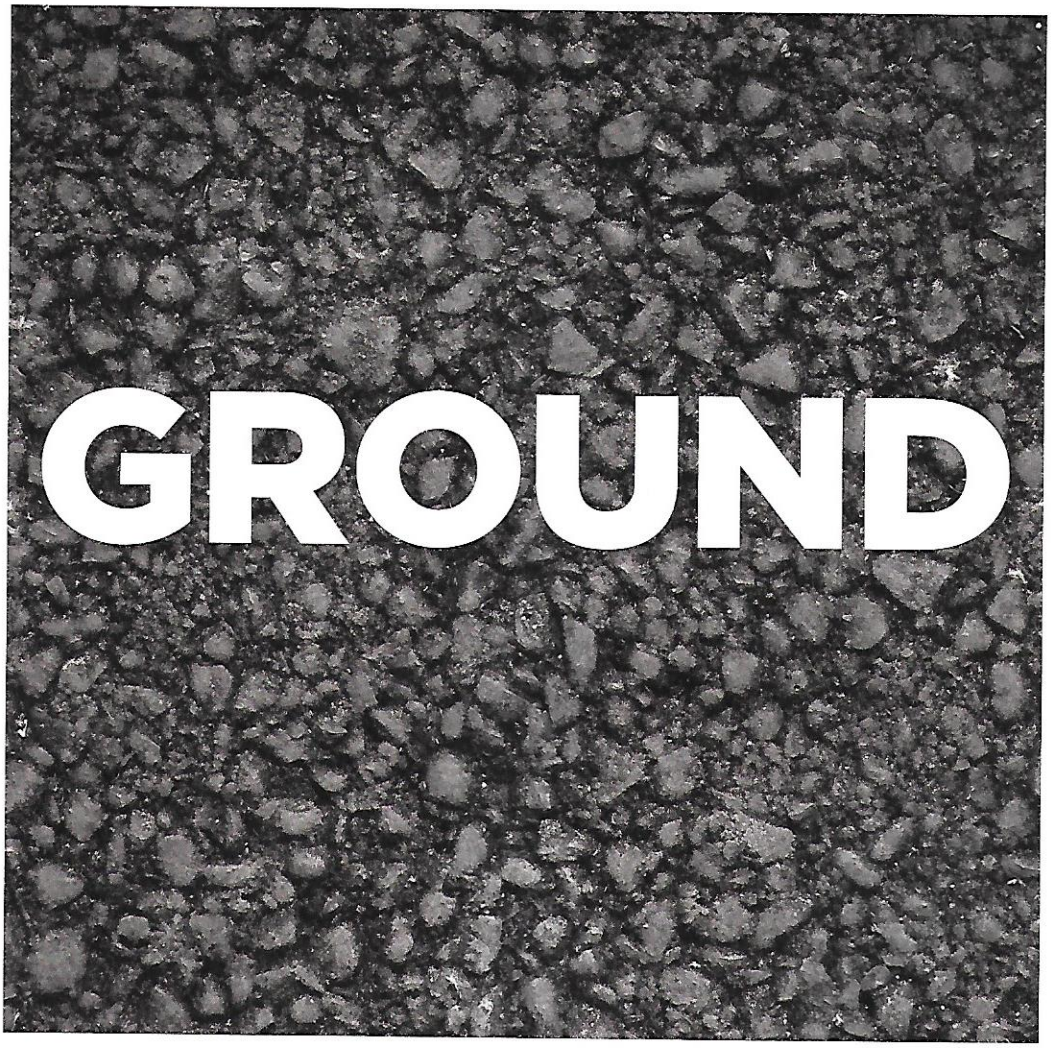

AS COOL ROOFS SPREAD TO CUT URBAN HEAT, THE ASPHALT INDUSTRY IS FIGHTING HARD TO STOP COOL PAVEMENTS.

