

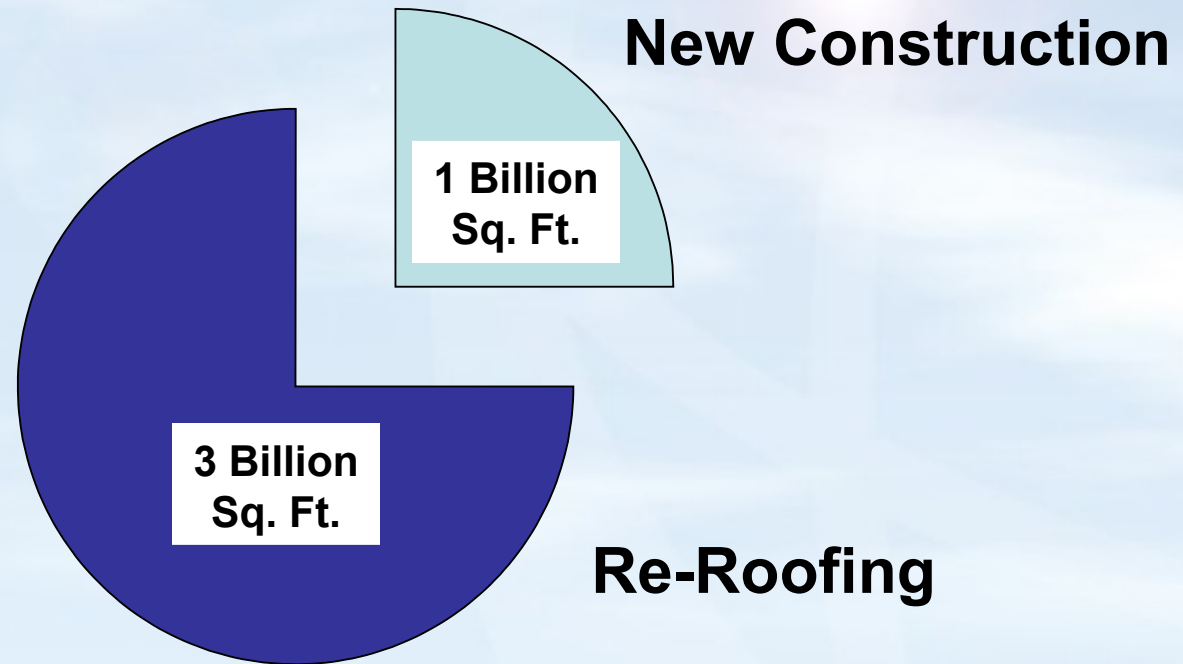


## **The Expanding Role of the Roof in a Sustainable World**

**Dr. James L. Hoff**  
Research Director

Center for Environmental Innovation in Roofing

## North American Low-Slope Roofing Market (Billions of Square Feet, 2006)



Source: Roofing Industry Consensus Data

## Commercial Roofing Prior to 1970: **Built-Up Roofing**



- Originally developed to waterproof ships
- Redundant layers of “tar” and “felt” provided effective water barrier
- Dominated low-slope commercial roofing for over 100 years

1970:

## The First Energy Crisis / Growing Environmental Concerns



- OPEC oil embargo

- Quality of roofing asphalt decreased as more gasoline was extracted from every barrel of oil
- Roofing asphalt became more brittle, less plastic



- Asbestos

- Traditional roofing “felts” relied on asbestos fibers for strength
- Asbestos fibers replaced by lower strength organic (paper) fibers

## 1970 Energy Crisis: Insulation Thickness Increased To Save Energy

Thicker insulation created “thermal shock” as surface temperatures varied by over 150° F in a single day...



... causing roof membranes to age prematurely.



1970s:

## **New Roofing Alternatives Developed**

New material alternatives to asphalt & asbestos were introduced...



... but with a steep learning curve and some initial failures



## 1970s: The Lesson for the Roofing Industry



**"As an industry, we have spent far too much time and far too many dollars fixing past problems related to durability not to become unflinching advocates for the **utmost importance of durability** in any green building initiative."**

James L. Hoff. "Advancing Sustainable Roofing: LEED and the Commercial Roofing Industry." Proceedings of the 20th International Convention of the Roof Consultants Institute, Miami Beach, Florida, March, 2004.

