U.S. EPA Heat Island Reduction Program

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

Webcast Transcript

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Introduction

Slide 1-2: The Writing’s on the Wall: Recent Cool Wall Research and Measures

Operator: This is Conference #8178947.

Good afternoon. My name is Omar, and I will be your conference operator today. At this time, I would like to welcome everyone to “The Writing’s on the Wall – Recent Cool Wall Research and Measures” conference call.

All lines have been placed on mute to prevent any background noise. If you should need assistance during the call, press star, zero on your telephone keypad and an operator will come back to assist you. Thank you.

Mrs. Victoria Ludwig, you may begin your conference.

Victoria Ludwig: Thank you (Omar). Hello, everyone, and welcome to our webcast today. We are happy that you are here. We have an action-packed lineup of some great speakers. So, I encourage you to stay for the entire 90 minutes. We are going to talk about cool walls today.

Slide 3: Cool Walls Webcast Agenda

And the agenda for today is we have – we are presenting today the results of a great research project that was conducted by Lawrence Berkeley National Lab and other researchers funded by – funded by the California Energy Commission. They have done some groundbreaking research on the energy, greenhouse gas and temperature and other benefits of using cool walls. And, then, we also have a case study of Hawaii’s incentivizing methods to encourage adoption of cool walls actually there in the state.

We are going to have a question-and-answer at the end. You can submit questions throughout, however, just using the chat box. We will explain how that works in just a second. And – but, you can submit them throughout. At the very end, we will actually conduct the question-and-answer session.

So, now, I’d like to turn it over to Alexis St. Juliana, who will explain some logistics of how the webcast will operate today.

Slide 4: Webcasts now use Adobe Connect

Alexis St. Juliana: Thank you, Victoria. And thank you, everyone. I thank everyone for joining today. For those of you that have attended past Heat Island Webcasts, you might notice that we are using a new platform, Adobe Connect. I really hope that everyone is able to join today without problems. But, if you weren’t, we do have a few troubleshooting tips.

And the first is to test out a different Web browser. If you are using an Internet Explorer, you might try Firefox or Chrome. You may also need to download an updated version of Abode Flash Player or the Adobe Connect plugin. These two fixes usually resolve most connection problems. But, if you're still having trouble, you should contact your information technology (IT) department. And Adobe Connect also has some pretty extensive online help features.

In the future, all invitations and reminders will come from the Environmental Protection Agency (EPA) Call Center. So, we really ask you to add the epacallcenter@epa.gov address to your email safe senders list so that you get all these messages and reminders moving forward.

And one additional feature I will note about the Adobe Connect software is that the hyperlinks you see on your screen are active. So, if you click on the link, that should open a browser and take you to the correct page.

Slide 5: How to Participate

Many of you may have also noticed that there is a new listening option. You might be listening from your computer and your lines were on hold until the operator opens the call. And, obviously, to make this work, you will need to have your computer speakers or headphones turned on. Folks also have the option to call in to 855-210-5748. And if you're experiencing feedback problems, you might try to mute your computer speakers to avoid that feedback. And participants joining by either method are muted.

Slide 6: How to Participate

There are two main ways that we'll ask you to participate today. One is through the question-and-answer box that you see on the upper right-hand side. Please enter your questions throughout the webcast and let us know who those questions are for. And we will hold on to them until the very end and respond to those during the designated question-and-answer period. If we don't quite get to responding to all those questions, we will post responses on the Heat Island webpage after the fact.

The other way to participate is through the polling pod. And we'll let you know when the pod is active and you can participate. And one final way that you may participate – at the very end, we will have a feedback form. And, so, if you have any comments on the new software or thoughts about today's topics, that is another way to let us – let us know your thoughts.

Slide 7: Introduction

Victoria Ludwig: Great. Thank you. So, let's kick it off. I didn't introduce myself. I'm Victoria Ludwig with the U.S. Environmental Protection Agency.

Slide 8: EPA's Heat Island Reduction Program

I'm the manager of our Heat Island Reduction Program, which has been something that we've been working on for more than 20 years to help study and raise awareness and promote the idea of reducing heat islands because of all the benefits that it provides – public health benefits, climate change benefits as well as electricity savings and others.

We do this by providing outreach and technical assistance to state and local governments, to non-profit and others who are trying to develop policies and programs that will reduce the heat island effect and cool off our urban areas. We work with a breadth of audiences. You can see academia, other federal agencies, non-profit organizations and industry. So, it's a – these are all the key players in the heat island field who are important for advancing different measures to reduce the heat island effect.

Slide 9: Heat Island Program Resources

We have a great series of resources. I'll direct you to the first one, which is our flagship resource. It's a technical guidebook called the "Compendium of Strategies – Reducing Urban Heat Islands." We have some chapters on the basic science of heat islands, individual chapters on each of the main mitigation strategies that are in existence now – cool pavements, cool roofs, trees and vegetation and green roofs. We also include some examples of what's happening locally and, also, some different policy options available to local governments for advancing heat island mitigation measures.

We have a website. It has a lot of great information. But, I wanted to point out that we just updated a section of the website that talks about how to measure and characterize and map your urban heat island. So, it shows you how to design – explains how to design an approach for designing – for measuring and sort of understanding where your hot spots are and exactly how hot they are. So, I would encourage you to check that out as soon as you can.

We also have a database of about 75 local and statewide measures and initiatives that are happening right now. There is more going on. But, these are 75 that we know of. If you all on the line have any measures that you are doing initiatives, please let us know. Drop me a line and we'd love to add that to the database.

We have webcasts of which today is proof of that. We will probably do another webcast within the – before the summer. If you want to find out about those webcasts, please sign up for our newsletter. We have a link there. And we also have – we'll show you the link again. But, in addition to finding out about the webcast, you will also find out if you sign up when the – when the postings of these webcasts have been put on our website. And you will find recent news on research and policy and everything heat island basically. So, that's our program.

