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SMART SURFACES COALITION

Incorporating Smart Surfaces into State Energy Planning

A Smart Surfaces Primer for State and Territory Energy Offices

Contents

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Introduction

Confronted with record electric sector load growth in most states, State and Territory Energy Offices are prioritizing affordable, reliable, and secure power. To meet the immediate and future needs of the electric grid, many State Energy Offices are leading statewide energy planning efforts to reflect governor priorities around energy affordability, reliability, and security, by assessing energy cost reduction opportunities, new generation options, energy efficiency, and support for deploying technologies to optimize energy systems. Smart Surfaces — including cool roofs and walls, cool pavements, rooftop and canopy solar, green roofs, and trees — offer cost-effective solutions to achieve energy efficiency, reduce electricity demand, and shave peak demand costs, while providing resilience, public health, and economic development benefits.

Given their energy, power system, and economic benefits, State Energy Offices may wish to consider incorporating Smart Surfaces into State Energy Plans, resilience plans, extreme heat plans, and climate action plans. States may also develop or commission state-level reports that explore economic, market, policy, and regulatory implications around Smart Surfaces. For states in warm climate zones, widely adopting Smart Surfaces like cool roofs and cool walls can deliver significant energy cost savings. Such investments can be particularly valuable during heatwaves and other peak demand events that place pressure on the electric grid.

This primer is one of several Smart Surfaces resources developed for State Energy Offices and draws examples from a database of Comprehensive State Energy Plans created and maintained by the National Association of State Energy Offices (NASEO).[1]

How Smart Surfaces Can Align with State Energy Office Goals

When leading or advising statewide plans, State Energy Offices may spotlight technologies or strategies that help the state meet energy affordability, resilience, reliability, economic development, and environmental stewardship goals. The following section discusses how Smart Surfaces meet each of these goals.

Affordability

Electric bill affordability has long been a priority issue for many state-level officials, but with rapidly rising energy costs, the issue has become more prominent recently. States hosting new data center sites are responding to unprecedented large load additions to their existing power grids and upwards pressure on total energy demand. For instance, states in the PJM region and the country's emerging "data center" belt, are facing record-high electricity auction prices, leading to governors in states like Virginia and Pennsylvania to identify new power generation, deploy demand management programs, and enact policies to protect residential consumers from escalating bills. Several states are also grappling with more frequent and intense heat waves, requiring new cooling energy loads.

State policymakers are actively seeking practical, cost-effective planning strategies to achieve greater affordability. Smart Surfaces often provide first cost reduction benefits and generally offer substantial lifecycle economic benefits, generating cost savings by reducing the localized use of building cooling systems as well as mitigating urban heat island effects. Studies show that retrofitting 80 percent of commercial building roof area in the United States with cool roofs would yield net annual cooling energy cost savings of $735 million.[6] Many cool roof products are either lower on a

WHAT ARE SMART SURFACES?

"Smart Surfaces" is a term coined by the Smart Surfaces Coalition[i] 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.[ii] 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 specced properly with lighter colored materials, permeable pavements also reflect more sunlight and thus help mitigate urban heat island effects.

Trees and Green Stormwater Infrastructure
Trees and green stormwater infrastructure (such as bioswales, urban meadows, 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.[2]

i 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.
ii 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.

first cost basis or cost competitive with their dark roof counter parts when incorporated during new construction or full replacement reroofing projects.

Employing cool walls yields annual source energy and energy cost savings in all warm U.S. climate zones, shaving up to 8.3 percent off from monthly energy bills across single-family homes.[7] Furthermore, introducing Smart Surfaces measures optimizes building energy efficiency to allow building owners to install smaller, less expensive, and right-sized heating, ventilation, and air conditioning (HVAC) equipment. Through demonstrated lifecycle cost savings, State Energy Offices can present a strong business case for adopting Smart Surfaces and incorporate these technologies into statewide plans centering energy affordability.

Reliability

Smart Surfaces can improve overall energy system reliability by curbing peak cooling demand. On hot summer days, cool roofs can reduce peak cooling demand by 11 to 27 percent in air-conditioned buildings.[8] This helps reduce the frequency of summer blackouts and costly grid repairs caused by air-conditioning use surges that overwhelm power grid operations.

