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## TH26 -THE EXPANDING ROLE OF THE ROOF IN A SUSTAINABLE WORLD

Presented by:

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Center for Environmental Innovation in Roofing  
Washington, DC

**CONSTRUCT2009**  
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Indianapolis, IN



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- Please remember to mute all electronic devices.
- You must swipe your card at the door in order to receive credit for your course.
- No one under the age of 18 is allowed in meeting rooms.



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## Learning Objectives:

Upon completing this program, the participant should know how to:

1. Understand the magnitude of environmental impact associated with roofing
2. Identify current and emerging roofing technologies that may be used to mitigate environmental impact
3. Discover how these technologies may be combined and integrated to produce synergistic benefits
4. Discuss the emerging role of the roof as a platform for clean energy production and the consequences of this role on roof system design and performance



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## Why Sustainable Roofing?

Few Major Building Systems Offer As Many  
Energy & Environmental Benefits...

... And Few Major Building Systems Are  
Installed as Frequently as Roofs!

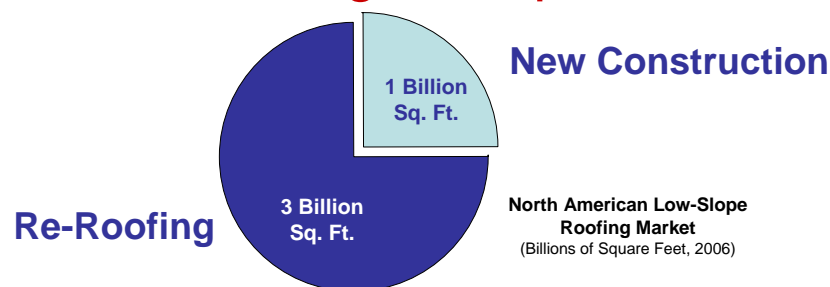


## Sustainable Roofing Benefits:

- ✓ Increased Energy Efficiency
- ✓ Clean Energy Production
- ✓ Cleaner Air & Water
- ✓ Reduced Material Waste
- ✓ Extended Building Life Cycle



## The Roofing Multiplier Effect:



Each year, 4 billion square feet of commercial roofs are installed in North America, exceeding new commercial construction by a factor of 4!



## Sustainable Roofing Opportunities:

- Energy* {
1. High R Roofs
  2. Cool Roofs
  3. Rooftop Energy Production
  4. Roof Daylighting
  5. Rooftop Water Management
  6. Roofing Material Management
  7. Roof Life Cycle Management
- } *Environment*



## High R Roofs





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## What is a High R Roof?

“A High R Roof is a roof that provides a level of thermal resistance (R) substantially higher than current minimum standards and practices.”

Center For Environmental Innovation In Roofing  
Knowledge Center

( <http://roofknowledge.org/main/energyefficientroofs/highroofs/whatisahighroof> )



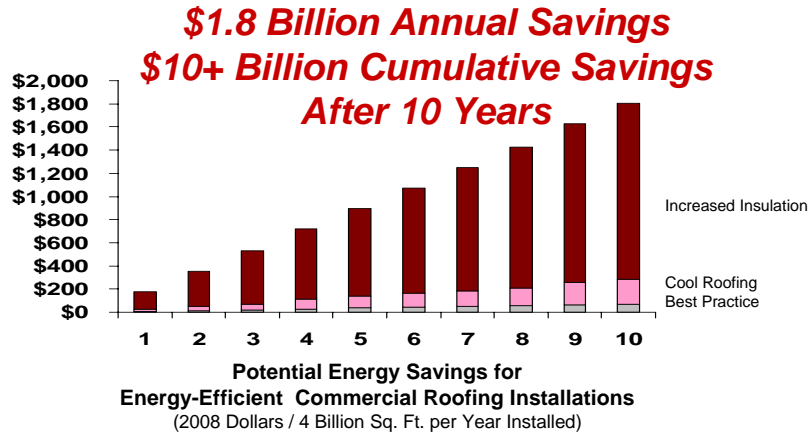
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## Why High R Roofs?

