ROOFING

The resilience of cool roofing

By Craig A. Hargrove

A warming world needs cooler roofing.

Energy savings, yes, but also resilience and durability.

Mitigating urban heat islands is a resilience strategy.

The United States is getting warmer.

That's not just speculation. That's according to the U.S. Global Change Research Program (USGCR), a government initiative that "coordinates and integrates federal research on changes in the global environment and their implications for society."

In 2017 the USGCR released a report stating with medium-to-very-high confidence that the United States has been experiencing rapid warming since 1979, with recent decades being the warmest in the last 1,500 years. The report predicts that this trend will continue late into this century, with an increase of 2.5 degrees Fahrenheit expected by 2050 and much larger increases expected by 2100. As a result, in the coming decades heatwaves are expected to become more frequent and intense.

One of the many consequences of this trend will be an increased demand for energy. And yet, as a result of our aging infrastructure, states are finding themselves with fewer traditional energy resources. New York, for instance, continues its decommissioning of Indian Point Nuclear Power Plant, just north of New York City, with full closure expected in 2021. This raises the question: how does New York State intend to replace the energy the plant created so they can meet increasing power demands?

As it turns out, they don't — not entirely. New York has determined that its best option is not finding alternative sources of power, but following states like Massachusetts and Rhode Island in enacting programs to reduce energy use. New York isn't alone in applying this calculus to energy policy, and the cumulative effect such decisions have on the built environment is significant.

The combination of rising temperatures and decreasing sources of energy have prompted increased focus on the efficiency and resilience of the built environment. Buildings consume 40 percent of our energy and 70 percent of our electricity while emitting one-third of the United States' greenhouse gasses, according to the Alliance to Save Energy.

Efficiency continues to be captured and mandated by local building codes and legislation, like New York City's Climate Mobilization Act, a recently enacted suite of laws intended to make the city carbon-neutral by 2050. But resilience, arguably as important and a necessary partner of efficiency, is often harder to quantify. What is resilience, and how does it help address issues like global warming

Cool roofing can save 10 to 15 percent on electricity costs by reducing air conditioning costs during peak demand when electricity is most expensive.

HOFFMAN ARCHITECTS

and energy resource depletion? We can explore the subject by looking at the resilience of cool roofing.

What is resilience?

In general, resilience is the ability to resist or recover from difficulties. When we consider resilience in the built environment, we're really talking about two things. "Asset resilience" refers to a building's robustness, or, in this particular context, how well its design and construction can reduce operational costs, wear and tear due to thermal cycling, and impact on that asset's surroundings. "Community resilience" is the corresponding ability of the local infrastructure and environment, such as power plants and the energy-supply grid, to resist stresses imposed by the collective assets. Community resilience can significantly reduce disruptions in the energy supply chain, curtail greenhouse gas emissions, slow climate change, and limit demands on available resources.

HOFFMAN ARCHITECTS

Cool roofs contribute to community resilience by helping mitigate the urban heat island effect.

Asset and community resilience are often inversely proportional, with greater resilience of one reducing a corresponding burden on the other. For instance, a building that requires less energy to operate will reduce its impact on the local energy supply system, slightly reducing the level of resilience required by that system. When a large number of buildings are designed and constructed this way, the cumulative effect is a significant reduction in the demand on community infrastructure. The inclusion of cool roofing on a building can have such an impact on both asset and community resilience.

Resilience and roofing

Conventional low-sloped roofing assemblies can be a significant source of stress on the resilience of both the asset and the community. On warm days, such coverings absorb sunlight, holding that energy in the form of heat within the assembly, transferring it into the building and warming the surrounding air. Heat that is absorbed into the building results in increased energy consumption and deterioration of building components due to thermal fatigue. Insulation can slow this transfer but will not eliminate it. These roofs can be as much as 50 degrees Fahrenheit warmer than the outside air temperature, contributing to urban heat island effect and taxing community resources.

By contrast, a cool roof is one that resists the absorption of energy by reflecting much of the sun's radiation and efficiently emitting thermal radiation through the use of coatings or materials that combine reflectivity and infrared emittance (both measured on a scale of 0 to 1 and called the roof's "radiative properties"). A cool roof can reflect 80 percent of solar radiation without warming the atmosphere, leaving a roof that might be only 5 to 10 degrees Fahrenheit warmer than the surrounding air. Such roofs can lower energy costs 10 to 15 percent by reducing the need to air condition a building using electricity during peak demand times, when such costs are 30 to 70 percent higher.

The result is not just an increase in the resilience of the building, but of the surrounding community, by decreasing demand on available resources and infrastructure. The widespread use of cool roofs can also have a cumulative effect on the temperature of the planet.