Additionally, reducing the number of times that the grid operates at maximum capacity reduces the use of polluting peaker plants for back-up power, which exacerbates pollution-related health issues from particulate matter and other pollutants. To mitigate the frequency and impact of grid outages and improve public health outcomes, State Energy Offices could incorporate Smart Surfaces into SESPs and other comprehensive planning initiatives that prioritize energy reliability.

Cool Roofs
Similar to cool pavements, cool roofs reflect a higher percentage of sunlight away from the roof, 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.[3] 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.[4] In addition, cool roofs may experience less wear and tear due to reduced temperature fluctuation, which can lower maintenance costs and extend roof lifespan.

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.

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 and 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.[5]

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.


Photo courtsey of Smart Surfaces Coalition

Resilience

Energy resilience is defined as the ability to adapt to the impacts of energy disruptions. When combined with storage, solar canopies (a Smart Surface solution) can provide both on-site back-up power during outage events and act as shade structures to deliver cooling benefits. Cool roofs and walls can contribute to a facility's passive survivability, or its ability to preserve indoor thermal comfort in the absence of operating cooling equipment.

As a resilience measure for peak demand events in the summer, some grid operators may employ rolling blackouts, which can result in life-threatening indoor air temperature gains and high thermal discomfort. In buildings without air-conditioning, cool roofs are shown to decrease indoor ambient temperature by 2.16 to 5.94 degrees Fahrenheit.[9] So, in addition to supporting homes with no existing cooling systems and those who cannot afford air conditioning, cool roofs bolster passive survivability during outage events.[iii] This allows occupants to stay safe and comfortable for longer when prolonged blackout events occur.

Smart Surfaces are also more durable and provide greater resilience benefits than conventional surface infrastructure materials. Metal roofs have longer lifespans than asphalt and single-ply roofs and demonstrate greater resistance to wildfire and high-speed winds. Permeable pavements, tree canopies, and green infrastructure can help manage stormwater to increase flooding resilience, while also mitigating urban heat island effects and thus contributing to energy savings and peak demand reduction. These measures contribute to the structural safety of buildings and a jurisdiction's resilience to climate hazard risks.

iii Passive survivability is defined as a building's ability to maintain reasonably safe thermal conditions in the event of lost power or heating fuel. The U.S. Green Building Council's definition can be found here, through a LEED Program Pilot Credit: https://www.usgbc.org/credits/new-construction-core-and-shell-schools-new-construction-retail-new-construction-data-48

Economic Opportunity

Economic development goals often appear in Comprehensive State Energy Plans and energy workforce development roadmaps. Smart Surfaces contribute meaningfully to the economic vitality of a city by creating jobs and boosting summer tourism and foot traffic for local businesses with more comfortable outdoor environments during hot summer months. A 2016 study from the London School of Economics suggests that cities could lose almost 10 percent of the value of all goods and services due to heat stress.[10] Increased attention to outdoor environmental comfort can also improve workforce safety for outdoor trades. According to the Federation of American Scientists, extreme heat costs an estimated $100 billion per year in lost productivity and causes an average of at least 3,389 heat-related injuries and 33 heat-related fatalities annually – not accounting for all unreported or unattributed incidents.[11]

In an analysis conducted on behalf of the City of Baltimore, the Smart Surfaces Coalition found that for every dollar invested in city-wide Smart Surfaces adoption, the city would see between $12 and $14 in benefits. The benefits are calculated by modeling the cost savings of improved health outcomes. Fewer cases of heat-related illnesses improve hospital capacity and lower publicly funded medical expenditures, freeing up dollars from local and state government budgets to be used towards other investment priorities.

Smart Surfaces investments can also create new jobs. According to a report completed for Stockton, California, the Smart Surfaces Coalition found that Smart Surfaces adoption could create 817 full-time jobs over a 30-year analysis period.[12] Installing Smart Surfaces requires local labor and involves planting trees, resurfacing roads, coating roofs, and installing solar panels. According to the Smart Surfaces Coalition's report on Costs and Benefits for Smart Surfaces Adoption for Baltimore, Smart Surfaces jobs generally pay above-average salaries, buoyed by the average salary range of solar photovoltaic installers.[13] Jurisdictions can also establish local hiring preferences to support job creation for residents.