BY ARTHUR ALLEN

At the Greenbuild conference in Philadelphia in November, the National Asphalt Pavement Association booth featured a provocative report, packaged as a little booklet by three engineers at Arizona State University. The report concluded that, contrary to what federal scientists and green building promoters have been saying, light-colored roofs and pavements were not necessarily superior to dark-colored ones, environmentally speaking, and might even do more harm than good.

The report, titled *Unintended Consequences: A Research Synthesis Examining the Use of Reflecting Pavements to Mitigate the Urban Heat Island Effect,* stated that "cool" surfaces would not necessarily reduce the urban heat island effect or global warming. Furthermore, it said, light-colored pavements could heat neighboring buildings in the summer and cool them during the winter, while causing snow and ice buildup and even reducing rainfall.

To say this asphalt-industry-funded paper was an objective examination of the costs and benefits of cool surfaces would be stretching the truth, but the authors defend it. "Our purpose was to say that the emphasis on high-albedo [highly reflective] pavements is overstated," says the paper's lead author, the sustainability scientist Kamil Kaloush. "The work we've been doing shows this is a complex problem. We think these issues should be looked at now, instead of 10 years down the road when the damage is done."

The logic behind encouraging the use of lighter-colored surfaces is ostensibly a simple matter of physics, one that anyone who wears black in the summer would recognize: Darker colors absorb more heat. Cities have many dark-paved roofs and roads, so replacing them with lighter ones should help lower urban temperatures, reduce air-conditioning, and diminish smog—apparently a no-brainer for a warming planet and its hot cities.

But the companies that sell billions of dollars' worth of dark roofing and asphalt would like you to believe otherwise. They've launched a concerted campaign to slow down the movement for cooler roofs and pavements, which includes casting doubt on federally funded research, calling for investigations of green building arbiters, and accusing scientists of biased "greenwashing."

The asphalt industry would obviously like to see increased use of asphalt concrete, which is pitch—a petroleum by-product—mixed with gravel, sand, or other particles. As the design and construction industry embraces green building codes, there are bound to be winners and losers. The asphalt group is feeling like a loser. "We're seeing an increase in legislation requiring green building codes," says Howard Marks, the vice president of environment, health, and safety at the asphalt association. Many of these codes pull their criteria right from the Leadership in Energy and Environmental Design regime, or LEED, developed by the U.S. Green Building Council (USGBC). "It's putting our material at a disadvantage, and the scientific evidence isn't there to back it up," Marks says.

ASPHALT COMPANIES ARE TRYING TO DISCREDIT COOL-ROOF RESEARCHERS AND THEIR FINDINGS.

Unhappy with the science, published by the U.S. Department of Energy's Lawrence Berkeley National Laboratory and others, that has been used to defend the LEED criteria, the pavement industry decided to purchase some of its own. Last year it put out a bid for a $50,000 survey, says Jan Kleissl, a University of California, San Diego, engineer whose research caught the asphalt industry's eye because it indicated cool pavements could heat neighboring buildings in some circumstances.

Kleissl took a pass, but the project was awarded to Kaloush's group at Arizona State, which in October released *Unintended Consequences*. The authors called it a "white paper," which historically means an official report assembled by a disinterested panel. But this one seems to fit comfortably into a more recent definition of white paper, per Wikipedia: "content put out to promote the products or services of a single company."

The paper's motivation is not hard to recognize. Since 2000, the USGBC and, later, the Sustainable Sites Initiative (a joint project of the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at the University of Texas at Austin, and the United States Botanic Garden) have included "cool" surfaces in their rating systems that encourage ecological stewardship in development. Some states and cities, including California; Washington, D.C.; New York City; Philadelphia; and Chicago, have included coolness requirements in guidelines for new roofs. Cool pavements are discussed in these sorts of guidelines, but as of now, few localities require them.

Cool roofs have been around for a couple of decades, and the industry is growing at a rate of 6 percent a year, compared to 2 to 3 percent for black roofs, according to the Single Ply Roofing Industry, a trade group. But pavements are still in play, and the asphalt and concrete industries are fighting hard for market share.