- Globally:
- Most effective way to reduce green house gas emissions between now and 2030
- Locally:
- Increasing federal, state & local incentives available
  - Established economic payback



## Why High R Roofs?



Source: Center for Environmental Innovation in Roofing. Based on 4 billion square feet roof installations, assuming \$0.12/KWH cooling cost, \$1.00/therm heating cost, 2.0 cooling COP, 75% heating efficiency, 20% of roofs replace existing cool roofs, 5% of roofs installed over unheated spaces, and 20% of roofs installed over non-cooled spaces. Calculations derived using the NRCA EnergyWise Calculator and DOE Cool Roof Calculator. Increased insulation compares the suggested roof insulation R values of ASHRAE 189-P against current typical state energy code practice (ASHRAE 90.1 - pre 2007). A cool roof is defined as a roof offering 50% long-term solar reflectivity or the thermal equivalent for the service life of the roof. Best practice defined as 2 or more staggered insulation board layers to minimize thermal loss at board joints.



## Minimum Roof R Standards

Minimum R-Values:

### Low-Slope Commercial Roof Insulation

ASHRAE Climate Zone	Typical City Example	"Old" ASHRAE 90.1 -1999	"New" ASHRAE 90.1 - 2007
1	Miami	10	15
2	Houston	15	20
3	Atlanta	15	20
4	Baltimore	15	20
5	Chicago	15	20
6	Milwaukee	20	25
7	Minneapolis	25	30

**First upward revision in roof R values since 1972**



## High R Roof Standards:

- LEED v3
  - Credit EA-1 (Optimize Energy Performance)
- ASHRAE 189.1-P
  - Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings (Proposed, First Draft)



## LEED v3 / ASHRAE 189.1 New Building Energy Savings Targets (ASHRAE Climate Zones 2 through 5)

	Energy Savings Target	Proportional Roof U-Value*	Proportional Roof R-Value*
ASHRAE 90.1-2007	Baseline	0.050	20.0
LEED 2009 Minimum**	10%	0.045	22.2
LEED Points Available: (EA Credit 1)	1	12%	0.044
	3	16%	0.042
	5	20%	0.040
	7	24%	0.038
	9	28%	0.036
	11	32%	0.034
	13	36%	0.032
	15	40%	0.030
	17	44%	0.028
19	48%	0.026	
			ASHRAE 189.1-P

\* Roof R-Value / U-Value Needed to Achieve Proportional Energy Savings \*\*Minimum LEED 2009 (v3) Prerequisite  
 Source: Center for Environmental Innovation in Roofing. Note: Chart is applicable for buildings within ASHRAE Climate Zones 2 through 5 - from Houston, Texas to Chicago, Illinois. Target energy savings and proportional roof insulation R-values will be lower in Zone 1 and higher in Zones 6 and 7. For a detailed analysis of a specific building in a specific location, ASHRAE 90.1-2007 should be consulted.



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## Cool Roofs



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## What is a Cool Roof?

“A cool roof interacts with solar radiation to reduce solar heat transfer from the roof into the building and reduce ambient air temperatures above the roof surface.”

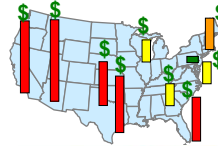
Center For Environmental Innovation In Roofing  
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<http://roofknowledge.org/main/energyefficientroofs/coolroofs/whatisacoolroof>

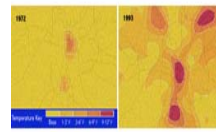


## Why Cool Roofs?

- Building Energy Savings



- Heat Island Reduction



Atlanta, GA

1972      1993

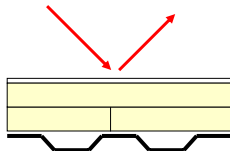
- Peak Electricity Reduction

Standard Rate:      Summer Peak Rate:  
 \$                      \$\$\$



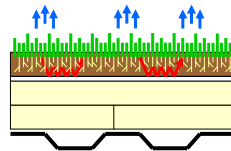
## Cool Roof Options

Cool Reflective Roofs



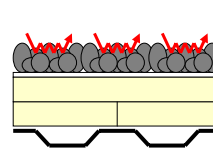
*Reducing Heat Build-Up By Reflecting the Sun's Rays*

Cool Vegetated Roofs



*A Traditional Alternative Using Transpiration & Thermal Mass*

Cool Ballasted Roofs

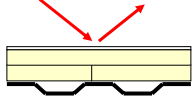


*An Emerging Alternative Using Thermal Mass*



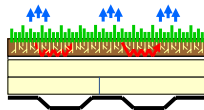
## Cool Roof Options

**Cool Reflective**



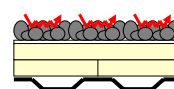
- + Wide variety of material options
- + Little or no initial cost premium
- + LEED credit (SS Credit 7.2)
- Benefits vary with local climate & energy costs
- Surface may change with age