Environmental Stewardship

Many states include their existing environmental goals in their plans and how certain energy measures or technologies help address those goals. For example, this could include improving outdoor thermal comfort, maintaining good outdoor air quality, and mitigating the impacts of extreme weather events. Shade trees and tree canopies, in addition to providing significant cooling benefits for urban areas during heat waves, can sequester 0.36 metric tons of carbon per acre annually. In a 2018 study, researchers also found that rain gardens sequester more carbon emissions than the embodied carbon accumulated from material production, construction, and transportation for system installation.[14]

While siting solar projects on agriculturally productive lands has proven challenging in some areas, the United States has no shortage of rooftops and uncovered parking areas to host solar canopies. In the United States, researchers estimate that nearly 14,000 square miles of parking could benefit from solar canopy coverage, with the potential to generate between 422 and 800 Gigawatts of solar capacity.[15] Solar shade canopies simultaneously provide passive cooling and supply power in the place of emissions-intensive fossil fuel energy generation. Additionally, many passive cooling and optimized shading techniques help with rightsizing or altogether avoiding the installation of new air-conditioning (AC) systems in some climate zones. This reduces atmospheric refrigerants emitted by AC systems and greenhouse gases with magnitudes higher global warming potential than carbon dioxide.

Opportunities to Incorporate Smart Surfaces into Planning Efforts

State Energy Officials inform and, in most cases, advise governors and state legislators, non-energy agencies, and the public about energy prices, energy system optimization, and energy security. As a result, State Energy Offices often play a central role in shaping and guiding state energy planning. With a clear benefits framework, states can adopt Smart Surfaces or tailor their plans to incentivize adopting certain Smart Surface solutions that make the most sense in the context of their planning goals, climate zones, resource landscape, and workforce availability. Adopting Smart Surfaces strategies can also catalyze a supportive market and policy environment for other energy efficiency and extreme weather response measures.

Comprehensive State Energy Plans

Over half of the 19 states that have revised their Comprehensive State Energy Plans in the past four years recognize energy affordability and reliability as a core issue.[16] Historically, State Energy Offices have elevated energy efficiency measures, similar to Smart Surfaces, as low-cost, near-term solutions for energy savings, cost reductions, and enhanced fuel and grid reliability.

Several Comprehensive State Energy Plans, including those from New Hampshire, Oregon, Pennsylvania, Vermont, and Virginia, reflect the convergence of these factors by highlighting energy affordability, reliability, and innovation as paramount to statewide energy sector growth. New Jersey's 2026 Executive Order No. 2, signed by Governor Mikie Sherrill, mandates action to address the state's energy affordability crisis through opening 3,000 megawatts under their Community Solar Energy Program and expanding virtual power plant programs to provide support for solar development on rooftops for both clean energy generation and shade-derived cooling benefits.[17] When updating their Comprehensive State Energy Plans, states can assess a range of complementary solutions and tools, which could include Smart Surfaces for their cost-effectiveness and role in reducing peak summer energy demand.

Photo by OakCityDrone/istock

Through the panoramic perspectives of their Comprehensive State Energy Plans, states can also identify how Smart Surfaces solutions fit into existing incentive programs, utility-led or demonstration programs, and applied research and development programs.

Sample Language

State Energy Offices can consider adopting parts or all the following actions into the recommendations or roadmap portion of their Comprehensive State Energy Plans.

Table 1. Planning Actions that States Can Consider Adopting

Risk mapping and assessment	• Map and assess heat and flooding vulnerability using accessible public health and insurance claim data. • From mapping exercises, identify opportunities to implement cool surface improvements, shade trees, and solar canopies.
Define Smart Surfaces Adoption Pathways and Set Targets	• Create Smart Surfaces product lists across roofing, building envelope, street and pavement, and canopy categories for inclusion in grant, tax credit, and low-interest financing programs to drive adoption. • Scale Smart Surfaces adoption through measurable commitments, such as “equip X percent of suitable rooftop area with cool roofs, green roofs, or solar panels by X year”, or “reduce measured urban heat intensity in priority geographic areas by X percent in X years”.
Identify and Develop Financing Solutions	• Integrate Smart Surfaces into existing statewide Guaranteed Energy Savings, Commercial and Residential Property Assessed Clean Energy, Revolving Loan Funds, and Loan Loss Reserve programs, enabling city infrastructure departments, private and public building owners and operators, and other project leads to help provide financing for construction of Smart Surfaces. • Identify and apply for federal resilience funding and loans.
Conduct Educational Campaigns	• Develop educational campaigns and disseminate results of reports assessing how Smart Surface adoption mitigates extreme weather risks. • Incorporate Smart Surfaces modules into existing energy education curricula in elementary, secondary, and higher education across the state.
Support Local Jurisdictions with Adoption	• Incorporate Smart Surfaces into local building codes. • Conduct a statewide Smart Surfaces cost-benefit analysis or support local jurisdictions with analyses, working directly with or adapting open-source assessment resources by the Smart Surfaces Coalition.
Conduct Cost-Benefit Analyses	• Partner with product manufacturers and research institutions to assess Smart Surface lifecycle costs, benefits, and maintenance needs to maximize cost-effectiveness and performance.

