



# Incorporating Smart Surfaces into Building Energy Codes

A Smart Surfaces Primer for State and Territory Energy Offices





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## Introduction

As State and Territory Energy Offices work to support a more reliable, resilient, and affordable energy system, Smart Surfaces—which include technologies such as reflective roofs and pavements, solar photovoltaics, green roofs, porous pavements, and trees—provide a cost-effective opportunity to reduce peak electricity demand and cut energy bills for households and businesses. In addition to their energy benefits, Smart Surfaces can also mitigate extreme heat and manage stormwater, helping protect critical infrastructure and improve public health and quality of life. State Energy Offices can help enable the strategic implementation of these proven solutions by incorporating Smart Surfaces into building energy codes, coordinating with local governments, and educating key stakeholders. This primer, part of a series of Smart Surfaces resources developed for State Energy Offices, explores how State Energy Offices can support the implementation of Smart Surfaces via building energy codes.

Extreme heat is the leading cause of weather-related mortalities in the United States,<sup>1</sup> and projections show that the frequency and severity of extreme heat events will increase in the coming decades. State and local jurisdictions can alleviate the impacts of high temperatures by implementing Smart Surface policies and building codes that increase energy efficiency, reduce peak demand, improve building comfort, reduce outdoor air pollution, and improve resilience.

Many dense urban areas experience the urban heat island (UHI) effect, which causes temperatures in cities to be significantly higher than surrounding less developed rural areas. The UHI effect is caused by the high prevalence of dark, impermeable surfaces such as asphalt roads and dark-colored roofs, in addition to the exhaust heat from combustion vehicles, buildings' HVAC systems, and industrial machinery, coupled with lower tree canopy and vegetation.<sup>2</sup> Jurisdictions across the U.S. are reducing the impact of extreme heat and the UHI effect by implementing Smart Surfaces into their urban planning and policy efforts and building codes.

# Benefits of Smart Surfaces

Smart Surfaces help reduce the temperature of buildings and street surfaces, as well as the air temperature outside and inside buildings. Smart Surfaces such as cool roofs and cool walls reduce the demand for air conditioning in buildings, support safer indoor temperatures in non-air-conditioned buildings and during power outages, and help reduce utility costs for residents. For example, in non-air-conditioned residential buildings, solar reflectance from cool roofs can lower maximum indoor temperatures by 2.2 to 5.9 degrees Fahrenheit (1.2–3.3 degrees Celsius), and in air-conditioned residential buildings, cool roofs can reduce peak cooling demand by 11 to 27 percent.<sup>10</sup> Some single-ply cool roof technologies for low-slope roofs are less expensive on a first cost basis than dark roof products, typically ranging from \$2.51-\$4.39 per square foot, while the national average for dark single-ply or asphaltic membranes is \$3.04-\$5.32 per square foot.<sup>11</sup> Cool walls have similar impacts to cool roofs, reducing HVAC energy costs by up to 27 percent in single-family homes.<sup>12</sup>

When adopted on a city-wide scale, Smart Surfaces can help:

- reduce peak grid loads during extreme heat events, lowering the chances of blackouts and brownouts.
- reduce the production of low-level ozone or smog due to reduced ambient air temperatures.
- increase how much sunlight is reflected back into the atmosphere, which keeps the temperature at ground level cooler, as well as providing global cooling benefits.

## WHAT ARE SMART SURFACES?

“Smart Surfaces” is a term coined by the Smart Surfaces Coalition<sup>i</sup> and includes a variety of surface infrastructure interventions and technologies that help enhance local resilience, reduce energy costs, and lower peak demand.

### Cool Pavements

Cool pavement, also referred to as reflective pavement, reflects a higher percentage of sunlight than typical asphalt pavement. Due to the higher reflective value, cool pavement stays cooler throughout the day and reduces the urban heat island effect and thus peak demand. There is no specific reflectivity value that a pavement must have to be labeled as “cool.” Rather, it is a relative category that may differ among jurisdictions with different definitions, requirements, or incentive thresholds.<sup>ii</sup> Cool pavement can be applied on roads or parking lots, although the materials for different applications may vary.

