



BEYOND
SMART CITIES

**SUSTAINABLE SITES - GREEN BUILDING TECHNOLOGY
TRAINING PROGRAM**

FOR GREEN BUILDING AND SUSTAINABILITY SPECIALISTS

KRISHNAJI PAWAR, LEED AP BD+C, GSAS CGP, ISO 14001:2015, GCP
GREEN BUILDING SPECIALIST CURRICULUM





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HEAT ISLAND REDUCTION - CREDIT

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LEARNING OBJECTIVES



Intent of Heat Island Reduction - Credit

Behind the intent

Step by Step Guidance

Requirements

Required Documentation

Connection to Ongoing Performance

Terms and Definitions

SS- CR(1 - 2) - DESIGN

INTENT

To minimize inequitable effects on microclimates and human, especially frontline communities, and wildlife habitats by reducing heat islands.

POTENTIAL TECHNOLOGIES & STRATEGIES

☒ Materials and landscaping techniques that reduce the heat absorption of exterior materials.

☒ Consider replacing constructed surfaces with vegetated surfaces such as vegetated roofs and open grid paving or specify high-albedo materials to reduce the heat absorption.

HEAT ISLAND REDUCTION

REQUIREMENTS

OPTION 1 Provide any combination of the following strategies for 50% of the site hardscape (including roads, sidewalks, courtyards and parking lots):

☒ Shade from the existing tree canopy or within 5 years of landscape installation.

☒ Shade from structures covered by solar panels.

☒ Shade from architectural devices or structures that have SRI of at least 29

☒ Hardscape materials with an SRI of at least 29

☒ Open-grid pavement system (at least 50% pervious)

OPTION 2 Place a minimum of 50% of parking spaces under cover with SRI of at least 29.

IMPLEMENTATION

REQUIRED DOCUMENTATION

Documentation	Option 1	Option 2
Nonroof and roof area calculations	X	
Site plan(s) with elements and measurements, including LED project boundary, building footprint, roof and hardscape area, and area of each roof and nonroof measure	X	
Manufacturer's documentation of SRI, SR, and paving permeability	X	X
Parking space calculations		X

BEHIND THE INTENT

Dark, nonreflective surfaces used for parking, roads, roofs, walkways, and other hardscapes absorb the sun's warmth and radiate heat, creating heat islands. Urban areas can have temperatures 1.8° to 5.4°F (1° to 3°C) warmer than surrounding suburban and undeveloped areas, and as much as 22°F (12°C) warmer in evenings. These heat islands may contribute to regional average warming trends. A study of surface warming resulting from rapid urbanization in east China found urban heat islands responsible for 14.2% of regional warming. Urban heat island effects have numerous negative consequences: plants and animals sensitive to temperature fluctuations may find habitat affected by heat islands inhospitable. Human health may suffer because exposure to ground-level pollution is often worse in places affected by heat islands. Additionally, heat islands increase cooling loads in the summer, necessitating larger, more powerful air conditioners that use more electricity, in turn increasing cooling costs, producing more greenhouse gases, and generating pollution.

According to a study of the metropolitan areas of Baton Rouge, Chicago, Houston, Sacramento, and Salt Lake City by the Department of Energy's Lawrence Berkeley National Laboratory, the energy savings potential of heat island reduction measures ranges from \$4 million to \$64 million per year. Efforts to reduce heat islands can have a reasonable payback period when included as part of an integrated systems approach to improving building performance, such as by installing solar panels on shading devices or using a vegetated roof to insulate a building and extend the life of the roof.

The most effective measure of a roofing material's ability to reject solar heat is the solar reflectance index (SRI). However, to measure the solar heat rejection of components that are not roofing materials, or "nonroof"—for example, vegetation, shading devices, and other less reflective components—solar reflectance (SR) is used in this credit instead. SR is a more appropriate way to measure nonroof materials, which have more thermal mass. In addition to a product's initial SRI or SR value, this credit considers a product's three-year-aged SRI or SR values, which measure material performance over time. The credit encourages project teams to adopt a variety of strategies, including reducing hardscape and incorporating high-SRI or high-SR materials such as vegetation and shaded parking, which minimize a project's overall contribution to heat island effects.

