Heat Island Effect—Roof

[STRATEGY]

BRIEF DESCRIPTION

Reduction of the heat island effect can be achieved by selecting cool roof surfaces or installing a vegetative roof. Heat islands are typically defined as 'urban' regions that have higher temperatures than the surrounding landscape. Cool roofs reflect sunlight and emit heat more efficiently, and are seen as a potential strategy to reduce the heat island effect. Vegetative roofs installed on top of conventional flat or low sloping roofs are a layered system constructed of living vegetation. The increase in permeability and moisture with living vegetation is seen as another potential strategy to reduce the heat island effect. Details on vegetative roof strategies are not included in this TechNote.

Applications

Cool Roofs

- Solar reflectance and thermal emittance (range on a scale from 0 to 1) are the key material surface properties. The larger the value is, the cooler the roof will remain in the sun.
- Solar Reflectance Index (SRI) calculated from solar reflectance and thermal emittance values. LEED program currently uses minimum aged SRI values of 78 and 29 for low and steep sloped cool roofs, respectively. More than 75 percent of the roof surface must meet or exceed these values.
- Some of the ENERGY STAR® program labeled materials meet LEED SRI values. The ENERGY STAR® program specifies minimum solar reflectance (low slope: 0.65 initial, 0.50 aged; steep slope: 0.25 initial, 0.15 aged) but does not consider thermal emittance.

Vegetative roofs

- Green or vegetative roofs can be designed in conjunction with solar panels, infiltration beds, rain gardens, bioretention systems, cisterns, and rain barrels.
- Vegetative roofs are not addressed in this TechNote.

Design Notes

Location

- Cool roofs can be installed anywhere, but the impact on the heat island effect and energy performance will depend on the geographic location.
- Low sloped roofs have surfaces with a slope of 2:12 inches or less. Steep-slope roofs have surfaces with a slope greater than 2:12 inches.

Color and Materials

- Cool roof materials are available in all colors for steep slope roofs and lighter colors for low sloped roofs. There are more than 2000 options for metal roofing materials that meet or exceed an SRI of 29.

The following table shows a sample of the SRI range and number of products available for various types of cool roofs.

Type	Material	Color	SRI Range	Number of Products*	Number of Vendors*
Steep Slope	Metal	Red	29-58	250	60
		Brown	29-54	75	30
		Green	29-51	200	40
		Tan	29-79	150	50
		Grey/ Copper/Blue/ Beige/White/ Others	29-86	1000	110
	Coatings	Red	30-46	100	10
		Brown	29-79	50	5
		Green	29-51	100	5
		Tan	29-86	75	10
		Grey/ Copper/Blue/ Beige/White/ Others	29-86	900	130
	Tile	Various	29-82	80	5
	Shingles	Various	29-79	20	2
Low Slope	Metal	Beige/Grey/ White	78-86	150	60
	Coatings	Beige/Grey/ Red/White	78-114	450	120
	Modified Bitumen	Light	78-105	40	10
	Single Ply	Light	78-117	80	20

* Approximate number of product and vendors identified using the Energy Star Cool Roofs Qualified List. This table shows only a sample of colors available and approximate number of products and vendors available.

Cool Roof Products that meet LEED SRI ranges
(Source: modified from Energy Star Cool Roofs Product List
http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=RO)

References/Useful Resources:

[1] Extensive Green Roofs. http://wbdg.org/resources/greenroofs.php?r=site_potential
[2] U.S. Environmental Protection Agency, Heat Island Impacts. http://www.epa.gov/hiri/impacts/index.htm
[3] Cool Roof Rating Council. http://www.coolroofs.org/
[4] Guidelines for Selecting Cool Roofs. www1.eere.energy.gov/femp/pdfs/coolroofguide.pdf
[5] U.S. Environmental Protection Agency, Heat Island Effect. http://www.epa.gov/heatisld/

Energy Savings

Cooling Energy

- Cool roofs can decrease air-conditioning needs. Annual savings are estimated up to \$0.13/ft^2/yr roof area. (Roof Savings Calculator: http://www.roofcalc.com)

Social Benefits

Thermal Comfort

- Improve indoor thermal comfort for spaces that are not air conditioned.

Building Life

- Decrease roof operating temperature and thus extend roof service life

Environmental Benefits

- Decrease ambient temperatures near the building can improve site habitat and annual migration corridors.

Guiding Principles[1]

Optimize Energy Performance (Energy Efficiency)

- Reduce the energy use by 30 percent compared to the baseline building performance rating per ASHRAE Standard 90.1-2007.