The concrete industry has funded work at the Massachusetts Institute of Technology indicating that vehicles get better fuel efficiency on concrete. The asphalt industry is fighting back—which it must do, because pavement is the main use for its

ABOVE
At the Lawrence Berkeley National Laboratory's cool pavement showcase in Berkeley, California, research associate Jordan Woods measures solar reflection levels with an albedometer.

product. Considering that highways cost roughly $1 million a mile to construct, the incentive is clear. "When California was developing standards for cool pavements, the whole room was filled with about 80 people from the asphalt industry," says Hashem Akbari, a professor of engineering and building at Concordia University in Montreal. The army of industry reps who turned out for a 10-minute discussion showed how determined they were to defend their turf, Akbari says.

Several scientists and engineers interviewed for this story said the Arizona State study cherry-picked evidence to support its point. The Global Cool Cities Alliance on January 27 went so far as to write a letter to Gary Dirks, who directs Kaloush's institute at Arizona State, saying the university should recall the paper from its website. It contains nearly 60 mistakes or misleading statements, wrote Kurt Shickman, executive director of the alliance in Washington, D.C.

"*Unintended Consequences* is a biased, misleading, and error-riddled industry white paper written for and with funding from the National Asphalt Paving Association in order to discredit the energy, climate, and health benefits of reflective roofs and pavements," Shickman wrote. "Given the raft of inaccuracies" in the study, he added, it harmed the university's reputation as a center of solar power research. "We would strongly recommend that [the university] retract *Unintended Consequences* or submit the paper for peer review in order to protect your institutional reputation."

That said, the paper, which examined both cool roofs and pavements, did raise some potentially serious concerns. It states that white roofs are at risk for developing damaging condensation, that highly reflective surfaces increase human exposure to ultraviolet rays, and that cool pavements can heat neighboring buildings. It also raises questions about the role of reflective surfaces in global warming.

The survey's claims about condensation come largely from a study, cosponsored by the Single Ply Roofing Industry and the Oak Ridge National

Laboratory, that found minor condensation in three of 10 field-tested cool roofs. Samir Ibrahim, the director of design services at Carlisle SynTec in Carlisle, Pennsylvania, which makes both black and white roofing materials, claims his company's white roofs sometimes leak because of condensation. However, other experts said both black and white roofs can have the problem. "You do have to install these roofs right," Shickman says.

The Arizona State survey said cool pavements could create glare and discomfort and could increase the heat of neighboring walls and buildings, potentially driving up air-conditioning costs during the summer. It suggested that green building certificates for cool pavements were premature.

THE ASPHALT INDUSTRY'S ATTACKS CONTAIN "A RAFT OF INACCURACIES," SAYS AN ADVOCATE FOR COOLER ROOFS AND PAVEMENTS.

The Sustainable Sites Initiative gives credits to projects that provide shaded pavements, highly reflective surfaces, or open grid pavement, says Meg Calkins, a professor of landscape architecture at Ball State University in Muncie, Indiana, and the author of *Materials for Sustainable Sites* (Wiley, 2008).

Calkins acknowledges that glare can be a problem but says there are plenty of cool pavement solutions. "Walking through a park in Sacramento on pavements made with white Portland cement can make you uncomfortable. It's too much glare," she says. "But gray Portland doesn't cause that much, and it meets our standards." So do lighter shades of red brick, as well as porous asphalt, which cools while allowing stormwater to enter the ground. Asphalt can also be "cooled" by techniques such as chip seal surfaces and shot blasting, which removes the binder from the surface of an asphalt pavement.

The asphalt industry has argued that asphalt melts snow faster than does cooler pavement and is thus preferable in cold climates. But that may not be a big enough factor to outweigh the summer cooling effects of lighter pavements, in most U.S. cities, at least. Radiant heating can be used to clear sidewalks in particularly snowy areas, Calkins points out—at Ball State, heated sidewalks allow the campus to forgo the use of chemicals to melt snow.

