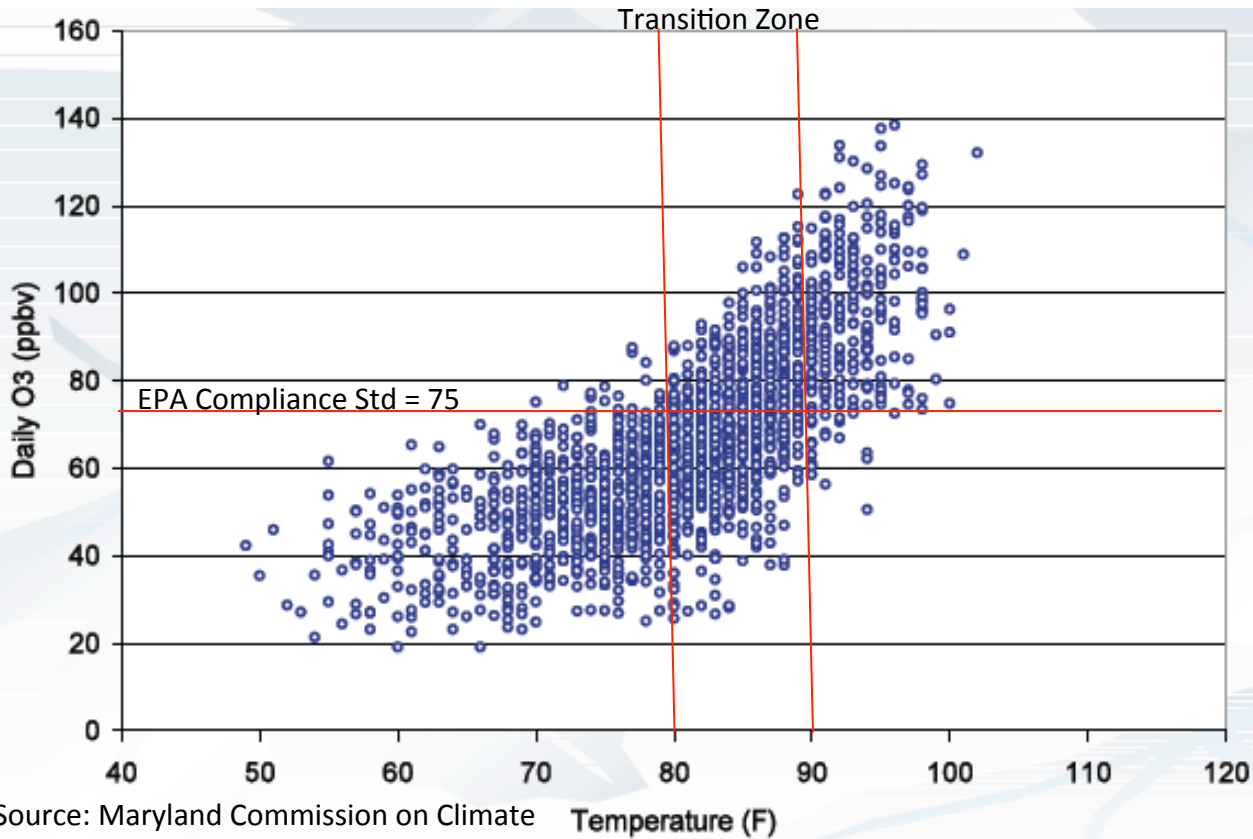


Peak electricity load and temperature



5-10% of peak electric demand for AC use is due to the urban heat island effect

Air quality and temperature



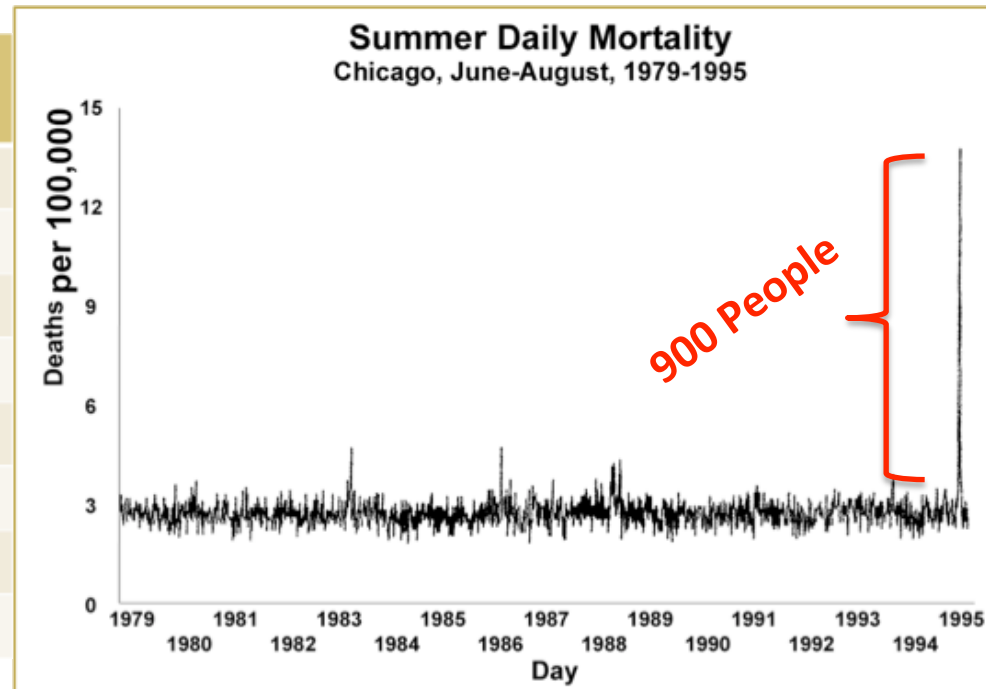
Maximum surface temperature at BWI versus peak 8-hr ozone concentrations in the Baltimore non-attainment area for the period May-September, 1994-2004 (Piety, 2007).

