The Writing's on the Wall: Recent Cool Wall Research and Measures

Webcast Questions and Answers

February 22, 2018

Questions Answered During the Webcast:

Can you explain how the reduction in canyon temperatures is greater with cool walls than cool roofs when the graph showed greater effects with roofs? Is it due to greater area of walls? If so, won't that vary significantly, depending on average building height?

George Ban-Weiss (University of Southern California): First off, there may have been a misinterpretation. If you look at the daily average temperature reductions for cool walls versus cool roofs, it was actually cool roofs that led to somewhat larger reductions, although they are – they are quite similar. The fact that walls were similar to roofs has to do with the fact that if we're talking about canyon air temperature reductions, the wall itself is actually in the canyon. You get more direct temperature reductions from walls than you do for roofs.

The roofs are, of course, at the top of the canyon. You can have a cool roof that reduces the temperature of the air above the roof. Then, that cooling effect needs to be mixed down into the canyons. So, that is part of the answer. The other part has to do with what was stated in the question, the fact that wall area is larger than roof area.

And would it depend on the height of the building? Yes, it definitely would. One thing that is mentioned in the write-up quite extensively on this project is that, you can't really do a one-size-fits-all study. It's the comparison of cool walls and cool roofs and – not only the comparison – the absolute temperature reductions that you would expect from cool walls or cool roofs depends on the city under investigation, the morphology of the urban area, the building heights, the street widths and then, also, just the overall baseline climate. It wouldn't be fair to extrapolate the results shown here to other cities necessarily. I think you'd need to investigate other cities separately for that comparison.

Why is the temperature outdoor going down when the amount of radiated heat increases? Doesn't more reflectance from walls just get absorbed by the surrounding environment – other buildings, pavement et cetera – and add to the urban heat?

George Ban-Weiss: Those are related questions. To answer the first one, what we are looking at is that slide that said that the amount of radiation leaving the canyon for cool walls is about 40 percent that of roof. We are looking at sunlight that is reflected off of walls or roofs. When it's reflected from walls or roofs – let's use roof as the simpler example. When sunlight is reflected by the roof, then it stays as what we call a shortwave radiation. It stays as basically sunlight and the majority of that reflected sunlight actually makes it back to space out of the atmosphere entirely.

If you are talking about walls, then, yes, a fraction of the sunlight that gets reflected by walls does get absorbed within the canopy by pavements and by other walls. We did account for that in our calculations, but it's not all of the reflected solar radiation. That's roughly half of it. If you think about sunlight that's incoming to a wall, you get about half of the reflected sunlight that gets absorbed by other surfaces in the canopy and then about half that makes it out of the canopy and back to space.

I think what the first question was missing is that we're not talking about thermal radiation here. We're not talking about increasing the amount of thermal radiation that's being emitted by surfaces. We're talking about sunlight that's being reflected from surfaces, not thermal radiation that's being emitted from surfaces.

Hopefully, that answers both questions. That figure was sunlight being reflected, not thermal radiation. Yes, a portion of it does get absorbed – a portion of the radiation reflected by walls does get absorbed by other surfaces in the canopy, but it's only about half of it. The net effect is that you still get a cooling in the canopy even with that addition of sunlight being absorbed by pavements and walls, because the net is that you're actually increasing reflected radiation. That absorption of sunlight by other surfaces can somewhat attenuate the effects, but it doesn't reverse it.

Do you see any one metric being used to set requirements for codes?

Haley Gilbert (Lawrence Berkeley National Laboratory): When we talk about metrics for walls and codes, we highly suggest using solar reflectance as a metric to define what would be the wall requirement. I think that's getting at the root of that question. In ASHRAE 90.1, we have a different metric, but we are working with them to change that metric to solar reflectance and thermal emittance. Those are the surface properties of the product, and those two properties would help to define its coolness. Those are the two measures that we would be looking to include when it comes to building codes and standards, incentive programs, as well as anything that needs to specify a cool wall product.

How can people get involved in the code-making process?

Haley Gilbert: In the code-making process or getting cool walls into codes? I'll take both. If they would like to be engaged with us as we pursue to increase adoption of cool walls in codes, they can reach out me, Haley Gilbert. My email is on that first slide, that's hegilbert@lbl.gov. If you have interest in cool walls and want to learn more, please reach out to me as well. Getting involved in building codes, Howard probably has some better insight into that one.

Howard Wiig (State of Hawaii): I did outline that in a couple of my slides. I deal with the International Energy Conservation Code (IECC) because that's our code of choice. As mentioned, there also is ASHRAE and, then, there are a number of beyond codes out there also, and you can get involved in those. If you email me, I can detail them for you.

