2007 ENERGY EFFICIENCY GLOBAL FORUM & EXPOSITION

The Expanding Role of the Roof in a Sustainable World

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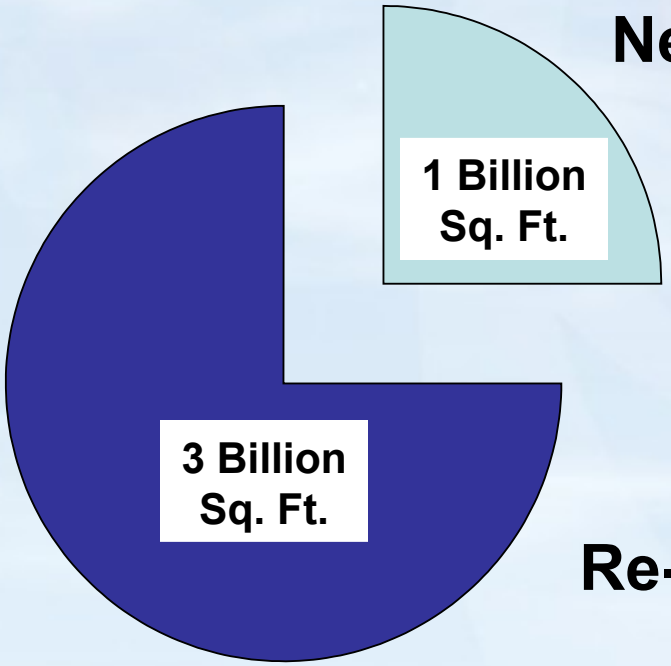
North American Low-Slope Roofing Market
(Billions of Square Feet, 2006)



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 150^0 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