STEP-BY-STEP GUIDANCE

Determine which option the project will pursue. Exemplary performance is available to teams that pursue both options and locate 100% of parking under cover.

- Option 1 is for projects with compliant roofs and at-grade (i.e., nonroof) systems, but no covered parking.
- Option 2 is for projects with only covered or underground parking.

Option 1. Nonroof and Roof

STEP 1. MINIMIZE HARDSCAPE

In early design, look for opportunities to limit the amount of hardscape on the project site. Increasing the landscaped portion of the site is the most effective strategy for reducing overall heat island effects and supports achievement of other credits (see Further Explanation, Heat Island Mitigation Strategies and Related Credit Tips). ➡

STEP 2. IDENTIFY HARDSCAPE AND ROOF AREA

On a site plan, determine the total hardscape area and the total applicable roof area within the project boundary.

STEP-BY-STEP GUIDANCE +

- Hardscape area includes all paved roads, sidewalks, courtyards, and parking lots.
- Applicable roof area excludes roof area covered by mechanical equipment, solar energy panels, skylights, and any other apertures.
- The top level of multilevel parking structures is considered nonroof surface if it has parking spaces, but roof area if it has no parking spaces.

STEP 3. SELECT ROOFING MATERIALS

To the extent feasible, incorporate vegetated roof systems or high-reflectance roofing materials that comply with Table 1 of the rating system requirements. On the site plan, determine the areas of vegetated and high-reflectance roof. For all applicable roof areas, gather manufacturer's documentation of SRI to verify compliance with credit requirements.

- Roof reflectance is the focus on sites that are designed to minimize hardscape.
- Roofing material selection is typically the most economical way to mitigate heat island effect.
- Consider how roof surfaces will be maintained. For example, regular cleaning will be needed to maintain the reflectivity of high-SRI surfaces.
- Selected materials may meet either the initial SRI threshold or the 3-year aged SRI threshold. They are not required to meet both.

STEP 4. IDENTIFY AREA OF PLANTERS AND SHADED, PERMEABLE, AND REFLECTIVE HARDSCAPE

On the site plan, determine the area of hardscape that is mitigated by one of the eligible nonroof measures listed in the credit requirements. Gather manufacturer's documentation of SR and paving permeability, as applicable, to verify compliance with credit requirements.

- Calculate the area of each nonroof measure in plan view.
- Count each hardscape surface only once, even if it is addressed through multiple strategies (e.g., permeable paving that is also shaded).
- Selected materials may meet either the initial SR threshold or the 3-year aged SR threshold. They are not required to meet both.

STEP-BY-STEP GUIDANCE +

STEP 5. EVALUATE COMPLIANCE AGAINST CREDIT REQUIREMENTS

Determine credit compliance using Equation 1 (standard) or Equation 2 (weighted) (see Further Explanation, Examples 1 and 2).

- Equation 1 determines the combined compliance of roof and nonroof measures for the whole project.
- Equation 2 weights the SR and SRI for total hardscape and roof area, showing its overall consequence on heat island effect. This equation is useful for projects that have multiple roof angles and nonroof or roof materials that fall both above and below the required SR and SRI values.
- Project teams should first evaluate compliance with Equation 1. If the project does not achieve compliance with Equation 1, the team should move to Equation 2.