Slide 10: Contact Information

If you need to contact me, please do anytime. Here are some links for the website and, then, the newsletter signup, which I encourage you to do if you haven't already.

So, I think we can get started. I wanted to just remind you real quick that the presentations will be posted on our website in maybe two to three weeks. You can check our homepage for that or, as I said, sign up for our newsletter to be – to be made aware of that. And, again, please submit questions as they occur to you, if you can. Also, indicate which speaker you are directing your question to.

Building energy and greenhouse gas benefits

Slide 11: Building Energy and Greenhouse Gas Benefits

So, let's kick this off. Our first speaker will talk about some of the energy and greenhouse gas savings that can come from using cool walls. His name is Ronnen Levinson. Dr. Levinson is a staff scientist and leader of the Heat Island Group at Lawrence Berkeley National Laboratory in Berkeley, California. Within his research portfolio, he develops cool roof, wall and pavement materials; improves methods for the measurement of solar reflectants; and quantifies the energy and environmental benefits of cool surfaces. Dr. Levinson holds degrees in engineering physics and mechanical engineering, and he has authored or co-authored over 80 publications. So, he is going to talk about the great research that he did.

Ronnen, I am turning it over to you.

Ronnen Levinson: Thank you, Victoria. Good morning and good afternoon, everyone. As Victoria said, this first talk is going to be about energy and greenhouse gas benefits.

Slide 12: Building energy and greenhouse gas benefits of cool walls

I'd like to begin, however, by thanking our sponsor. This work was funded by the California Energy Commission through the Electric Program Investment Charge.

Slide 13: A "cool" wall reflects sunlight to reduce cooling load, save energy, and lower emissions

A cool wall is one that reflects sunlight to reduce the cooling load which, in turn, saves energy by lessening the need for air conditioning and reduces emissions of greenhouse gases from the building's energy use. Walls come in all colors. And you can see that from this photo of a newly-constructed apartment building that I walk past daily. A conventional wall might reflect a quarter of sunlight and off-white or a dull-white wall might reflect 60 percent of sunlight. And that's the transition and I'll be using in the examples that I discuss today.

Slide 14: We used EnergyPlus to model cool-wall heating, ventilation, and air conditioning (HVAC) energy savings

We modeled the heating, ventilation and air conditioning, or HVAC, energy savings that could be attained by upgrading to a cool wall from a conventional wall with the Building Simulation Tool EnergyPlus. And we considered 10 different building categories. This includes homes, whether single-family or multi-family; offices of different sizes; stores, standalone and in strip malls; and a couple of flavors of restaurants.

Slide 15: We evaluated annual energy, cost, and emission savings in each California and U.S. climate zone (> 100K simulations!)

Using EnergyPlus, we evaluated the annual energy use, energy cost and emission reductions that are attainable in each climate zone in California and across the United States. California is divided up into 16 climate zones, and we considered 15 climate zones around the country. And we have little maps here to show you what these zones are.

Slide 16: Cool walls save energy, carbon dioxide in homes, offices, and stores in all California climates + U.S. climates 1 - 4

What we found is that using cool walls will save energy and reduce carbon dioxide (CO_2) emissions in homes, in offices and in stores in all California climates and in U.S. climate zones one through four. And to give you an idea of the magnitude of these cool wall savings, we compared savings from cool walls, which are a new concept in modern energy efficiency standards, to cool roofs, which have been used widely over the last few decades. The circles show savings from cool walls and the triangles show savings from cool roofs so that you can compare them. And we also have colors showing different vintages of buildings, which I'll talk about in a moment.

But, if I look at the upper plot, which shows annual HVAC cost savings per unit area of surface that you are making cool, across the 16 climate zones in California, what I can see is that the results for the walls – those are the circles – are usually above the results for the roofs, which are in triangles. And that's an indication – simple one – that cool walls can be as or more effective than cool roofs. A wall receives less sunlight than a roof does. But, walls usually have perhaps half as much insulation as a roof. It's just harder to insulate a vertical cavity than it is to put insulation beneath the roofing material or in an attic.

Slide 15: We evaluated annual energy, cost, and emission savings in each California and U.S. climate zone (> 100K simulations!)

Across the United States, what we see is that in climates zones on through four, cools walls are delivering savings. And I am going to flip back to the map for a moment that I showed in the previous slide to give an idea of what it means to be talking about climate zones one through four. You can see that climate zone is at the very southern tip of the country. And as we move north, the numbers grow larger. Climate zones one through four are the – well, Miami plus what's shown in red, what's shown in brown and what's shown in yellow. And that's roughly the southern half of the United States.

Slide 17: Example: Single-family home in Houston, TX

Here is an example for a single-family home in Houston. And I chose Houston because it's neither the hottest nor the coolest place where one would expect to see cool wall savings based on the previous simulations. On the plot, I'm showing both the annual HVAC energy cost savings – that's heating, ventilation and air conditioning, so it's considering what happens across the entire year – and, also, the annual HVAC CO_2 savings.

If you have a single-family home in Houston, Texas and it's new construction, that is, it conforms with the 2012 energy efficiency standards, which are the latest in effect in Texas, then you would save about $50 a year. If you had an older that was built in the 1980s according to the standards in effect at that time, then you would save $75 a year. And if you had a home that was built before 1980, what we call the oldest vintage, you are saving $129 a year.

And that is a theme that we see throughout the simulations that were done across California and across the United States. Savings in these pre-1980 homes are typically over twice that in new homes. And that's because the older homes simply don't have as much insulation. And this is important because if you were to look at the median year of construction of residential or commercial buildings in California or across the United States, it's in the 1970s, which means that over half of the buildings in our country were built before 1980 before the advent of modern building energy efficiency standards.