Associated LEED Credits (NC 2009)[2]

SS Credit 7.2: Heat Island Reduction: Roof (1 point)

- Use roofing materials with a solar reflectance index (SRI) equal to or greater than the values in the table below for a minimum of 75 percent of the roof surface. Roofing materials having a lower SRI value than those listed below may be used if the weighted rooftop SRI meets the following criteria:

$$\frac{AreaRoofMeetingMinimumSRI}{TotalRoofArea} \times \frac{SRIofInstalledRoof}{RequiredSRI} \geq 75\%$$

Roof Type	Slope	SRI
Low-sloped roof	$\leq 2:12$	78
Steep-sloped roof	$\geq 2:12$	29

EAc1: Optimize Energy Performance (1-19 points)

- Demonstrate a percentage improvement in energy performance compared to a baseline performance per ASHRAE/IESNA Standard 90.1-2007.

[1] Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings www.wbdg.org/pdfs/hpsb_guidance.pdf

[2] USGBC LEED Reference Guide for Green Building Design and Construction, 2009 Edition

Product Images

Cool coating

Cool single-ply membrane roof

Cool Metal Roof

Sources: http://www1.eere.energy.gov/femp/pdfs/coolroofguide.pdf
http://www.wbdg.org/resources/coolmetalroofing.php

Cost Range

For cool roofs, the material cost typically ranges from no cost premium to $0.75/ft^2

Roof	Typical Non-Cool Surface	Cool Alternative	Price Premium ($/ft^2)
Built-Up Roof	Mineral aggregate embedded in flood coat	Light-colored aggregate, like marble chips, gray slag	0.00
	Asphaltic emulsion	Field applied coating on top of emulsion	0.80-1.50
	Mineral surfaced cap sheet	White mineral granules	0.50
Metal[$]	Unpainted metal	May already be cool	0.00
		Factory applied white paint	0.20
	Painted metal	Cool-colored paint	0.00-1.00+
Modified Bitumen	Mineral surfaced cap sheet	Factory applied coating, white mineral granules	0.50
	Gravel surface in bitumen	Light colored gravel	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
Shingles[$]	Mineral granules	White granules	0.00
		Cool-colored granules	0.35-0.75
Sprayed Polyurethane Foam	Liquid applied coating	Most coatings are already cool to protect the foam	0.00
	Aggregate	Light colored aggregate	0.00
Thermoplastic Membranes	White, colored, or dark surface	Choose a white or light colored surface	0.00
Thermoset Membranes	Dark membrane, not ballasted (adhered or mechanically attached)	Cool EPDM formulation	0.10-0.15
		Factory cool ply or coating on dark EPDM	0.50
Tiles[$]	Non-reflective colors	Clay, slate: naturally cool	0.00
		Cool colored coatings	0.00

Roof Surfaces, Cool Alternatives, and Approximate Price Premiums
Source: http://www1.eere.energy.gov/femp/pdfs/coolroofguide.pdf

Product Types

Cool Roof Materials

- Metal
- Roof Coatings
- Metal Built-up Roofing (includes asphalt and coal tar pitch)
- Foam Roof Systems:
- Modified Bitumen
- Shingles, Slate, or Tile
- Single-Ply-Thermoset (includes EPDM, Hypalon)
- Single-Ply–Thermoplastic (includes TPO, PVC, etc.) (http://www.coolroofs.org/HomeandBuildingOwnersInfo.html)

Vendors

Metal Roof

AEP-Span (www.aepspan.com)
Interlock Roofing Ltd. (www.interlockroofing.com)
Coastal Metal Service (www.coastalmetalservice.com)

Tile Style Roof

Eagle Roofing Products (www.eagleroofing.com/)
Florida Metal Roofing Products, INC., (http://fmrp.net/)
Maruhachi Ceramics of America, Inc (www.mca-tile.com)

Coatings

Valspar Corporation (www.valspar.com)
National Coatings Corporation (www.nationalcoatings.com)
Gardner-Gibson (www.gardner-gibson.com)

To achieve the LEED expectations for Heat Island Effect – Roof, the following specification language may be useful.

STEEP SLOPE ROOFING[3]

Install materials on 75 percent of the roof surface with a SRI of above 29.

LOW SLOPE ROOFING[4]

Install materials on 75 percent of the roof surface with a SRI of above 78.

[3] Specification language modified from the Whole Building Design Guide's *Federal Green Construction Guide for Specifiers,* SECTION 07 30 00 (SECTION 07300) – STEEP SLOPE ROOFING. Accessed August 2012 at http://www.wbdg.org/ccb/FEDGREEN/fgs_073000.doc Last updated January 2010).

[4] Specification language modified from the Whole Building Design Guide's *Federal Green Construction Guide for Specifiers,* SECTION 07 30 00 (SECTION 07300) – STEEP SLOPE ROOFING. Accessed August 2012 at http://www.wbdg.org/ccb/FEDGREEN/fgs_075000.doc Last updated January 2010).