EQUATION 1. Standard nonroof or roof calculation

$$\begin{array}{ccccccc} \text{Area of} & & \text{Area of high} & & \text{Area of} & & \\ \text{Nonroof} & & \text{Reflectance} & & \text{Vegetated} & & \\ \text{Measures} & & \text{Roof} & & \text{Roof} & & \\ + & & + & & + & & \\ 0.5 & & 0.75 & & 0.75 & & \\ \hline & & & \geq & & & \\ \text{Total Site} & & & & \text{Total Roof Area} & & \\ \text{Paving Area} & & & & & & \end{array}$$

EQUATION 2. Weighted nonroof or roof calculation

$$\begin{array}{ccccccc} \text{SR of high} & & & & \text{SR of high} & & \\ \text{reflectance} & & & & \text{reflectance} & & \\ \text{nonroof A} & & & & \text{roof A} & & \\ \left(\text{Area of high} \times \frac{\text{SR of high}}{\text{Required SR}} \right) & & \text{Area of} & & \left(\text{Area of high} \times \frac{\text{SR of high}}{\text{Required SR}} \right) & & \\ \text{reflectance} & & \text{other nonroof} & & \text{reflectance} & & \\ \text{nonroof A} & & \text{measures} & & \text{roof A} & & \\ \hline 0.5 & & 0.5 & & 0.75 & & \\ + & & + & & + & & \\ \hline & & & \geq & & & \\ \text{Total Site} & & & & \text{Total Roof Area} & & \\ \text{Paving Area} & & & & & & \end{array}$$

1. Summed for all high-reflectance nonroof areas.

2. Summed for all high-reflectance roof areas.

STEP-BY-STEP GUIDANCE +

STEP 6. INCORPORATE ADDITIONAL MITIGATION STRATEGIES IF NECESSARY

If the project does not meet the credit requirements with either calculation, revise the project design to extend or incorporate additional nonroof or roof mitigation strategies. Then recalculate to confirm compliance.

Once the credit strategy is finalized, include performance requirements in the applicable specification sections, or specify particular systems and products that meet credit requirements.

Option 2. Parking under Cover

STEP 1. DETERMINE TOTAL VEHICLE PARKING SPACES IN PROJECT

Calculate the number of parking spaces within the LEED project boundary. This value must be consistent with the parking spaces used for other credits.

- Include motorcycle parking as vehicle parking spaces.
- Do not count bicycle parking spaces.

STEP 2. LOCATE AT LEAST 75% OF PARKING SPACES UNDER COVER

Where possible, locate parking spaces underground, under a deck, under a roof, or under a building.

- Indicate covered parking on a site map.
- Count uncovered parking at the top level of a multilevel parking structure as uncovered spaces in the credit calculations.

STEP 3. DESIGN PARKING COVER TO MEET CREDIT REQUIREMENTS

Ensure that the roof over the parking area meets the credit requirements for eligible types of parking cover (see Further Explanation, Heat Island Mitigation Strategies).

- Uncovered parking at the top level of a multilevel parking structure is not required to meet the prescribed roof criteria because it is considered nonroof surface.
- If there are no parking spaces on the top level of a multilevel parking structure, this area is considered roof area and must comply with the criteria listed in the credit requirements.

REQUIREMENTS

Choose one of the following options:

Option 1. Nonroof and Roof (2 points except Healthcare, 1 point Healthcare)

Meet the following criterion:

Area of Nonroof Measures

0.5

Area of High-Reflectance Roof

0.75

Area of Vegetated Roof

0.75

Total Site Paving Area

2

Total Roof Area

4

Alternatively, an SRI and SR weighted average approach may be used to calculate compliance.

Use any combination of the following strategies.

Nonroof Measures

- Use the existing glint material or install plants that provide shade over paving areas (including playgrounds) on the site within 10 years of planting. Install vegetated planters. Plants must be in place at the time of occupancy permit and cannot include artificial turf.
- Provide shade with structures covered by energy generation systems, such as solar thermal collectors, photovoltaics, and wind turbines.
- Provide shade with architectural devices or structures. If the device or structure is a roof, it shall have an aged solar reflectance (SR) value of at least 0.28 as measured in accordance with ANSI/CES 3100. If the device or structure is not a roof, or if aged solar reflectance information is not available, it shall have an initial SR of at least 0.33 as measured in accordance with ANSI/CES 3100.
- Provide shade with vegetated structures.
- Use paving materials with an initial solar reflectance (SR) value of at least 0.33.
- Use an open-grid pavement system (at least 50% unbound).