Slide 18: Can scale savings by Solar Availability Factor (SAF) to adjust for shading & reflection by neighboring buildings

Now, I'm going to talk about a few questions that might have come to your mind as you heard about this. The first is, "Well, it's a wall that I'm making cool. Perhaps my wall is shaded, so my wall wasn't in full sun. How does that affect the savings that I would attain?"

You can scale the savings that I showed in the previous slides to what I call a solar availability factor. And the solar availability factor is the ratio of the sunlight that strikes a wall after you consider the effect of the neighboring buildings to the sunlight that would be incident on the wall if the building were isolated.

And here is an example. If I have a single-family home – that's the central building in red – and it has neighbors – it has a neighbor to the east across the street, it has a neighbor to the east across a pair of backyards, and it has neighbors to the north and south across narrow side yards – what I do is look at what is the ratio of the height of these buildings to the separation between them. And that yields what we call an aspect ratio. And I've drawn some aspect ratios down at the bottom of the slide in the lower left corner.

From this aspect ratio, which would be 0.2 for that building that's far to the east, one to the building that's closer to the west and two for building that are quite close to the north and south, I can then evaluate based on the location of the building – for example, this building here in Fresno, California – and the month of year the solar availability factor. So, my multipliers in this case are 0.9 for the east building, 0.6 for the west building and 0.5 for the north and south buildings.

Slide 19: Cool wall products with high solar reflectance (SR) are sold today

Another question that you might ask is, "Can I get a cool wall product today?" And the answer is yes. Here, I'm showing measurements that we have made on a variety of wall products that we are testing outdoors. And I will arbitrarily say that a lower-tier cool wall would be one that reflects at least 40 percent and less than 60 percent of sunlight and a higher-tier cool wall reflects in excess of 60 percent of sunlight. And you can see that there are products in perfectly acceptable colors that are sold today.

I'll also quickly mention that if you look at the group on the top, those are all made with conventional pigments, ordinary things that you would find sold in, say, paint store product. The ones in the bottom use spectrally-selected pigments, which are slightly more advanced technology but has been used for roofing materials commercially for decades and in certain applications since the 1950s.

Slide 20: Wall products are undergoing 2 year exposure in California, 5 year exposure at U.S. sites

A final question that you might ask is, “Since we know that roof products tend to get dirty and become less reflective over time, what happens to wall products?” Well, we’d like to know the answer to this question, too. So, we have been conducting campaigns of product exposure at three sites across California and at another three sites across the United States. And we have roughly 50 to 70 products that are being exposed in each of these campaigns for two years across California and for five years at the U.S. sites. The California campaign will conclude this spring and the U.S. campaign has about another three and a half years to go.

Slide 21: Solar reflectance losses modest (≤ 0.05) after 15 months in California, 12 months in U.S.

Here is what we’ve learned so far. If you take a wall product and you expose it vertically in Berkeley or in Los Angeles or in Fresno or you take similar products and you expose them vertically in Arizona, in Florida or Ohio, at most, after 15 months in California or 12 months in the United States, the reflectance has decreased by five points out of a maximum possible of a hundred points. And that’s a pretty modest loss. If we were talking about roofing products instead, over a similar time period, the reflectance loss might be 10 to 20 points.

Furthermore, the really high reflectance losses are observed only for materials that were bright white to begin with. For a dull white material whose initial solar reflectance might be around 60 percent, those losses are perhaps two to three points. And that means, in short, that wall products so far do not appear to get particularly dirty. So, if you installed a cool wall product that had a high solar reflectance to begin with, it’s likely to retain that high solar reflectance.

Slide 22: Thank you!

And that’s my introduction to you to cool walls and the energy saving and greenhouse gas reduction benefits.

Victoria Ludwig: Thank you, Ronnen. This is really exciting to see all this great research. I commend you. And I think it’s encouraging to realize that cool walls already do exist. And, hopefully, the research, I’m sure, will – and what Hawaii is doing will help to continue to advance these great technologies that provide a variety of benefits.

And, now, we’re going to hear from a researcher that has also been looking at different benefits. There are a myriad of benefits. The ones that apply to heat islands are the ones that George is going to talk about. So, let me introduce him.

Dr. George Ban-Weiss is an assistant professor in the Department of Civil and Environmental Engineering at the University of Southern California. His research group uses numerical models and field observations in concert to investigate local solutions for countering the impacts of climate change and reducing air pollutants. Prior to his current position, he was project scientist in the Heat Island Group and Climate Science Department at Lawrence Berkeley National Lab. Dr. Ban-Weiss received all three of his degrees from the University of California, Berkeley. And he was also, if I neglected to mention, part of this overall research project that we've been talking about today.

So, looking forward to hearing your presentation, George. You are on.

George Ban-Weiss: OK. Thank you very much. And I'm very happy to be part of this webcast. Are we doing the poll now or are we – are we moving on?

Victoria Ludwig: This is – yes. I guess we are. Sorry about that, folks. Sorry, George.

George Ban-Weiss: No problem.

Victoria Ludwig: Take another breather.

George Ban-Weiss: OK.

Poll question 1

Slide 23: Poll 1

Victoria Ludwig: We have a poll question, folks. This is the audience participation segment. So, we just want to get your thoughts on something. We wanted to know if you have thought about cool walls at all. What benefit that they provide appeals to you the most? I know it's maybe hard. But, please just choose one, if you can. And we'll give you about 30 seconds to answer.

I'll read the – some people have already gone for it. All right. But, the options are reduced urban temperatures, energy savings, lower greenhouse gas emissions, improved building occupant and pedestrian comfort or other. Which benefit appeals to you most? We'll give you just a few more seconds to answer and, then, we can talk about the results.