**Cool Vegetated**



- + Additional environmental benefits beyond cool roofing
- + LEED credit (SS Credit 7.2)
- Increased weight and depth requirements
- High initial cost
- Maintenance cost

**Cool Ballasted**



- + May also manage storm water
- + Low initial cost
- + Minimal change with aging
- Increased weight requirements
- Limited, but growing code recognition



## Rooftop Energy





## Why Rooftop Energy?

- Direct Access to Sun and Wind
- Low Cost “Energy Real Estate”
- Close to the Customer / Close to the Grid
- Expanded Federal, State & Local Incentives
- Rapidly Approaching “Grid Parity”



## Why Rooftop Energy?

Roofing Segment:	Surface Area <sup>1</sup>
Commercial (Flat)	50 Billion Square Feet
Residential (Steep)	150 Billion Square Feet
<b>Total U.S. Rooftops</b>	<b>200 Billion Square Feet</b>
<b>Energy Potential<sup>2</sup></b>	<b>50,000 Megawatts</b> (10 Grand Coulee Dams)

<sup>1</sup>Derived from Census data

<sup>2</sup>Assumes 1 watt average solar power production during daylight hours per square foot of suitable roof surface (225 billion square feet total roof surface X 25% suitable usage factor X 1 watt / square foot)



**BusinessWeek** November 3, 2008

**Will Demand for Solar Homes Pick Up?**  
Builders find the savings from cheap power is making solar homes more attractive

By Adam Aston

As global financial markets melted down in October, Congress handed a gift to America's green energy industry: It renewed and broadened a set of tax credits for wind and solar power, geothermal, tidal energy, and more. The move did little to prop up eco-energy stocks, which have followed oil prices down. But the news did send a positive jolt to one of the economy's darkest sectors: homebuilding. Or, more specifically, solar-powered homes. Consumers recognize that green homes "save money month in, month out," says Rick



**15%**  
Minimum pretax compound rate of return per year for a typical household solar system in California in 2009.  
Data: OnGrid Solar

**15%**

*Estimated minimum pretax annual rate of return for a residential solar system in California and many other states, starting in 2009.*



## Rooftop Energy Technologies

- Photovoltaics (PV)
  - Conventional
  - Thin-Film
  - Roofing-Integrated (RIPV)
- Solar Thermal
- Combined PV / Solar Thermal
- Roof-Mounted Wind Turbines



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## Roof Daylighting



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## Why Roof Daylighting?

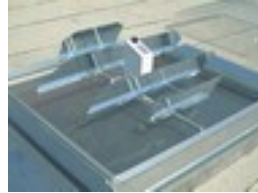
- Easy to install or retrofit in typical low-rise commercial buildings
- Proven energy savings / high return on investment when integrated with building lighting system
- Increasing federal, state & local incentives available



## Roof Daylighting Technologies



**Passive Systems**  
Capture, Reflect & Direct Daylight



**Active Systems**  
Follow the Sun to Maximize Sunlight Capture



**Integrated Systems**  
Combine Solar and Artificial Lighting into an Integrated Package



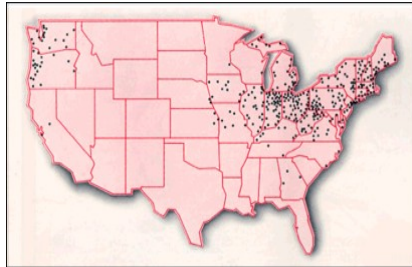
## Rooftop Water Management





## Why Rooftop Water Management?

- Reduced storm water runoff
- Improved water quality in rivers and lakes



Cities with Combined Sewer Systems

*Combined sewer systems are remnants of the country's early infrastructure and so are typically found in older communities.*

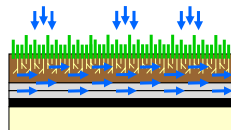
*Combined sewer systems serve roughly 772 communities, home to over 40 million US citizens.*

Source: US EPA



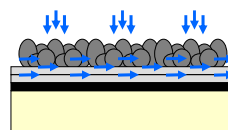
## Water Management Options

### Vegetated Options



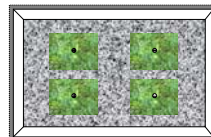
*Retaining Storm Water  
Runoff with Planting Media &  
Moisture Retention Mats*