High-Reflectance Roof

Use roofing materials that have an aged SRI equal to or greater than the values in Table 1. If aged SRI is not available, the roofing material shall have an initial SRI equal to or greater than the values in Table 1.

Table 1. Minimum solar reflectance index value, by roof slope



REQUIREMENTS +

	slope	Initial SRI	Aged SRI
Low-sloped roof	< 2:12	82	64
Steep-sloped roof	> 2:12	39	32

Roof area that consists of functional, usable spaces (such as helipads, recreation courts, and similar amenity areas) may meet the requirements of nonroof measures. Applicable roof area excludes roof area covered by mechanical equipment, solar energy panels, skylights, and any other appurtenances.

Vegetated Roof

Install a vegetated roof using native or adapted plant species.

OR

Option 2. Parking under Cover (1 point)

Place a minimum of 75% of parking spaces under cover. Any roof used to shade or cover parking must (1) have an aged SRI of at least 32 (if aged value information is not available, use materials with an initial SR of at least 39 at installation); (2) be a vegetated roof; or (3) be covered by energy generation systems, such as solar thermal collectors, photovoltaics, and wind turbines.

The credit calculations must include all existing and new off-street parking spaces that are leased or owned by the project, including parking that is outside the project boundary but is used by the project. On-street parking in public rights-of-way is excluded from these calculations.



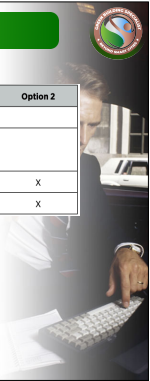
CONNECTION TO ONGOING PERFORMANCE

LEED O+M SS Credit Rainwater Management: Reducing a site's hardscape area and/or using open-grid paving will improve infiltration rates and may help projects earn the related performance-based credit. Vegetated roofs can also contribute to rainwater management.



REQUIRED DOCUMENTATION

Documentation	Option 1	Option 2
Nonroof and roof area calculations	X	
Site plan(s) with elements and measurements, including LEED project boundary, building footprint, roof and hardscape area, and area of each roof and nonroof measure	X	
Manufacturer's documentation of SRI, SR, and paving permeability	X	X
Parking space calculations		X



EXEMPLARY PERFORMANCE

✓Achieve both Options 1 and 2. Locate 100% of parking under cover.

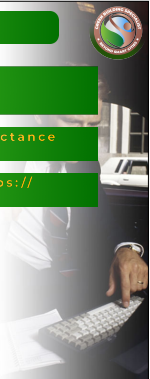


REFERENCED STANDARDS

✓ASTM Standards E903 and E892: astm.org
Cool Roof Rating Council Standard (CRRC-1): coolroofs.org
HEAT ISLAND REDUCTION

✓ASTME 1980 Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces

✓Cool Roof Ratings Council, Rated Products Directory: <https://coolroofs.org/directory>



TERMS AND DEFINITIONS

Common road for the purposes of this credit, a common road is defined as a narrow or small road or alleyway between buildings, which may or may not be drivable.

Solar reflectance (SR) The ratio of the reflected solar flux to the incident solar flux.

Solar reflectance, initial (initial SR) a solar reflectance that is measured prior to aging.

Solar reflectance, aged (aged SR) a solar reflectance that is measured after laboratory or natural aging.

Solar reflectance index (SRI) a measure of the constructed surface's ability to stay cool in the sun by reflecting solar radiation and emitting thermal radiation. A standard black surface has an initial SRI of 0, and a standard white surface has an initial SRI of 100.

Thermal emittance (TE) the ratio of the radiant heat flux emitted by a specimen to that emitted by a blackbody radiator at the same temperature.



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THANK YOU

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