OK. I think we have given folks a good chance here. So, we're going to close the poll and let you know once I scroll down here that it looks like the most appealing benefit is the energy savings at 47 percent. The second highest is people are interested in the benefits of reduced urban temperate. It's at 20 – roughly 23 percent. And next up is the occupant and pedestrian comfort, which is actually something that – it's kind of a tie with greenhouse gases. And I know George is going to talk a little bit about pedestrian comfort. So, thanks, everyone, for your – for your thoughts. This helps us sort of to get some feedback of where you all are coming from.

So, George, apologies again. I hope – you can now go.

Urban climate and other co-benefits

Slide 24: Urban Climate and Other Co-benefits

Slide 25: Investigating the Influence of Cool Wall Adoption on Climate in the Los Angeles Basin

George Ban-Weiss: OK. Excellent. Let me try to advance the slide. OK. So, I'm going to talk today about our portion of this project, which was looking at the influence of cool wall adoption on the urban climate of the Los Angeles Basin. And I just want to make sure to acknowledge a few people – first, Jiachen Zhang, who is my Ph.D. student that did most of the heavy lifting on this work and a couple of other, my students, and, of course, important contributions by Ronnen Levinson also.

Slide 26: The urban heat island (UHI) effect describes cities being warmer than rural surroundings

So, everybody on this call knows what the urban heat island is. But, I thought I'd spend 10 seconds defining it just in case. So, the urban heat island is a phenomenon that describes where cities are warmer than their rural surroundings.

Slide 27: City dwellers are facing severe heat-related challenges

And it causes various heat-related challenges, including heat stroke and exhaustion, increases in summertime energy, air pollution issues and more.

Slide 28: Some strategies for reducing urban heat

And, so, cities are considering various options for reducing urban heat islands that include solar reflective cool roofs, cool pavements and vegetation at roof level and at street level.

Slide 29: Some strategies for reducing urban heat

And as has been mentioned already, solar reflective cool walls are a topic that has not been studied as extensively as the others. And I'm going to talk quite a bit about solar reflectance and albedo, which in this context I am using to mean the same thing. So, I'll quickly define it. The albedo we're defining here as the ratio of reflected to incident sunlight. So – and I'll – you know, the highest albedo attainable would be one. That would mean reflecting all incoming sunlight. And the lowest would be an albedo of zero, which means absorbing all incoming sunlight. So, they have not been yet systematically investigated. So, that's what we're doing in this work.

Slide 30: Research goals

So, our research goals were to look at and quantify the climate effect of hypothetical widespread cool wall adoption in the Los Angeles Basin, so basically trying to bound the maximum possible impact of cool walls assuming that all buildings adopt cool walls. So, we look at the increase – the increases in reflected sunlight out of the city of L.A. after adopting cool walls and, then, the consequent air temperature reductions in urban canyons after adopting cool walls. And, then, we thought this would be a nice opportunity to compare the climate effects of cool walls to cool roofs using a consistent modeling framework. And, so, that's part of this work, too. It's that comparison.

Slide 31: We use Weather Research & Forecasting (WRF)- Single Layer Urban Canopy Model (SLUCM) for our climate simulations

So, to do this, we used a modified version of a regional climate model that is called WRF, the Weather Research and Forecasting Model. And we made various modifications to the model to be able to investigate this problem more accurately, which I don't really have time to go into. And the model itself includes formulations to be able to account for the effects of urban canyons on radiation transfer – for example, the way that buildings shape the ground and the way that sunlight can get trapped in urban canyons. Urban canyons are basically the space between buildings – that U-shaped cavity between buildings.

Slide 32: Domain/configuration for WRF simulations

So, for this investigation, the modeling we did was focusing on southern California. You can see the figure on the left. The red square there is our highest-resolution nested domain for the modeling. So, it's simulated at two kilometers. And, then, as you telescope out to the larger areas, those are simulated at lower resolution. And, then, you can see in the middle figure and the right figure a couple of the data sets that we used to described the variations in land cover in the Los Angeles Basin essentially looking at how much of, you know, the fraction of surfaces in the urban area that are actually impervious surfaces as opposed to pervious vegetative surfaces and soil surfaces.

Slide 33: Deriving realistic urban morphology per urban land use type

One thing that was very important for this project to be able to accurately quantify the effects of cool walls was to get a realistic sense of the urban morphology – so, basically looking at building heights, wall areas, you know, the widths of urban canyons, meaning the space between buildings and things like that. And, so, to do so, we used a data set called the LARIAC, the Los Angeles Region Imagery Acquisition Consortium. And it's basically a highly-accurate three-dimensional building footprint data set that shows footprint and height for each building. And we also used another street centerline data set and we're able to characterize the morphology or the geometry of various buildings around the basin.

Slide 34: Simulated scenarios

So, we did a bunch of different scenarios. The first one is a control scenario where we assume low albedo for walls for roofs. And, then, the idea here is to look at basically the sensitivity of the climate of the L.A. Basin to increase in wall albedo. And, then, we can use those sensitivities to then scale our results to whatever wall albedo increase is of interest. We did simulations for cool roofs with equivalent albedo increases to be able to compare and contrast the climate impacts of those things.

The results that we're looking at are summer July of 2012. And, so, we're basically modeling the climate as it was for July of 2012 and then doing these perturbation scenarios where we see, OK, what if – what if July of 2012 was the same but it had – you know, all walls had an albedo of 0.5? And, then, in an extreme case, to completely bound the system, what if all walls had extremely high albedo of 0.9 et cetera?

Slide 35: Grid cell albedo increases from cool walls are largest in the early morning (and late afternoon) where urban fraction is highest

OK. So, this is now showing – think of it like a bird's eye view. If you're – if you're a bird and you're looking down – what the albedo of the urban areas looks like. This shows the albedo increase from cool wall adoption for two times of day, early in the morning, 6:00 a.m., and noon local standard time. And the basic point here is to show that walls are unique because they are vertical surfaces. And, so, you get larger albedo increases in the morning and in the evening. It has to do with the way that, you know, the sun is lower and the sun sees more wall in the morning than it does when the sun is overhead at noon. And, so, you can see the figure on the left for 6:00 a.m. has more, you know, red colors, which means a larger bird's eye view albedo increase in the morning and that evening, although that is not shown.