### Ballasted Options



*Retaining Storm Water  
Runoff with Moisture  
Retention Mats*

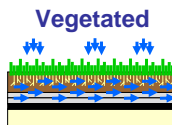
*... Plus Hybrid  
Vegetated /  
Ballasted Options*



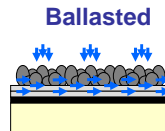
*Combining the  
best of both  
options*



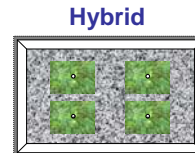
## Water Management Options



- + Possible LEED credits (SS Credits 6.1 & 6.2)
- + LEED cool roof credit (SS Credit 7.2)
- Cost premium



- + Possible LEED credit (SS Credits 6.1)
- + Low initial cost
- Limited, but growing cool roof recognition



- + Opportunity to optimize economics & benefits
- + LEED cool roof credit for 50% vegetated



## Roofing Material Management





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## Why Roofing Material Management?

### Annual U.S. Landfill Waste

- 160 Million Tons Of Construction Waste
- 40 Million Tons of Roofing Waste
  - 25%+ of Total Construction Waste

Source: US EPA (1998)



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## Current Roof Recycling Options

- **Asphalt Shingles / Wood Shakes:** Local and regional recyclers are developing roof recycling programs.
- **Single-Plies:** Several roofing manufacturers and trade associations have initiated recycling pilot programs for some single-ply membranes.
- **Metal Roofing:** The metal industries have well-established recycling programs.
- **Insulation:** A new organization has started a successful national recycling program for foam insulation boards



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## Roof Life Cycle Management



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## Why Roof Life Cycle Management?

- **Increase Sustainable Service Life**
  - Roofing system
  - Entire building
- **Reduce Environmental Impacts**
  - Reduce solid waste from unnecessary re-roofs
  - Eliminate leak-related toxins (mold, micro-organisms)
  - Reduce degradation of energy-efficiency (wet insulation, soiled roof surfaces)

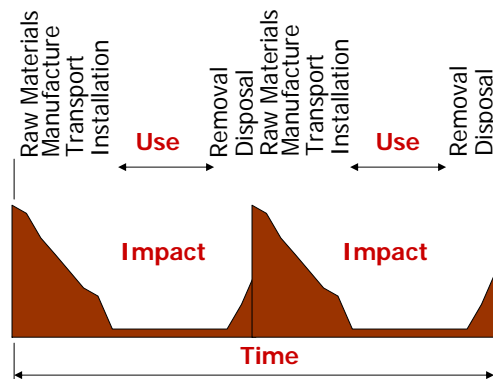


## Roof Life Cycle Management Tools

- Life Cycle Planning / Roof Asset Management
- Commissioning / Periodic Roof Inspection
- Preventative Roof Maintenance
- Roof System Renewal

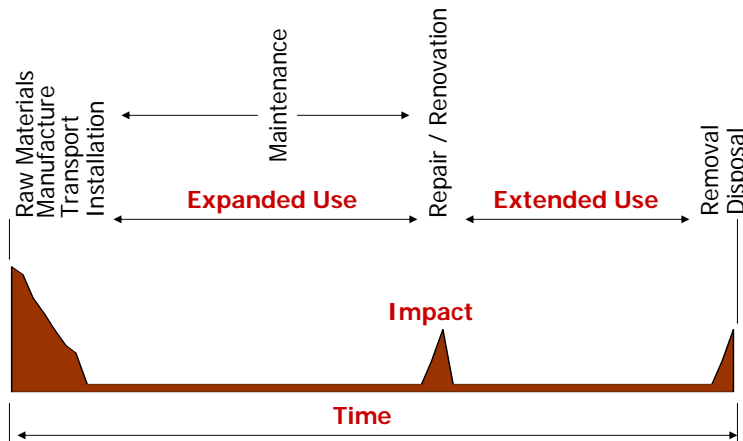


## The All-Too-Common Roof Life Cycle





## The Sustainable Roof Life Cycle



## Why Sustainable Roofing?

- ✓ Increased Energy Efficiency
- ✓ Clean Energy Production
- ✓ Cleaner Air & Water
- ✓ Reduced Material Waste
- ✓ Longer-Lasting Buildings
- ✓ Healthier Building Occupants



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**Thank You for Attending!  
Any Questions?**

**Dr. James L. Hoff**

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[jhoff@roofingcenter.org](mailto:jhoff@roofingcenter.org)

This concludes the American Institute of Architects  
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