### Permeable Pavements

Permeable pavement allows for the infiltration and temporary capture of water unlike typical impervious concrete or asphalt pavement. Permeable pavements reduce stormwater runoff, leading to increased flood prevention and lower water treatment costs, thereby saving energy. When spaced properly with lighter colored materials, permeable pavements also reflect more sunlight and thus help mitigate urban heat island effects.<sup>3</sup>

### Trees and Green Stormwater Infrastructure

Trees and green stormwater infrastructure (such as bioswales, urban meadows, permeable surfaces, and rain gardens) can help manage stormwater, improve air quality, and mitigate extreme heat events by reducing the temperature of surrounding air, pavement, and building surfaces. For example, shade from trees can lower street-level temperatures by more than five degrees Fahrenheit.<sup>4</sup>

<sup>i</sup> The [Smart Surfaces Coalition](#) is a 501(c)(3) organization committed to the rapid, cost-effective global adoption of Smart Surfaces to enable cities to thrive despite climate threats, save cities billions of dollars, create jobs, decrease heat, reduce flood risk, mitigate climate change, and improve city livability, health, and equity.

<sup>ii</sup> Although there is no common definition of cool pavement, a target solar reflectance of 0.30 or higher is a good starting point for policymakers and developers to consider.

# Smart Surfaces in Building Codes

States and local jurisdictions can include Smart Surfaces, such as cool roofs and walls, in their building energy codes in several different ways.

1. Jurisdictions can include Smart Surfaces in the mandatory requirements section of the building energy code, which would require cool roofs and/or walls in all new and renovated construction, regardless of the compliance pathway the builder chooses.
2. Jurisdictions can also require Smart Surfaces in the prescriptive compliance pathway. Cool roof or wall requirements can be included in C402 or R402, or as part of the credit options in C406 or R408 that a builder can choose to comply with in order to reach the required number of credit points.
3. A third option could be to include cool roofs and cool walls in the Energy Rating Index (ERI) compliance pathway.<sup>13</sup>
4. A fourth option could be to provide an incentive for builders who incorporate cool roofs or other Smart Surfaces, such as providing a density bonus, reduced insulation requirement, or a reduced cost or streamlined permit. For example, the Hawaii Building Energy Conservation Code relaxes insulation requirements for commercial and residential building walls that have a solar reflectance of at least 0.64 (64 percent or greater).<sup>14</sup>

State Energy Offices vary significantly in their authority or influence over building codes. Some State Energy Offices develop the state energy code, provide training to building professionals, and/or help with code enforcement, while other State Energy Offices may have less formal involvement. For a deeper dive into how State Energy Offices participate in building code development, adoption, and enforcement, please see the [NASEO Energy Codes 101](#) publication.

## Cool Roofs

Similar to cool pavements, cool roofs reflect a higher percentage of sunlight away from roofs, leading to cooler temperatures on the roof surface and in the building. On a hot sunny day, cool roofs can stay more than 50 degrees Fahrenheit cooler than conventional dark roofs.<sup>5</sup> Because of their cooling effect, cool roofs can reduce air conditioning needs and lower energy costs in the summer. Studies show that retrofitting 80 percent of commercial building roof area in the U.S. with cool roofs would yield net annual cooling energy cost savings of \$735 million.<sup>6</sup> In addition, cool roofs may experience less wear and tear due to reduced temperature fluctuation, which can lower maintenance costs and extend roof lifespans.