Slide 36: Grid cell albedo increases from cool walls are larger than from cool roofs in the early morning and late afternoon

This figure here shows the diurnal cycles – so, basically, the evolution of albedo increase throughout the day – for the two cool wall adoption scenarios that we looked at. And, then, it's comparing it to cool roof scenarios, which are the two green lines. And, so, you can see that because roofs are horizontal surfaces, the bird's eye view increase from cool roofs is constant throughout the day whereas for walls, it has this diurnal cycle where, again, you can see when you look at the blue lines that the albedo increase from the bird's eye view is higher in the morning and in the evening.

And you can see that for a – for a constant albedo increase – so, compare, for example, the solid blue line to the solid green line. Those are the – those are the same albedo increases for roofs and walls. And you can see that in the early morning and in the late afternoon, the blue line is higher than the green line. So, the bird's eye view albedo increase is larger for cool walls than for cool roofs. But, then, for most of the day, the albedo increase if – from the bird's eye view is larger for cool roofs than for cool walls.

Slide 37: The daytime cumulative increase in reflected solar radiation induced by cool walls is 43% of that induced by cool roofs

What really controls the climate impacts, though, is a few things that are listed here. One of them has to do with how much sunlight ends up being reflected out of the urban area. And for walls, it introduces a new complication because sunlight that's reflected from walls doesn't necessarily make it out of the urban canyon like it does for roofs. Right? With roofs that's a horizontal, almost all the sunlight that's reflected makes it out of the urban system. For walls, a portion – roughly half of the sunlight will get basically absorbed within the urban canopy itself.

So, to think through how cool walls can affect climate, we need to think about the fact that solar radiance on walls is about 40 percent of that on roofs for July in L.A. County. And that has to do with the fact that they are vertical rather than horizontal. But, on the other hand, there is actually more wall area than there is roof albedo or – sorry – than roof area. So, the net wall albedo – why do I keep saying albedo? The net wall area is about 60 percent larger than that for roof area. And, then, the third bullet here mentions the point that I made before, which is that solar radiation that's reflected by walls is partially absorbed by opposing walls and pavements.

And, so, if you think about the daily cumulative increase in sunlight that's reflected out of the urban area, cool walls don't have as high of a daily cumulative increase. So, you can see at the bottom there for the cool wall high scenario there is about 780 kilojoules per meter squared that makes it out of the urban area. And that's about 43 percent of that. That's for cool roofs. So, a portion of it gets trapped in the urban area.

Slide 38: Cool walls reduce canyon air temperatures throughout the LA basin

So, when you then look at the climate impacts of all this, this is showing the change in canyon air temperature, which is a – I'm not going to – I don't have time to go into it. But, it's a new diagnostic variable for this model to look at the air temperature within the canyon rather than at the sort of the top of the canyon. And what you can see here is temperature change that's cause by cool wall adoption at two times a day in the afternoon, which is roughly the hottest time of day, and then in the evening, which is when many – a lot of cities have their maximum urban heat island effect.

And, so, you can see here that you have temperature reductions that are up to roughly half a degree Kelvin or Celsius. And you see that as you move to the east side of the basin, you have more cooling. That has to do with the fact that you have the onshore sea breeze in the L.A. Basin. And, so, the climate impacts of cool walls are kind of accumulating as you move to the east and the winds are moving there from west to east.

Slide 39: Cool walls lead to less cooling than cool roofs for most daytime hours

This figure here now compares cool roofs to cool walls. And you can see – first look at the solid blue line. That's for the sort of maximum case of really high-albedo cool walls. You can see that there are two peaks in temperature reduction. The first is at 9:00 a.m. and the second is at 1800 hours or 6:00 p.m. And that shape of the diurnal cycle is somewhat complex. And I don't have time to go into it, but it has to do with the diurnal cycle and the amount of radiation that a wall sees because, remember, that is higher in the morning and evening than it is at noon. It also has to do with some atmospheric dynamics that I – that I won't get into right now.

And, then, if you compare that to the solid green line, that's the climate impact of adopting cool roofs with the same albedo increase. And, so, you can see in that case your peak temperature reduction is a bit larger than for cool walls and it comes a little bit later in the day.

Slide 40: Daily average temperature reduction per 0.10 facet albedo increase

This table summarizes daily average temperature reduction that you get per sub-facet albedo increase. And, so, the takeaway point is that for daily average temperature reductions, you get pretty similar results for cool walls and for cool roofs. So, as an example, look at the two lowest numbers. That's saying that for both – or – sorry. Look at the second row and the fourth row. So, that compares really the climate impacts of really high-albedo cool walls and really high-albedo cool roofs. And you can see per 0.1 albedo increase, the temperature reductions are relatively similar, 0.5 versus 0.59.

Slide 41: Conclusions – climate in LA county

So, in conclusion, we found that daytime cumulative increase in upwelling sunlight induced by cools walls is about 43 percent of that of cool roofs. Canyon air temperature reductions from cool walls are largest in the early morning and late afternoon. And daily mean canyon air temperature reductions are similar for cool walls and cool roofs when you look at it from a – you know, per sub-facet albedo increase perspective.

Slide 42: Acknowledgements

And I just want to thank, again, the California Energy Commission for funding – a little bit of funding from the National Science Foundation, too – and a bunch of folks that helped us along the way. The first author on this is picture in the upper left here. That's Jiachen. And that's it. Thank you.

Victoria Ludwig: Great. Thanks, George. That was really interesting research. I think it shows a lot of promise for what cool walls can do. And I think it's – the local governments that I work with need to kind of hear some of this kind of research in order to make policies. So, I'm really glad that you guys did this.