The application of resilience measures may come with unanticipated consequences, however. Maintaining cool roof performance, for instance, requires maintenance because the radiative properties can diminish over time due to the accumulation of soil and discoloration of the roof's surface. Concerns have also been raised about the use of cool roofs in colder climates. Because the roof will not transfer as much thermal energy into the building, the location of the dew point (the temperature at which water in the air will change from vapor to liquid) on the interior may change, particularly in the winter, when the humidity differential between interior and exterior is often higher due to mechanical heating, resulting in condensation.

The efficacy of cool roofs in colder locations has also been a topic of discussion because these are "heating climates." The term means exactly what you'd think it might: in a heating climate, there are more annual "heating degree days" than "cooling degree days." While building codes have very specific definitions for these conditions, simply stated, a heating climate is one in which we spend more days heating our building than cooling it. If we spend most of our time heating a building, why would we want to reduce the heat we gain from the sun? The answer lies in the types of energy we use and the amount of heat we get from the sun during the winter.

Electricity is the most common form of energy used to cool a building, while heating is often achieved by alternative sources, such as natural gas. Because natural gas is less expensive than electricity (particularly during peak demand times), on average it costs less to heat a building than to cool it. In addition, the amount of energy we get from the sun in the winter is much less than that in the summer, due to factors like shorter days, sun angle, cloud cover, and snow accumulation. Ultimately, the deleterious effect that a cool roof has on the performance of a building in colder climates is negligible, and the general consensus is that the use of these assemblies is beneficial regardless of location.

Measuring cool roof resilience

While helping to mitigate climate change and preserve our available resources are admirable goals, many building owners and operators are understandably interested in the extent to which resilience measures will also lower operating costs. There is substantial data to support the assertion that cool roofs lower utility costs by decreasing electricity usage during peak demand periods. Recognizing the benefits of cool roofs in cutting electricity costs and easing the burden on energy infrastructure, many governing authorities are offering incentives to building owners for the installation of cool roofs on their facilities. The federal government has developed online tools, such as Oak Ridge National Laboratories' "Cool Roof Calculator," which "estimates cooling and heating savings for flat roofs with non-black surfaces" for specific locations within the United States.

> Ultimately, the deleterious effect that a cool roof has on the performance of a building in colder climates is negligible, and the general consensus is that the use of these assemblies is beneficial regardless of location.

Building owners may obtain more specific data regarding operating savings that may be realized by the installation of a cool roof (or a series of similar resilience measures) through a site-specific comparison of current utility costs and the efficiency anticipated from the subject improvements. This is generally accomplished through the collaborative effort of a mechanical engineer and a building enclosure consultant.

It should also be noted that the use of cool roof assemblies can extend the service life of building components by reducing thermal fatigue, further lowering life-cycle costs and preserving embodied energy.

Sensible resilience

The world is changing before our eyes. Climate change is real, our infrastructure is aging, available energy supplies are in ever-increasing demand. How we address these challenges will affect how we live into the next century. Our ability to respond to adversity lies in our resilience.

On both new and existing structures, simple measures like the installation of a cool roof can improve asset resilience by reducing energy usage and operating costs, extending the life-cycle of building components, and preserving the embodied energy of the built environment. The financial benefits of installing a cool roof on a facility are measurable, but the aggregate impact on community resilience – the reduction of greenhouse gas emissions, the mitigation of urban heat island effect, the lessening of the flow of materials into the waste stream, and the preservation of our existing infrastructure — is no less of a consideration.

Given the challenges, even small changes seem essential. Particularly when things are heating up. ■

Craig A. Hargrove, AIA, LEED AP (c.hargrove@hoffarch.com) is senior vice president and director, architecture with Hoffmann Architects, an architecture and engineering firm specializing in the rehabilitation of building exteriors. As manager of the firm's New York office, he oversees demanding building envelope projects, leading project teams in developing cost-effective solutions for roofs, facades, windows, and plazas that meet energy performance and resiliency goals.

Email comments to naomi.millan@tradepress.com.

building OPERATING management

ADVERTISING SALES

Laurie Vega
Facilities Group Publisher
(414) 228-7701, ext. 482
laurie.vega@tradepress.com

Tracey Joyce
Regional Sales Manager
(414) 228-7701 ext. 304
tracey.joyce@tradepress.com

Brian J. Terry
Publisher
(414) 228-7701, ext. 529
brian.terry@tradepress.com

Kimberly Reed
Customer & Data Service Specialist
(414) 228-7701, ext. 441
kimberly.reed@tradepress.com

Steve Shepherd
Regional Sales Manager
(414) 228-7701 ext. 426
steve.shepherd@tradepress.com

CORPORATE OFFICE

Trade Press Media Group, Inc.
2100 West Florist Avenue
Milwaukee, WI 53209-3799
414/228-7701 • FAX 414/228-1134

Find more content from *Building Operating Management*
facilitiesnet.com