## Green Roofs

Green roofs, also known as vegetative roofs, contain weather-tolerant plants and are typically installed on low-slope roofs. The vegetation on roofs reduces how much sunlight is absorbed by the building, saving energy used for heating and cooling, and reduces stormwater runoff. A review of studies shows that green roofs can reduce building cooling loads by up to 70%.<sup>7</sup>

## Cool Walls

Like cool roofs, cool walls reflect more sunlight than non-cool walls. As with cool pavements, there is no set definition of a reflectivity threshold for cool walls; however, an initial solar reflectance of 0.40-0.50 or higher is a good starting point for policymakers and developers to consider. Cool walls can reduce the cooling needs of a building by keeping it cooler during hot summer days, thus reducing electricity consumption and stress on the grid. Researchers estimate that cool walls can shave up to 8.3 percent off monthly energy bills for single-family homes in warm U.S. climate zones.<sup>8</sup>

## Solar Panels

Incorporating solar panels on building roofs, walls, and above parking lots and bus stops can provide shade for buildings and pedestrians while also generating clean electricity for the grid. One study showed a 4.5 F (2.5 C) reduction of daytime ceiling temperatures and a 38% reduction of the annual cooling loads in buildings that had roof-top solar.<sup>9</sup>



Photo courtesy of Smart Surfaces Coalition

## Smart Surfaces in Model Energy Codes

The 2024 International Energy Conservation Code (IECC) and ASHRAE 90.1-2022, two model codes commonly used for residential and commercial buildings, include cool roofs and cool walls as a prescriptive requirement in some climate zones. In the prescriptive compliance pathway of ASHRAE 90.1-2022 and 2024 IECC, cool roofs with a three-year aged solar reflectance index of at least 0.55 are required for low-slope commercial and multifamily (over three stories) building roofs in Climate Zones 0 to 3.<sup>iii,15,16</sup> In addition, both model codes' prescriptive pathways require

cool walls in Climate Zone 0, which includes tropical regions only outside of the United States. The 2024 IECC does not have any prescriptive or mandatory requirements for cool roofs or walls for single family and multifamily buildings of three stories and less;<sup>17</sup> however, given the importance of cool roofs in mitigating urban heat island, and increasing energy efficiency and cost savings, the States of California and Hawaii and a growing list of cities across the nation have also added cool roof requirements for residential roofs to their codes.

<sup>iii</sup> Climate zones 0 – 3 cover the most southern parts of the United States and up to parts of California in the West and up to North Carolina and parts of Virginia in the East. For a full map of all IECC climate zones, see <https://basc.pnnl.gov/images/climate-zone-map-iecc-2021>.

## Smart Surfaces in State and Local Building Codes

Most states and jurisdictions adopt a version of the IECC and/or ASHRAE 90.1 with some state or local amendments as their building energy code. Certain jurisdictions have strengthened the model code in order to have more stringent cool roof or wall requirements. For example, in 2020, the Hawaii State Energy Office adopted the 2018 IECC with strengthening amendments, which included cool roof requirements for commercial and new or replacement residential roofs. The statewide building code requires cool roofs for commercial and residential construction, and the City of Honolulu expands on the state code by requiring either cool walls or increased insulation in commercial and residential construction, making it one of the first jurisdictions in the U.S. to do so.<sup>18</sup> North Carolina's current energy code, the 2018 North Carolina Commercial State Energy Conservation Code, is based on the 2015 IECC and includes cool roof requirements for commercial buildings in Climate Zone 3, which encompasses most of the state.<sup>19</sup> In North Carolina, it is the Office of State Fire Marshal that administers the energy code.

The California Energy Commission leads the development of the statewide Energy Code, including the cool roof requirements. The 2022 California Energy Code requires cool roofs for newly constructed commercial and residential buildings, as well as for additions and alterations for existing buildings. For example, the code specifies a minimum aged solar reflectance of 0.63 and a thermal emittance of 0.75 for low-slope commercial roofs. For steep-slope commercial roofs, the code requires a minimum aged solar reflectance of 0.20 or 0.25 and a thermal emittance of 0.75 or 0.80, depending on the applicable California climate zone.<sup>20</sup> Some cities go beyond the statewide code by adopting even more stringent requirements.<sup>21</sup>

Similarly, the District of Columbia's District Department of Energy and Environment developed the DC Energy Conservation Code, which requires cool roofs with a minimum three-year aged solar reflectance of 0.55 for commercial and mid-rise residential buildings and above.<sup>22</sup>