Poll question 2

Slide 43: Poll 2

I think we're going to do another poll questions before our third speaker. But, I don't know. Yes, there it is. Great. So, this is the second and final poll question. We wanted to get a sense of if anyone on the line has considered any cool options for their cities. The – so, if you can – you can select as many as you like. But, please tell us which of these cool options you have considered – cool roofs, cool pavements, cool walls or none of the above. Let's see how we did. We'll just give folks a few more seconds.

OK. I think we can close the poll. And the results are, by far, cool roofs, 78 percent have been considered. There is close alignment between cool pavements and cool walls, actually, which is really exciting, cool pavement at 37.5 percent and cool walls at 34 and, then, none of the above at 16 percent. So, perhaps, after this webcast, those folks will consider some other – consider some of these options. And, again, you can go to our Heat Island website to find more information on these.

Existing cool wall codes and programs

Slide 44: Existing Cool Wall Codes and Programs

So, I'm going to introduce the next speaker, who is Haley Gilbert. Haley is a principal research associate in the Heat Island Group in the Energy Technologies area of Lawrence Berkeley National Laboratory. She leads the group's technical assistance activities to promote the appropriate use of cool materials, and she also manages several of the group's research projects including this California cool walls project that we are talking about today. Prior to joining Lawrence Berkeley National Lab (LBNL), she worked for the great federal agency, the U.S. EPA, on green building and sustainability projects. And Haley holds a master's degree from Yale University. She is going to talk about what's happening now on the ground with codes and programs for cool walls and what aspirations her and her group have for advancing these technologies even more.

Haley, I'll turn it over to you.

Haley Gilbert: Thank you, Victoria. Thank you for the opportunity to come here and speak today and share what we've been working on.

Slide 45: Existing cool wall codes and programs

So, George and Ronnen have been presenting on the benefits of cool walls.

Slide 46: Cool roofs are prescribed and incentivized across the U.S.

Another important component of this project for us was actually working to advance the adoption of cool walls. So, based on that poll, it seems like many of you are familiar with cool roofs and many of you have actually taken steps to implement or adopt cool roofs in your – in your jurisdiction. That is similar to what, you know, we've found when we looked at cool roofs across the U.S. We find them prescribed and incentivized across the U.S. in many states and cities. And that's kind of what this graphic is demonstrating.

Slide 47: We seek to replicate the cool roof model by advancing the building and climate-appropriate adoption of cool walls

And, so, the cool roof model has been very successful. So, when we thought about how to advance the adoption of cool walls, we thought "Let's replicate this cool roof model." And to do that, we set out to do a couple of things. One is to create some guidelines to help building owners and communities understand the appropriate adoption and implementation of cool walls, as Ronnen kind of outlines in his initial presentation – what are the benefits. We also wanted to look to develop language for building codes, green building programs and incentives which can help further the adoption and also investigate the feasibility of a cool wall rating program or system.

Slide 48: Cool walls are currently found in codes/standards and green building programs

Cool walls – it's just kind of exciting to find – are actually referenced already in many codes, standards and green building programs. I bet many of you are familiar or have heard of ASHRAE. There is ASHRAE 90.1, which is a standard for non-residential buildings. We find cool wall measures in ASHRAE 90.1. We also find them in ASHRAEs 189.1, which is the green building standard that they have developed.

We also find cool wall measures in California's Green Building Code. They have a set measures that are mandatory and, then, they have a set of voluntary measures which includes cool walls that local jurisdictions can adopt to go beyond code. And that's where we find cool walls. We also found them in the State of Hawaii – and we'll hear more from Howard about that later – and also in the national green building rating program, Green Globes.

Slide 49: We're working to expand & enhance those cool wall provisions

While we found cool wall measures in – you know, with existing codes and organizations, we also, after this research, thought there was merit to expand and enhance those cool wall provisions. So, for example, we're working with key staff from ASHRAE 90.1. In the current version, they've recognized cool wall measures for climate zone zero. I don't know if you can recall from Ronnen's map earlier, but climate zone zero is not found in the U.S. It's found in many, you know, important population centers across the globe such as Bangalore and India, but is not in the U.S. It's a very hot and tropical climate. So, we want to work with them to see if we can extend cool walls to climate zones one through three in the U.S. where we have found this energy saving and emission benefits. We also want to work with these organizations to be sure that the code language and the specifications for cool walls is clear, which will help with ease of implementation and adoption.

Slide 50: We're also working to develop new cool wall measures in codes/standards and green building programs

And while we found cool wall in many different existing building codes and standards, there are still other key programs that we are trying to introduce cool wall measures such as U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program. Dr. Levinson is working on submitting a pilot credit for LEED. That would be under the heat island reduction credits. We're also working with California's California Energy Commission to see if we can introduce cool wall measures into the Building Energy Efficiency Standards, commonly referred to in California, at least, as Title 24. And what is also important is targeting residential residences. And while ASHRAE 90.1 is widely used and adopted, it's for non-residential buildings. So, we hope to also work with International Energy Conservation Code (IECC) to include cool wall measures. And that would be helpful for increasing adoption in the residential market.

Slide 51: We're investigating options to incentivize the use of cool wall products

In addition to these kind of building codes and standards and these mandatory avenues for advancing adoption, we also want to investigate and advance incentives. One of the incentives that we found in California is PACE program, which is Property Assessed Clean Energy programs that provide innovative financing to homeowners to fund energy-efficient retrofit. So, if a product is listed on the eligible product list, the owner of the building can use this financing to fund the installation and cost of material. So, we found that with two PACE programs in California.

And that's something that can be – PACE programs are available nationally. It have to be kind of adopted by the state and then implemented at the local level. We also are working in California with our investor-owned utilities as well as our municipal-owned utilities to explore different incentive programs that we might be able to offer to, again, help push the market in adoption of cool walls where they are appropriate.