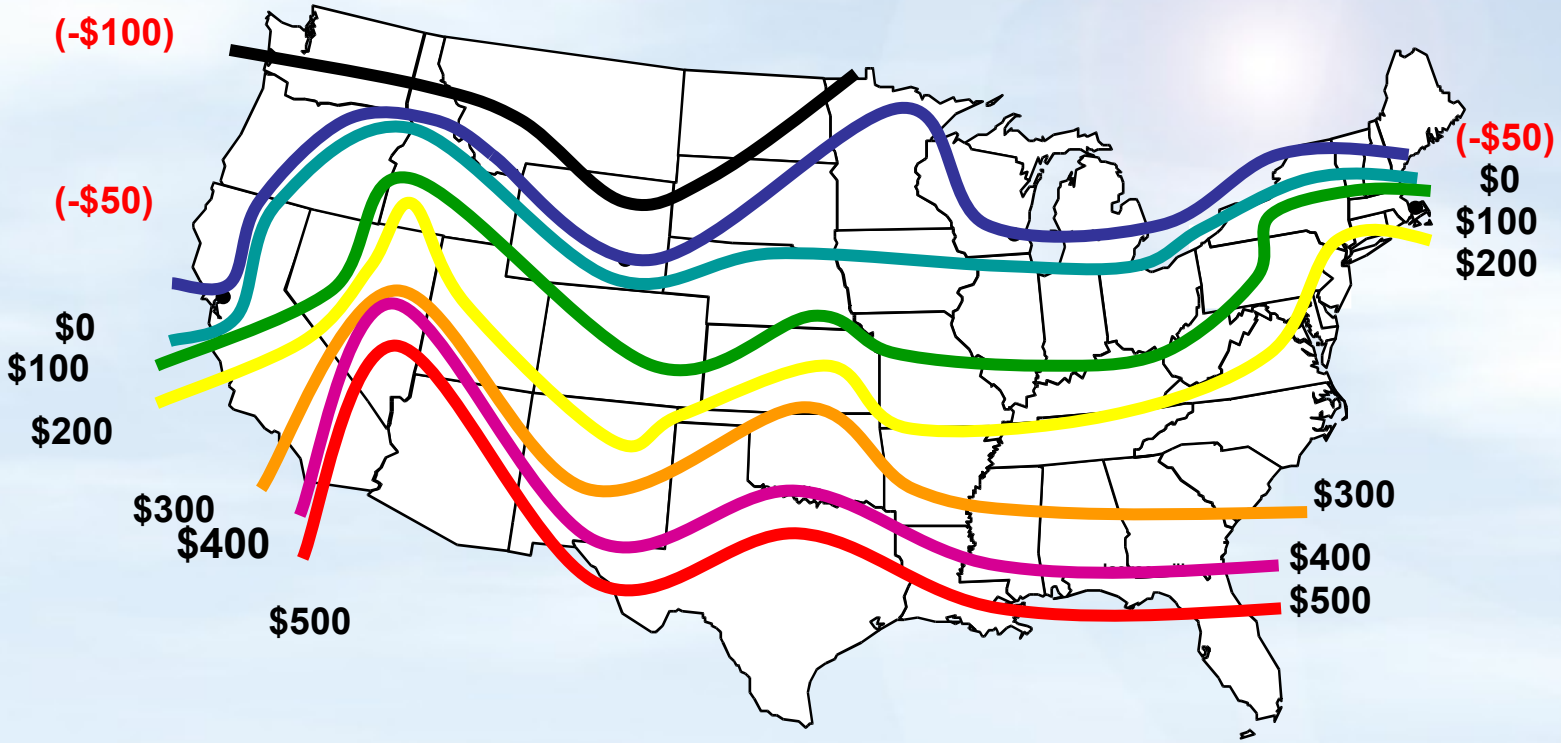
Cool Roof Issues

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:

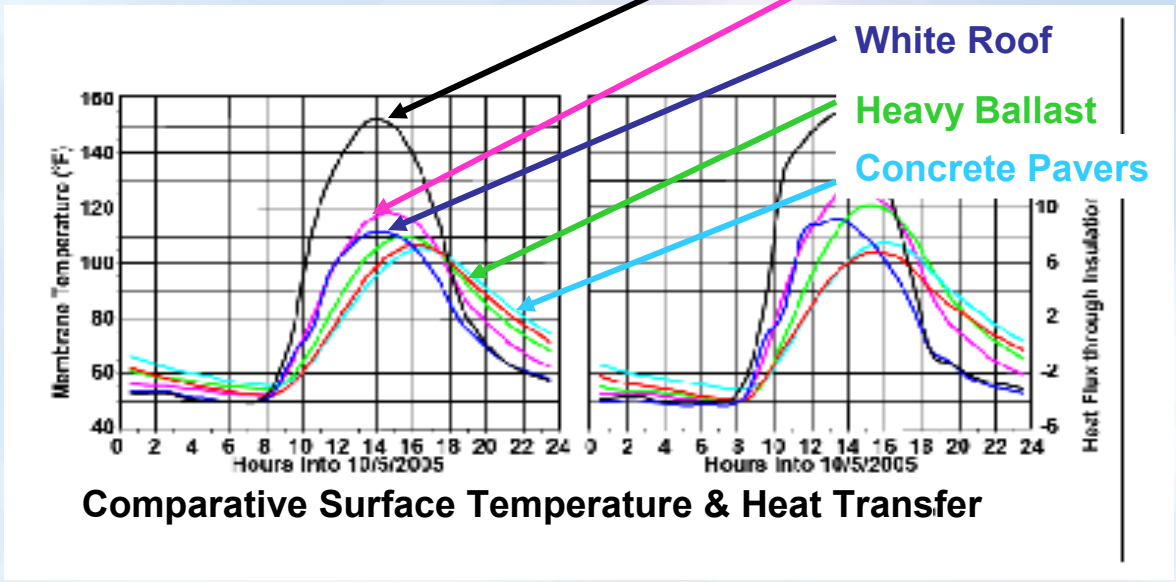
Reflective Roof versus Non-Reflective Roof

(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



Comparative Surface Temperature & Heat Transfer

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!