"You want to make sure reflective pavements are designed properly," says the scientist Ronnen Levinson, head of the Heat Island Group at Lawrence Berkeley National Laboratory, which is the country's research leader on cool surfaces. In Phoenix, the laboratory has worked with a local initiative to create a cool green asphalt coating that has been tested on playgrounds, parking lots, and roads. "If you want to use a highly reflective pavement near a building, you should make sure the neighboring building has a high-albedo wall," Levinson says. "But it doesn't have to look like the space shuttle."

About 90 percent of all paved surfaces in the United States are currently asphalt; about 30 percent of urban pavement is asphalt. Adding reflectivity in densely packed urban areas might not be a good idea, depending on the microclimate. But the idea that cool pavements will hike heating bills to neighboring buildings is misguided, Akbari of Concordia University says.

Less than 5 percent of urban areas consist of multistory buildings, so there isn't much surface area for pavement reflections to bounce off. "If you're in an area that has few vertical surfaces,

there's extremely little downside to using reflective pavement," Levinson says. Walls next to reflective pavements can be painted with reflective colors as well, he says, and reflected light can sometimes lower energy costs in neighboring buildings by increasing ambient lighting inside them.

Of course, "coolness" is not the only basis for deciding between asphalt and concrete. Asphalt streets are easier to dig up to put in new phone and electrical lines, whereas concrete works better for highways, bus stops, and airport runways. But as anyone who has driven in Texas in the summer can tell you, asphalt may not be the best solution for southern parking lots.

Some of the best field evidence for cool surfaces is found in the southern Spanish province of Almería, where thousands of acres of greenhouses are painted white to keep them from overheating. The sunlight reflected into space from this sea of greenhouses is so vast that it has cooled the temperature of Almería province by one degree Celsius since 1983, while the rest of Spain has grown significantly hotter.

However, the evidence for cool surfaces' effect on global—as opposed to regional—warming is murkier. The Stanford University engineers Mark Jacobson and John Ten Hoeve found in 2011 that reducing the urban heat island effect through cool roofs and pavements would have negligible effect on global warming. However, their study did not include energy cost reductions resulting from cool surfaces, and to the extent that cooler buildings reduce the need for carbon-fueled air-conditioning, they could slow warming.

Some computer models, however, suggest that cool roofs and pavements could stabilize weather over a city, resulting in less cloud formation, which would mean more solar radiation. So while the city and its buildings are cooler, the surrounding area could be warmer and get less rain. Other research has shown a more positive effect for cool surfaces, but the jury is still out.

At the same time, certain materials used in cool pavements—like Portland cement—can require a lot of carbon dioxide emissions to produce. There are ways to reduce the carbon footprint of concrete by using more fly ash, slag, and good mixing designs. By the same token, reclaimed pavement and recycled shingles can replace asphalt and thus reduce the need for new oil supplies.

The USGBC's standards are now applied by 14 federal agencies, 30 states, and 400 localities in the United States. But reflective pavement may not be appropriate in every climate zone, as Theresa Backhus, ASLA, a technical specialist at the USGBC, acknowledges. "In some northern areas, they need surfaces to absorb the heat. We're talking about developing a credit that's tailored more to a cold climate," she says.

Meanwhile, the asphalt pavement association continues to press for results that it likes. Marks, a vice president at the association, says Congress is looking into the relationship between the USGBC and Lawrence Berkeley National Laboratory. (Levinson and Backhus were unaware of any such probes.) Under pressure from the asphalt association, the Federal Highway Administration withdrew reflectivity standards from its sustainable highway program.

"Industries are very sensitive to any rule change that gives one an advantage over another," says another scientist who has been involved in the discussions. He asked not to be named, saying, "I really don't want to attract any heat." ●

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