Source: Maryland Commission on Climate Change

Up to 20% of U.S. smog concentrations are due to urban heat islands

Extreme Heat Events

City (% frequency JJA)	DT Mortality (% Inc)	MT+ Mortality (% Inc)
Seattle (6%) [#]	+3.7 (8%)	+4.7 ^a (10%)
New York (11%)	+16.6 (7%)	+16.9% (7%)
Washington (11%)	+0.9 (4%)	+1.7 (7%)
New Orleans (2%)	None	+3.7% (9%)
Phoenix (1%)	+2.7 ^b (7%)	None
Rome (11%)	+6.2 (14%)	+5.0 (12%)
Shanghai (11%)	None	+42.4 (10%)
Toronto (7%)	+4.2 (11%)	+4.0 (10%)



Frequency of multi-day occurrences of the most offensive air masses is increasing rapidly

A real-world example of regional cooling



The whitewashed greenhouses of Almeria, Spain have cooled the region by 0.8 degrees Celsius each decade compared to surrounding regions, according to 20 years of weather station data.

Source: Google Earth

The Benefits: Global Cooling

- Whitening 100 m² of gray roofing cancels the warming effect of 10 tons of CO₂ emissions (or 0.6 tons per year for the life of the roof)
- Globally, cancels 500 medium sized coal power plants worth of greenhouse gas emissions. (more than CFL deployment)

Cool pavements

Pavements are a major part of the urban fabric – nearly 40%.

Benefits: UHI reductions, less street lighting,



Cool Surface Policies in the U.S.



Samples of city cool roof policies

City-wide codes and ordinances

- New York City, Philadelphia, Washington DC, Chicago, Houston

Incentives

- Toronto rebate program
- Portland permitting incentives
- Philadelphia coolest block contest

Volunteer programs

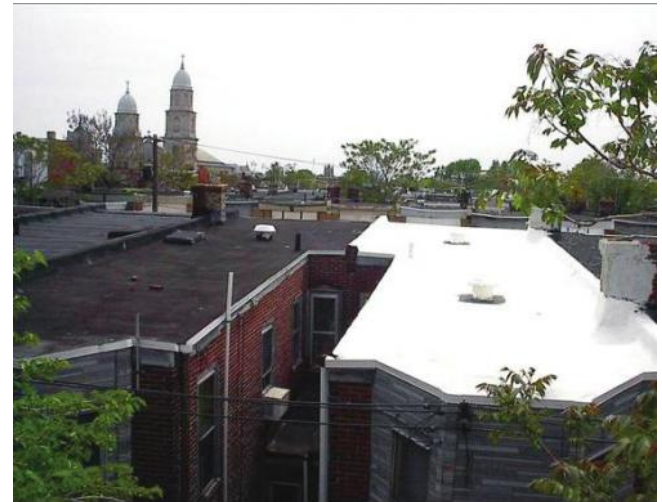
- New York City

Climate adaptation / UHI strategies

- Houston, Dallas, Melbourne, London

Government building specifications

- Washington DC



Mandatory Codes/Ordinances

- IECC 2012
 - Mandatory for Climate Zones 1-3
- California Title 24
 - $SR \geq 0.7$, $TE \geq 0.75$
- Florida (commercial buildings only)
 - $SR \geq 0.65$, $TE \geq 0.8$
- Chicago, Washington DC, NYC, Houston, Philadelphia, Dallas

Voluntary Standards / Credits

- Energy STAR
 - Low slope: Initial SR \geq 0.65, Aged SR \geq 0.50
 - Steep slope: Initial SR \geq 0.25, Aged SR \geq 0.15
- LEED Sustainable Sites Credit 7.2
 - Energy STAR compliant roofing over 75% of roof area earns credit
- Green Globes
- ASHRAE 90.1 & 90.2