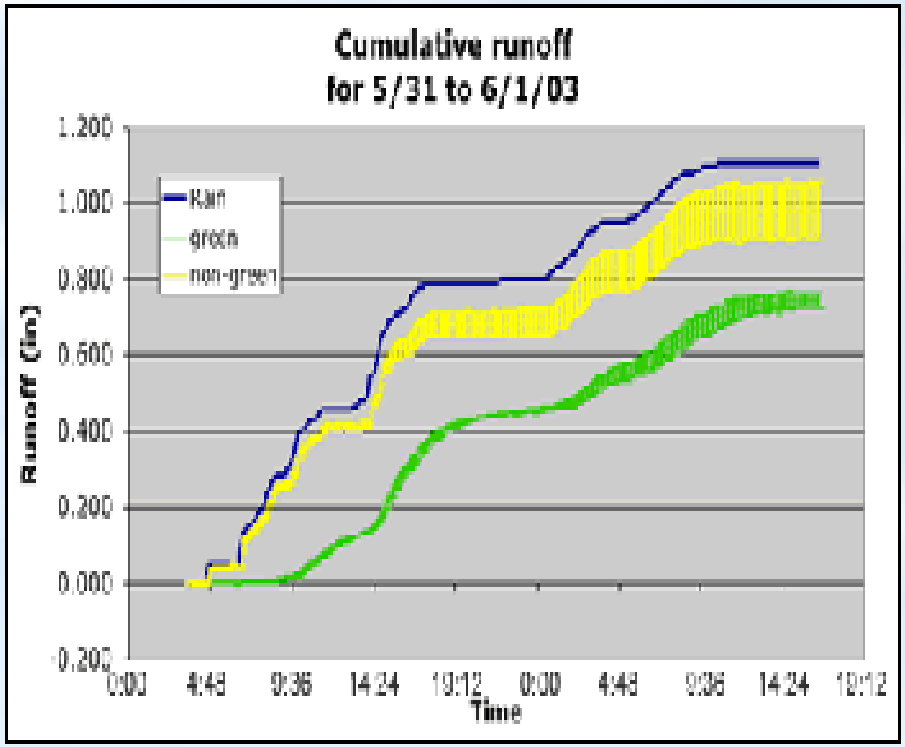
Garden / Green Roofs:
Saving Energy & Reducing Pollution

Chicago City Hall
Chicago, IL

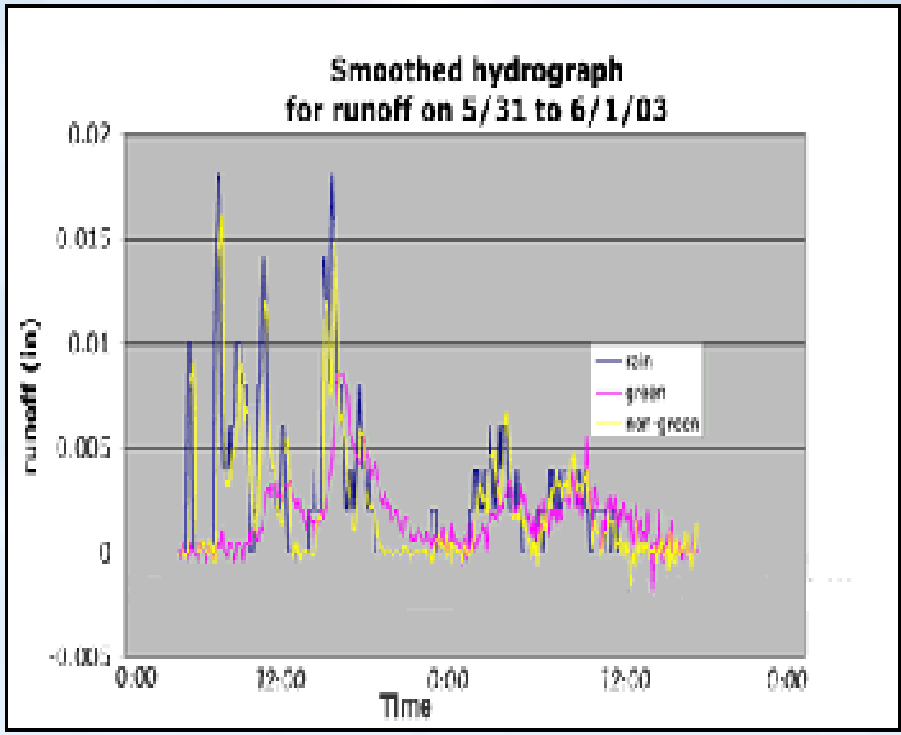
US Environmental Protection Agency
Denver, CO

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