And lastly, of course, we are working with EPA and their Energy Star program to see if we can certify cool wall products. There are already existing cool roof certified products. So, we are hoping we can also introduce certification for cool wall products.

Slide 52: We are developing cool wall guidelines for building owners/operators and communities

So, to talk about some of the programs and incentives that we'd like to adopt, to help with that, we have developed some cool wall guidelines, again, for building owners and operators and communities. It summarizes a lot of what Ronnen has presented and provides more details and questions and answers that are helpful when describing this energy efficiency measure to other. There is details on the building energy cost and emission savings. There is also more information on the solar availability and running those calculations for your area. And, then, there is a summary of what George presented as well, kind of the air temperature and pedestrian comfort benefits that we found.

Slide 53: Establishing a cool wall product rating system is key

And, lastly, this effort – one of the key things that we hope to do is to establish a cool wall product rating system. We found that this was key to advance cool roof adoption because it provided credible methods to evaluate and label cool wall products so they could be included in these building codes and incentive programs. It's also this independent rating system that gives confidence to the measures that you might find in the building codes. We hope to model this program on existing successful rating programs like the Cool Roof Rating Council or the National Fenestration Rating Council. Or we are also in talks with at least at the Cool Roof Rating Council to see if we might be able to expand their scope to also include cool wall products.

Slide 54: Cool walls can easily be implemented at the local level (i)

And, so, I've talked about some of the things that the research group as well as a working group of stakeholders – thing that we will be working on. But, there's some easy things that you all in local jurisdictions can do now to consider the adoption of cool walls.

So, for example, you can see if you have access to PACE program financing or other rebates through local utilities to incentivize the use of cool walls. You can also take the lead for your state and include cool wall measures in your local municipal building code. Here is an example in Los Angeles. They have the City of Los Angeles Green Building Code. And they have actually adopted a mandatory cool roof requirement. It's not cool wall yet. But, they were able to do that at the local level, and it exceeds what was required at the state level. So, local jurisdictions can adopt measures that are not included at the state level or the national level to kind of exceed those programs.

Slide 55: Cool walls can easily be implemented at the local level (ii)

You can also lead by example by working within your own portfolio of buildings, municipal or state-owned buildings. We have a beautiful example, again, here in Los Angeles, City Hall. I think this is historically, you know, important color that they have selected – the building itself. But, it is a beautiful cool color, we have to say.

You can also think of ways to feature information on cool walls and targeted communications for residents, for business. For example, in the spring and summer, you might think of having some tips that you send out or that you have in your Twitter, your Facebook to help people when it comes – we're coming into the hot extreme heat season. You also might think of ways to include cool walls and programs for weatherization or low-income household retrofits. Those are sometimes already existing. Cool walls is really one of the easy strategies that you can do to retrofit your building to make it more energy efficient in warm climates. It's pretty low-tech and easy to apply. So, I think it's a real good win-win for those types of programs.

And, again, I'd like to just recognize that the research team has been key in this. But, we've also throughout this project had the participation of several key industry manufacturers, building code stakeholders that have helped advance this component of the research as well. And that will help continue to work on this topic after this project to be sure that we have kind of appropriate adoption of cool walls.

So, thank you, again, Victoria. I think that concludes my slides.

Slide 56: Hawaii's Adoption of Cool Wall Codes and Measures

Victoria Ludwig: Great. Thanks, Haley. That was really interesting. There were a lot of things in there that I did not know as far as what has been done for cool walls. It's encouraging. And I think some of the ideas that you have for doing other codes and standards and ratings would be a great way to keep advancing the implementation of cool walls. So, I'm looking forward to working with you on that and to – and seeing how it all pans out.

Hawaii’s adoption of cool wall codes and measures

So, let’s get to our friend from Hawaii, who is going to talk about what they have done as far as research on cool walls and trying to put cool walls in to the state’s energy code and also working with national-level energy code standards. Our speaker today is Howard Wiig. He is an energy analyst with the State Energy Office, State of Hawaii. He has been involved with developing building energy codes tailored to Hawaii’s unique climate for over 30 years. He has been an active participant at the national level in energy code hearings that have formulated the International Energy Conservation Code and also the National Green Building Standard. Howard was recently instrumental in adding a new climate zone, the tropical zone, applying specifically to Hawaii to the 2015 iterations of those two codes I just mentioned. And, as a result, they were able to subsequently incorporate cool walls in to the state energy code in Hawaii.

So, aloha, Howard. I will turn it over to you.

Howard Wiig: Aloha to you from the land of Goldilocks where it’s not too warm and it’s not too cold. Everything is right in between. And as indicated, I’ve been with the energy office since the time of the dinosaurs and with codes since right about the time the meteorite struck the Yucatan. My presentation will be much more boots-on-the-ground oriented than the prior speakers.

Slide 57: The Writing’s on the Wall: Hawaii’s Cool Wall Energy Code Research

Slide 58: Cool Cars

And first and foremost, I would like to give a shout-out to Toyota for demonstrating that reflective surfaces can occur just about anywhere. They introduced titanium dioxide (TiO_2) into their car colors with a result that on sunny days the ambient temperature around the car has been reduced by about 12 degrees Fahrenheit. It’s my dream starting with this webcast that one day TiO_2 may be not will coat the entire surface of the earth but will be used very, very widespreadly. And one of the reviewers of the article that launched or publicized this car was our own Dr. Ronnen Levinson.

Slide 59: Incorporating Cool Walls into National Energy Codes

And as indicated, I have been involved in the code-making process since 2006. And if you follow the IECC at all, you will see that at least for some of the iterations, the efficiency has improved dramatically, including the tropical – introduction of the tropical climate zone and reflective roofs for commercial buildings. This came after a lot of work with a whole lot of people. And the next iteration of the IECC will be in – for the 2021 version, and the preliminary hearing will be next year. And I will definitely be there.