Incentives

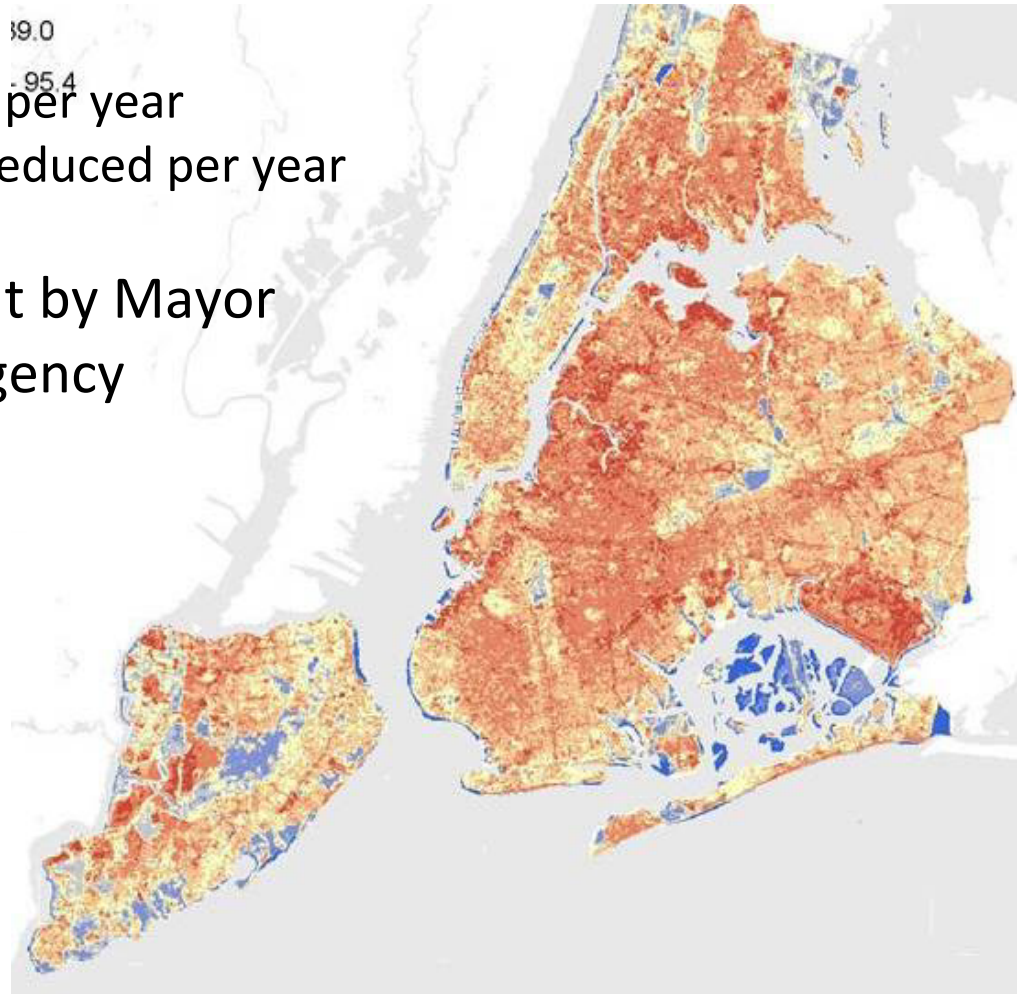
- Rebates – about 40 different rebates, sometimes as part of whole building efficiency programs or stand-alone as reflective roof incentives
- Fast-track permitting
- Land use easements – allowances to build on more of the land area than currently allowed etc.
- Efficiency loan programs in 13 states– matching the lifecycle benefits to costs.

Other support programs

- Public awareness programs
- Training (architects/designers, code officials, and implementers)
- Volunteer programs
- Government procurement policies
- Monitoring and measuring progress

Case Study: New York

- Goal: Cool NYC by 1 degree
 - \$100M in energy cost savings per year
 - 300K tons of GHG emissions reduced per year
- High-level, public commitment by Mayor Bloomberg backed by inter-agency coordination
- Robust volunteer efforts
- Cool roof ordinance, health initiatives, heat vulnerability mapping etc.
- Innovations in monitoring and measuring



The Cool Roofs and Pavements Toolkit

www.CoolRoofToolKit.org

- Descriptions of the science, the benefits, and the costs of cool surfaces.
- Simple steps to implement programs and policies drawn from global best practices.
- Links to sample materials and relevant organizations.
- A comprehensive “knowledge base” of research, best practices, code/ordinance language, sample program materials.
- Coming soon: a global expert forum



Knowledge Base

Welcome to the beta version of the Knowledge Base, a repository for cool surface and urban heat island information! The Knowledge Base is a user-friendly tool to find research, program materials, sample documents, case studies, code and standards, videos, images and other relevant items from around the world. Whether you are investigating a specific topic or paper or are simply browsing, the Knowledge Base is designed to help you quickly find what you are looking for.

Please note that we'll be adding lots of content and features to this beta version. Stay tuned for the official Knowledge Base launch in June 2012.

Please suggest content by emailing Carl@coolcities.org.

Search by Keyword:

Type a keyword or phrase...

Featured Topics



Philadelphia CoolRoofs Council



GSEP Cool Roofs and Pavements Working Group Meeting September 2011 (2)



Mexico CoolSurfaces Conference February 2012



Thank You!

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