## **Demands on the Roof:** **Pre-1970**

- Keep Water out of the Building

## **Demands on the Roof:** **1970s**

- Keep Water out of the Building
- Keep Heating & Cooling Energy in the Building

## **Demands on the Roof: Today**

- Keep Water out of the Building
- Keep Even More Heating & Cooling Energy in the Building
- **Keep Heat out of the Atmosphere** (Urban Heat Island Effect)
- **Keep Water out of the Sewer System**
- **Keep Everything out of the Landfill**
- **Don't Just Save Energy - Generate It**

## Cool Roofs:

# Saving Energy & Reducing Urban Heat Islands

### Cool Membrane Roofs



Ice Mountain  
Brea, CA

### Cool Metal Roofs



Lindberg Terminal  
St. Louis, MO

- Peak Cooling Loads Reduced
- Ambient Air Temperatures Reduced

## Cool Roof Issues

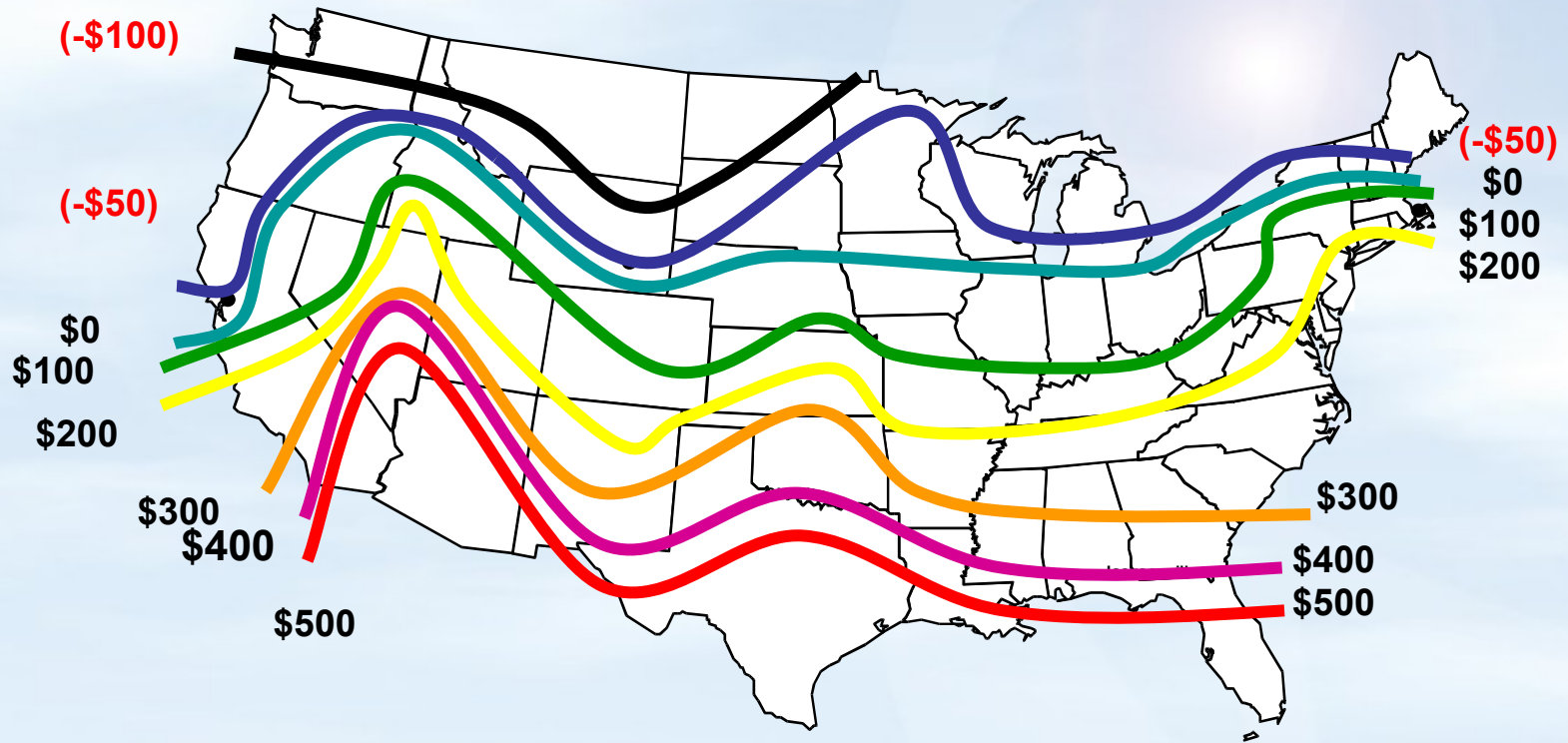
### How Do You Maintain Surface Reflectivity?