As I said, just sticking to IECC, you need to register with the International Code Council (ICC) as a lobbyist and then get to the hearings and then go through the selection process that I outlined. You get to know the efficiency advocates, speak individually with them, ask their support for cool wall proposals, do some favors for those who are supporting you, and ideally talk to people on the "other side," the builders, construction people, suppliers and so forth.

When we are talking about cool walls, are we talking about just paint to make a cool wall or paint plus insulation?

Ronnen Levinson (Lawrence Berkeley National Laboratory): Cool walls in this case just refers to the ability of the wall to reflect sunlight. We are not proposing increasing insulation or making other structural changes to walls, just modifying the nature of its surface.

How does glazing impact the results and benefits of cool walls? You mentioned that other buildings absorb reflected light. Do the models include the effect that would increase the heat gain for those buildings?

Ronnen Levinson: We have, in fact, done some building-to-building interactive modeling. It seems like the crosstalk between buildings is pretty modest. The reason is that if a building is close to its neighbor, that wall in the central building that's in the sun tends to be shaded by that neighbor. If the neighbor is far away, then only a small fraction of the sunlight that is reflected from the wall of the central building reaches the opposing wall of the neighboring building. It's pretty modest.

One of the thing I would point out that is if making the wall of the central building more reflective increases the amount of sunlight that strikes the opposing wall of the neighboring building, that's actually probably a pretty good thing because to the extent that you are increasing usable daylight that enters the neighboring building, you get to turn off artificial lights. That turns out to be a big win for energy savings.

You showed the pictures of temperature variation over the exterior surfaces of buildings. Are there data on the temperature changes inside the building?

Howard Wiig: Not from my standpoint. Our previous speakers are specializing in that. I just did the very informal test at the Laie Elementary School, which resulted in a five-degree drop even though the temperature was measured later in the day. There's plenty of data on the effect – interaction – between exterior temperature and interior. That is subject to a whole lot of variables, mainly how well insulated the interior wall is. Other people are better disposed to answer that.

With fully glass fenestration, walls become more and more popular for urban center construction. What effect does this construction method contribute or reduce to urban heat island effects versus the use of cool walls?

Ronnen Levinson: The first thing I would point out is that all of the analysis that we presented today is taking into account the fact that there are windows in buildings. When we showed certain energy savings, those were energy savings per unit area of wall that you modified or, in the case of the two-story home that I showed, we included the windows as part of that analysis.

If you are interested in mitigating the urban heat island effect and your building's façade is dominated by windows, there is an interesting technology that one of our project partners has, which is a certain type of solar control film for windows that specifically is designed to reflect the invisible near-infrared component of sunlight that strikes the window up and out of the city. If somebody has a glass-faced building, they might want to look into that sort of technology. I could provide some contact information if somebody emails me after the presentation.

Since the results of the cool wall study vary based on the building landscape, how can this be translated to codes?

Haley Gilbert: That's a good question. It's one that we are working with individual code entities on. It depends on the code itself - you have specifics that vary depending on building type, residential versus non-residential, and we also include things like climate zone. You will find that certain measures are in certain climate zones. They are appropriate for certain building types. As well, you put in language that can offer paths to compliance.

With cool walls, you often see measures that call for either shading – and that's provided by an awning or a tree or some sort of shading on a wall – or a cool wall. You often find there are different paths to compliance with the same idea of reducing the solar heat gain into the building. That's probably the approach that we'll take with many of these codes at first. It's this kind of more open, prescriptive compliance options. Depending on if we're working in California or on the national code, we will work with that entity to best tweak and alter the language so it fits the context as needed. No one size fits all, I would say.

Are learning credits or continuing education credits for today's webcast?

Alexis St. Juliana (Abt Associates): Unfortunately, the Heat Islands Program is not affiliated with any organization to offer those types of continuing education credits. If you do need record that you participated, we can provide that. Contact Victoria Ludwig.

Questions Not Answered During the Webcast:

Please send me the language for codes and standards. I want to look at it for inclusion in National Green Building Standard.

Howard Wiig: Hawaii's amendments to the 2015 IECC are available online: https://ags.hawaii.gov/wp-content/uploads/2012/09/StateEnergyConservationCode-20170331.pdf

What about glass walls?

Ronnen Levinson: We didn't study glass walls as part of this project. Those interested in improving the energy efficiency of glazing may wish to visit the website of Lawrence Berkeley National Laboratory 's Windows and Daylighting Group (https://windows.lbl.gov).