State Energy Security Plans

State Energy Security Plans (SESPs), developed and maintained by State Energy Offices, provide a comprehensive assessment of natural and human-caused risks to the energy sector and outline mitigation strategies to enhance the resilience of at-risk energy assets and the populations and critical facilities they serve. They are rich resources for data on hazards, with many SESPs identifying extreme heat and flooding as threats to energy infrastructure, and the U.S. Department of Energy's Risk Mitigation Approach Guidebook for SESPs includes 'Environmental Management' as a potential mitigation measure.[18]

The SESPs of Idaho, Kentucky, New Mexico, and Oregon all identify extreme heat and flooding as hazards affecting energy security and suggest nature-based solutions as suitable measures to address these risks.[19] The 2025 North Carolina Energy Security Plan highlights what was at that time a new record in peak summer energy usage in 2022, and the associated risk of power outages from cooling load spikes that impact the operation and efficiency of critical energy infrastructure. North Carolina's SESP also recognizes the impact of outages on public health, including how urban heat islands exacerbate heat-related illnesses and death, and the disproportionate impact of increasing electricity rates on households facing high energy burdens, who may prioritize paying energy bills during extremely hot or cold months over food, medicine, and other essential expenses.

In addition to proactive upgrades to the electric grid, such as dynamic line rating, digital relays, and reconductoring, as well as the deployment of technology solutions like microgrids, the recommended risk mitigation strategies outlined in North Carolina's SESP also include predictive grid maintenance to detect unplanned downtime and maintain essential services during severe weather events. Other SESPs can take a similar approach as North Carolina in identifying the scale and impact of extreme heat, flooding, and disruptive climate events and incorporate Smart Surfaces solutions like cool roofs, walls, and pavements and green stormwater management infrastructure to prevent impacts to critical power systems.

Resilience and Extreme Heat Preparedness Plans

State resilience and extreme heat preparedness plans provide multiple opportunities to incorporate Smart Surfaces interventions or similar solutions. Multiple state resilience plans recommend conducting or incorporating the results of statewide risk assessments to inform coordinated state and local responses and targeted investments for the most vulnerable populations and geographies. The 2023 South Carolina Strategic Statewide Resilience and Risk Reduction Plan, which was informed by an Advisory Committee with participation from the South Carolina Energy Office, includes a statewide heat risk assessment as well as a flood risk and vulnerability assessment.[20] The Plan also includes recommendations to remove barriers to permitting nature-based solutions, such as green stormwater infrastructure, and assess how changes to the Energy Code would impact grid resilience.[21] The 2025 North Carolina Comprehensive Climate Action Plan takes a similar approach and includes[22] a section focused on nature-based solutions, emphasizing the importance of urban forestry in reducing emissions and building resilience.[23]