At the city level, one of the most comprehensive cool roof building code amendments with the highest solar reflectance standards east of the Rockies was passed in Atlanta, Georgia, in June of 2025. New construction and roof replacements for both residential and commercial development must achieve a minimum solar reflectance of 0.70 for low-slope roofs and a minimum solar reflectance of 0.21 for steep-slope roofs.<sup>23</sup> Additionally, New York City, Chicago, Baltimore, Philadelphia, and Denver offer some examples of jurisdictions in colder climates that have cool roof requirements in their local building code.<sup>24</sup>



Photo courtesy of Smart Surfaces Coalition

## Additional Code Opportunities

Jurisdictions can also choose to encourage Smart Surface adoption via zoning codes instead of building codes. Zoning codes are determined at the local level and can provide an opportunity for jurisdictions that may not be able to change their building codes to implement cool surfaces locally. For an extended list of cool roof and cool wall requirements in state and local building and zoning codes and standards, visit the [Cool Roof Rating Council's Codes and Standards database](#). The Smart Surfaces Coalition also

has a [Policy Tracker](#) that can be filtered by policy type, goal, Smart Surface type, state, and climate zone. The Policy Tracker includes various types of policies such as building code amendments, zoning ordinances, and city, county, and state commitments, among others. The Policy Tracker also has a curated “best practices” section that has model ordinance, policy justification memos, and other resources for those interested in developing Smart Surface related codes, policies, and programs in their regions.



Photo courtesy of Smart Surfaces Coalition

# Additional Examples of State Energy Offices Mitigating Extreme Heat

Smart Surfaces should play a vital role in any statewide or local extreme heat mitigation strategy, in order to increase residents' safety, improve air quality and human health, and reduce demand on the electric grid. Outside of supporting Smart Surface adoption and implementation via building codes, some State Energy Offices have supported extreme heat mitigation efforts in other ways. Below are some additional examples of how some State Energy Offices have worked on mitigating the impacts of extreme heat:

- The Massachusetts Department of Energy Resources (DOER), along with multiple other state agencies, implemented the [Greening the Gateway Cities Program](#), a tree planting program that aims to increase tree canopy cover in parts of Massachusetts cities that have lower tree canopy, in order to reduce the urban heat island effect.
- The Oregon Department of Energy conducted a [cooling needs study](#) that analyzed the gaps in cooling access that exist throughout the state, and the report was submitted to the legislature to guide solutions.
- The Arizona Governor's Office of Resiliency led the effort to draft the state's first [extreme heat preparedness plan](#) that included encouraging interagency collaboration, increasing cooling access in affordable housing, and increasing weatherization workforce, among other strategies.
- New York State Energy Research and Development Authority (NYSERDA) is collaborating with the Department of Environmental Conservation (DEC) to create an [Extreme Heat Action Plan](#), which would establish a comprehensive state response to extreme heat emergencies.
- The District of Columbia Department of Energy and Environment (DOEE) published [Keep Cool DC](#), an extreme heat adaptation strategy, which incorporates strategies such as increasing cooling access, designing for heat, enhancing tree equity, and ensuring clean and reliable power. Smart Surface implementation is a part of the heat adaptation plan. To support the development of the plan, DOEE funded the development of a [Heat Sensitivity-Exposure Index Methodology Report](#), which analyzed heat sensitivity and vulnerability throughout DC.
- The Washington State Department of Commerce supports utility reporting under the [Utility Extreme Heat Shutoff Moratorium](#), which prohibits electrical and water utilities from terminating service during an extreme heat event.

# Additional Resources

- [Codes and Standards by U.S. Jurisdiction](#), Cool Roof Rating Council, 2026.
- [Smart Surfaces Policy Tracker](#), Smart Surfaces Coalition and Columbia University Sabin Center for Climate Change Law, 2026.
- [About Cool Surfaces](#), Lawrence Berkeley National Laboratory Heat Island Group.
- [Heat Island Community Action Database](#), U.S. Environmental Protection Agency.
- [Building Energy Codes 101](#), National Association of State Energy Officials, 2023.

# Endnotes

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