Howard Wiig: Architecture goes through "the latest fashion" just as predictably as women's clothing after The Paris Fashion Show. Today's fashion is all-glass. They're sprouting up like mushrooms here in Honolulu – looks like 100% glass façade.

What is the effect of a large tree?

Ronnen Levinson: Lawrence Berkeley National Laboratory has not quantified the effect of tree shading, but it could diminish both the annual cooling energy savings and the annual heating energy penalty of a cool wall by blocking the beam (direct) component of sunlight. If you're curious, you could draw a tree next to a building in SketchUp and look at its shadow by hour. See https://help.sketchup.com/pl/article/3000148.

As a paint manufacturer that deals with this already, how can I best get involved with helping this project going forward and also help with writing codes if possible?

Haley Gilbert: Please send an email to Haley Gilbert, HEGilbert@lbl.gov, to get involved in our Cool Wall Stakeholder Working Group. We are working to advance all the efforts described in the presentation.

In Zone 3C is there a 'heating penalty' that offsets the cool wall benefit? How much?

Ronnen Levinson: Yes, in most climates there is both cooling savings and a heating penalty. The heating, ventilation, and air conditioning (HVAC) annual energy cost savings shown in the presentation include changes (warm wall – cool wall) to HVAC energy costs over the course of the year.

Do cool walls need to have cool pavements/vegetation for max effect?

Ronnen Levinson: The presence or absence of cool pavement and/or vegetation should have little effect on the extent to which raising wall albedo influences building energy use by reducing solar heat gain. Strictly speaking, cool pavement or vegetation can alter the fluxes of sunlight and thermal radiation incident on a wall. However, these are small effects, and an increase in incident sunlight may be accompanied by a reduction in incident thermal radiation.

What is the effect of wall construction- Polyvinyl chloride (PVC) siding, stucco, brick, wood?

Ronnen Levinson: Plastic siding (a cladding) and stucco (a coating) are wall *surface* layers, while brick and wood are wall *structural* layers that might also happen to be surface layers if not coated. The cool wall savings determined in our study arise from raising the solar reflectance, or "albedo", of the wall's surface. Differences in wall *structure*—e.g., wood vs. fiber cement vs. masonry—could affect cool wall savings by altering the envelope's thermal resistance or thermal mass. However, each category of building was modeled with prototypes supplied by the U.S. Department of Energy, and then modified to comply with building energy efficiency standards of a certain area. The structure, thermal resistance, and thermal mass of each wall is based on the characteristics of these prototypes.

Can someone characterize the potential benefit impacts from surface roughness for cool walls?

Ronnen Levinson: Surface roughness can lower albedo, which in turn would reduce cool wall savings.

Are there any intellectual property issues with implementing cool walls?

Ronnen Levinson: No, I can't see any issues—one can't patent the practice of using light-colored or other solar-reflective wall coatings to cool buildings, given that this has been done for a very long time in hot climates.

Also, in carrying out research on cool walls, can few buildings be selected for the purpose?

Ronnen Levinson: Lawrence Berkeley National Laboratory would like to conduct demonstration projects.

Why would sea air affect the cooling- shouldn't that be normalized out?

George Ban-Weiss: As air moves from west to east in the Los Angeles basin, the cooling effect from cool walls accumulates. This is why cooling effects can be stronger on the east side of the basin. This would generally be true in most locations. The downwind part of the city would be expected to have larger temperature decreases than the upwind part. Our goal was to quantify the climate effects of hypothetical city-scale cool wall deployment, so this effect needs to be included, not normalized out.

Is there a tool available per latitude and climate zone to account for square foot energy savings and greenhouse gas reduction?

Ronnen Levinson: Lawrence Berkeley National Laboratory has created the Cool Surface Savings Explorer, a tool that can report these savings by building type and location. We will make it public later this spring.

Apart from white color, which other color is recommended for a cool? Are there special paints manufactured for such purpose?

Ronnen Levinson: Many light colors, and some dark colors that incorporate special pigments, are cool. Lawrence Berkeley National Laboratory is working to develop a product rating system that will help consumers identify paints with high solar reflectance.

Have winter penalties been evaluated?

Ronnen Levinson: Yes. The HVAC annual energy cost savings shown in the presentation include changes (warm wall – cool wall) to HVAC energy costs over the course of the year.

Can you talk about the challenges of trying to require high albedo walls which would affect the design aesthetic?

Ronnen Levinson: Many buildings already have dull-white or off-white walls with albedo (solar reflectance) ≥ 0.60.