Extreme heat preparedness plans, generally developed by states with hot summers, often supplement or intersect with broader state resilience plans. Similar to state resilience plans, many extreme heat plans emphasize the importance of interagency collaboration given the multidisciplinary nature of climate hazard mitigation and heat response. For example, New Jersey's Extreme Heat Resilience Action Plan tasks several state agencies with assessments and highlights existing initiatives that could inform the adoption of Smart Surfaces. The plan directs New Jersey's State Energy Office, the Board of Public Utilities (BPU), to analyze grid reliability during extreme heat events and provide grid resilience through the Garden State Energy Storage Program; and directs the Department of Transportation (DOT) to further design heat-resilient pavement and establish construction standards for transportation infrastructure.[24] In July 2025, the BPU established a statewide Urban Heat Island Mitigation Program (UHI Program) in response to interventions recommended in several complementary state plans.[25] In March 2026, the BPU approved UHI Program awards that promote publicly-accessible and community-driven cooling strategies in overburdened urban areas across three funding categories: larger-scale cooling infrastructure projects including green corridors and park redevelopment, sustainable cooling center fortification and resilience hub activation, and smaller-scale projects at the microclimate level such as community gardens.[26] Arizona, grappling with increased periods of extreme heat and heat-related fatalities in recent years, attributes such impacts to the intense urban heat effect in the Phoenix metro area, and a lack of tree coverage, reflective building surfaces, and cooling centers. The state's 2024 Extreme Heat Preparedness Plan also acknowledges higher vulnerability to extreme heat among elderly, socioeconomically disadvantaged, rural, and tribal populations with less access to shade infrastructure, healthcare, and transportation. In 2025, the Plan won the American Planning Association Hazard Mitigation and Disaster Recovery Division Kenneth C. Topping Innovation Award, a recognition of its innovative and proactive approach to a disaster that sits at the intersection of extreme weather and energy.

Hazard Mitigation Plans

Most states develop and maintain hazard mitigation plans as a requisite for accessing Federal Emergency Management Agency (FEMA) funding. Hazard mitigation plans align with FEMA's purposes of establishing risk-informed mitigation strategies, fostering cooperative relationships for an integrated state planning framework, strengthening connections between state and local plans, and improving a state's risk mitigation capabilities. Vermont's 2023 Hazard Mitigation Plan recommends planting more trees for shade cover and implementing other urban heat mitigation strategies.[27] The Plan also recommends weatherizing buildings to enhance resilience during hot weather. In urban areas with high air conditioning demand, this can significantly reduce both urban heat impacts and overall energy use. Pennsylvania's 2023 Hazard Mitigation Plan identified areas vulnerable to extreme heat based on frequency of heatwave events and included high-density counties with significant urban heat island challenges. The Plan recognized Philadelphia for working with the U.S. Environmental Protection Agency on mitigation programs to install white and reflective roofs citywide and establish cooling centers as refuge.[28]

Photo by Bilanol/istock

Decarbonization and Climate Action Plans

State Decarbonization and Climate Action Plans across the United States increasingly feature Smart Surfaces strategies as powerful tools for meeting climate and emissions reduction goals. These examples serve as models for other states developing or updating their own plans.

Among states setting climate targets and commitments, several climate plans recommend accelerating Smart Surfaces deployment. Minnesota's Climate Action Framework integrates initiatives focused on expanding urban tree canopies, implementing green stormwater infrastructure, providing technical assistance for communities impacted by urban heat islands, and advancing climate-resilient design.[29] The Vermont Climate Action Plan promotes solar PV roofs and canopies while encouraging solar siting on already-altered locations like parking lots and rooftops instead of natural lands. It also supports providing supplies and equipment to plant trees to enhance shade for heat resilience.

In Maine's 2024 plan, "Maine Won't Wait," the state emphasizes enhancing assistance to communities for tree planting in urban heat island zones.[30] New Jersey's 2024 Priority Climate Action Plan underscores the role of urban and community forests in reducing energy demand by providing shade and limiting air-conditioning use, with the Department of Environmental Protection committing to plant 250,000 street and shade trees by 2030 to sequester carbon and cool urban environments.[31] Two of the most recently released state climate action plans, Delaware's 2025 Climate Action Plan and New Mexico's 2025 Climate Action Plan, both include goals to expand urban tree canopies, noting co-benefits such as heat reduction, lower household energy costs, higher property values, and increased pedestrian activity during hotter months.[32] State decarbonization plans increasingly recognize Smart Surfaces as a viable, cost-effective technology for advancing state climate objectives.

Conclusion

States can incorporate Smart Surfaces into energy plans to accelerate adoption of the technology to help meet statewide energy goals around affordability, reliability, resilience, hazard mitigation, and environmental impact. By integrating these technologies into state energy planning efforts, State Energy Offices can help deliver multiple benefits, from reduced peak electricity demand to lower energy costs and enhanced resilience against extreme heat and flooding.

Photo by alacatr/istock

Additional Resources

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