**Minute Maid Stadium  
Houston, TX**

# Cool Roof Issues

## Are Cool Roofs Right For All Climates?



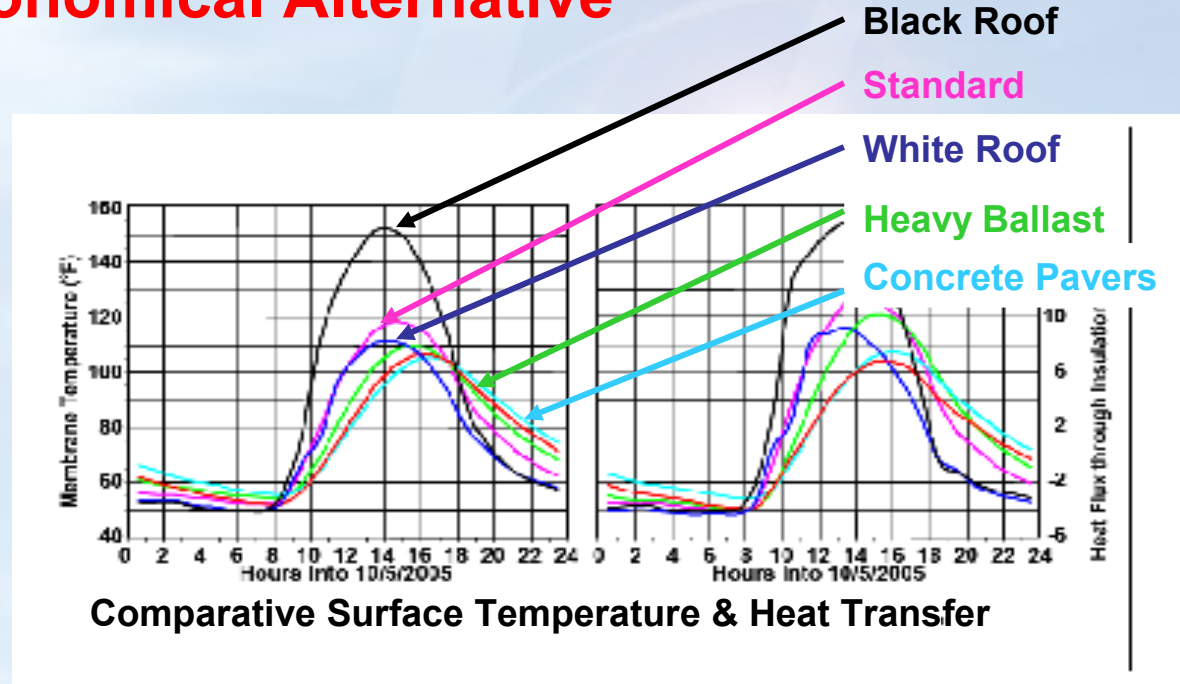
**Annual Heating / Cooling Cost Savings:  
Reflective Roof versus Non-Reflective Roof**  
(Dollars per 20,000 Sq. Ft. Roof Area / R-20 Insulation)

# Cool Roof Issues:

## Traditional Stone Ballast & Pavers Offer an Economical Alternative



Envelop Systems Research Apparatus  
Oak Ridge National Laboratories



Source: Oak Ridge National Laboratories

Ballasted roofs can provide the same peak energy savings and reduced air temperatures as “cool” roofs ...and their performance doesn't degrade over time!

## **Garden / Green Roofs: Saving Energy & Reducing Pollution**



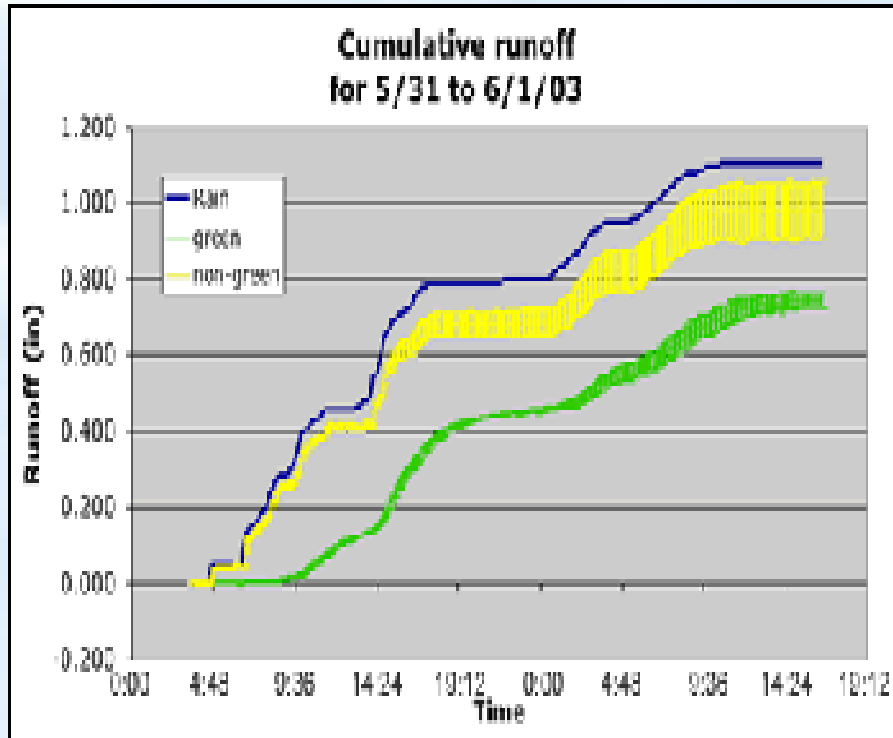
Chicago City Hall  
Chicago, IL



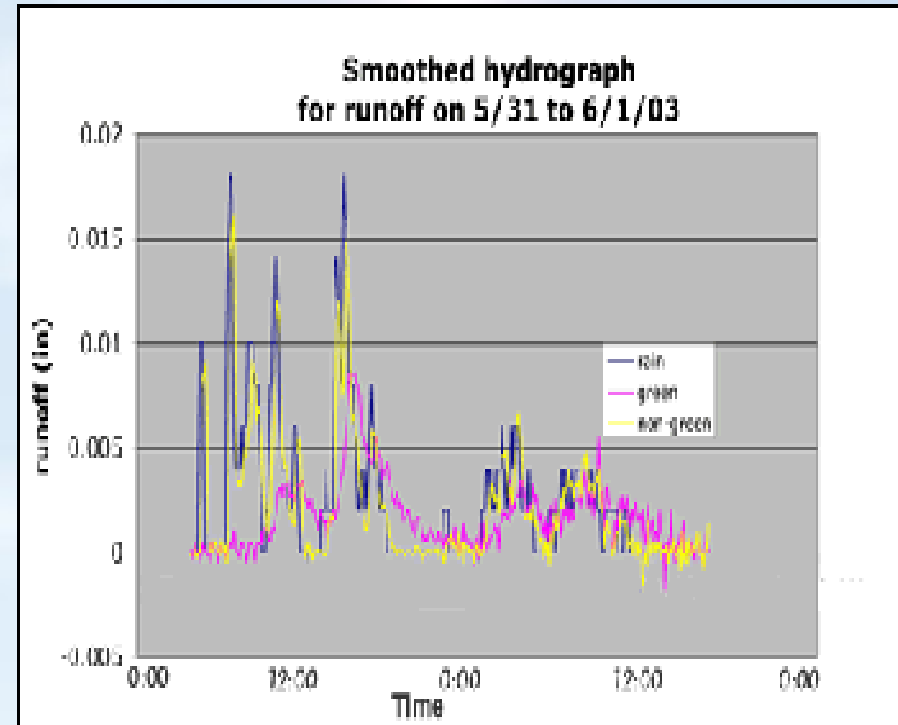
US Environmental Protection Agency  
Denver, CO

# Garden Roof Benefits: Reduced Storm Water Runoff

**Both Cumulative...**



**And Hourly...**



Source: Penn State University Cool Roofing Program

## **Garden Roof Benefits:**

- Ambient air temperatures reduced
- Maintenance requirements have been simplified.
  - A wide variety of hardy plants requiring little or no watering have been developed
  - Pre-fabricated tray systems reducing installation and maintenance expense are available
- Initial costs can be minimized by combining garden roofs with “cool” ballasted roofing systems.

## **Garden Roof Issues:**

- Underlying roof system must accommodate increased maintenance traffic
- Underlying roof system must be designed to meet or exceed expected garden service life
- Leak detection is difficult
- Roof repair and maintenance may be more complicated

## Solar Roofs: Clean Energy Production



Shiseido  
Windsor, NJ



Target Store  
Stockton, CA

## Solar Roofs

### Benefits:

- Clean energy generated
- Peak energy demands reduced

### Issues:

- Underlying roof system must accommodate increased maintenance traffic
- Underlying roof system must be designed to meet or exceed to expected solar system service life
- Leak detection may be difficult
- Roof repair and maintenance may be complicated

# Roof Recycling: Reducing Landfill Waste

**Cookson  
Elementary  
School  
Troy, Ohio**



## Roof Recycling

### Benefits:

- Landfill waste reduced
- Overall environmental impact reduced

### Issues:

- Economics do not currently support
- Only available in a regional pilot program for selected products
- Logistics (removal, storage, transportation) are very difficult
- Recyclers must have an assured supply before end markets can be fully developed

## Looking to the Future

- In order to reduce overall environmental impact, roofing materials will be **thinner and lighter** – bringing new challenges for durability
- In order to facilitate recycling, roofs will be designed with **eventual removal** in mind
- In order to maximize service life, **roof maintenance programs** will become more sophisticated
- The primary concern of the building owner in regard to roofing materials will continue to be **durability**