And one of the proposals I will put forth is for reflective – incorporating reflective wall into at least climate zones one, two, three. That’s where the reflective roofs are right now. We did talk a lot at the hearings about including climate zone four, which is along the Mason-Dixon line but didn’t quite make it. Maybe climate zone four will be included in the next hearings. And, again, I am pretty darn sure that we will get to reflective walls in there in the 2021 version.

Slide 60: Getting Codes Adopted

And here is a little bit of a boots-on-the-ground type advice. If you too would like to become involved in the code-making process and specifically promoting reflective walls, first and foremost – I believe we are speaking mainly to government agencies here. First and foremost, get registered with the ICC as a testifier and specifically with the IECC, International Energy Conservation Code. And, then – and bring along as many of your colleagues as you can. Depending on the size of your entity, you are allowed anywhere between 4 and 16 votes.

And votes really count at these events because there’s only a few hundred people involved, right, at the peak of the hearing process. There may be up to 300 people in the room. And, incidentally, late at night – sometimes these hearings last from eight in the morning until close to midnight. So, get your health way, way up there and your energy level because when you’re getting close to midnight, there may be only 20 people left in the room.

Your vote is 5 percent of the total. And in the last round of hearings for the 2018 IECC, that was the case and we had been – we faced a lot of opposition. But, when we were down around midnight, most of the people present were government people and we managed to get through a small number of efficiency measures specifically because of our endurance.

So, when you get to the hearing site, you will find that there are sort of professional efficiency pushers from the American Council for an Energy-Efficient Economy and so forth. Get to know them. And, then, ask “I’m here for reflective wall promulgation. Who should I talk to?” And they will know the different groups in the audience and the will say, “Go talk to that group, this group, this group.” Go to the group. Talk about reflective walls. You probably will get affirmative response. And, then, ask them “What is your pet project here at the hearings?” And if you’re, in good conscience, able to support that, say “Yes, I will – I will go along with you and support that.” Mutual support there. And, then, ideally, you will have beer with a builder.

The hearing is divided generally and somewhat evenly divided between us, government types who are pushing for maximum efficiency, and the construction industry or the builders. And you can spot us government types. We’re generally kind of skinny and academic-looking where the builders are – have a more robust constitution, shall we say. Get to talk to one or more of them. Have lunch. Have coffee. Ideally, buy them a beer and spend some real time getting into their heads and understanding what their point of view is. You will see – you will find that they are – they are nice guys. They are good husbands, good fathers, they treat their dogs really and they contribute to society. Get to know them so that during your testimony, you can acknowledge their point of view. This puts you much more in the centrist area and you get a lot more sympathy from the builder or construction side that way.

Slide 61: Cool Wall Code Option

And let’s talk about how we, as an example of the process I was just talking about – how we in Hawaii got reflective walls in. The 2015 IECC includes for residences mandatory R-13 interior wall insulation plus mandatory R-4.2 exterior insulation. And as we were considering adopting the 2015, the Building Industry Association (BIA), which is the local arm of the National Association of Home Builders (NAHB), approached me and said, “Howard, this exterior insulation requirement is going to add $8,000 to the cost of a home, a standard 2,000-square-foot residence, and it will save in our climate only 484 kwh a year.” And that turns out to be – even with our very high energy prices, turns out to yield a 43-year payback. Not exactly sensible. A mechanical engineer friend owed me something, so I asked him to run the numbers without giving him any background and he came up with exactly the same conclusion.

So, I sat down with the BIA folks and said, “What are the alternatives?” We came up with 0.3 projection factor or a visible light reflectance of 0.64. And note that – and that has the same effect – the same cooling effect as does R-4.2 exterior insulation. And you can see that the cost of that would be just a tiny fraction of the $8,000 that the BIA cited. So, that’s an example.

And why is it specified visible light reflectance? Because I contacted the major paint manufacturers and asked them for solar reflectance values and they said, “No, just visible light reflectance.” I couldn’t get it. Maybe, as momentum builds, they will offer solar light – or solar reflectance values.

Slide 62: Surface Temperature Comparisons: Sun/Shade/ Light Color/Grass

So, I like to do a hands-on measurement myself. I thought it’d be very scientific. I was at a friend’s house on the north shore of Oahu overlooking the big wave country and had my heat gun with me. And the afternoon sun was beating directly on this wall. So, I shot dark green full sun, 165 degrees. And right next to it was a shaded area, also the dark green. It goes down to 115 degrees. Delta 50 degrees Fahrenheit. Not bad. Then I went to a light-colored ball right next to the dark surface and I got 125 degrees. Delta 50 degrees. This is the difference that a chance in light or color can make. Then, just to round out the ecosystem, I shot full sun grass right underneath this, 105 degrees. Shaded grass, 85 degrees. So, this is a teeny little microsystem with these great variations in temperature based on the conditions that you subject it to.

Slide 63: Before Light Coating: Laie Elementary School Interior Temperature

Then, to do another little real-world experiment, I was contacted by the parents of kids at Sunset Elementary – or Laie Elementary, which is also on the north shore. And a lot of Hawaii buildings, my house included, are single-frame construction. And it was hot in the classroom. So, we went out – and it was kind of late in the morning – measured the interior temperature at 88.3 Fahrenheit. Then, under supervision, the kids and the parents coated what had been a dark green surface with a very light green surface. And when the paint dried, we shot interior temperatures.

Slide 64: After Light Coating: 5°F Interior Temperature Drop

And it was lowered by 5 degrees Fahrenheit. And keep in mind that this was later in the day. So – but, that made a great deal of difference – just that little experiment.

Slide 65: Extreme Materials Lab at Hawaii Institute of Geophysics and Planetology, Dr. Przemyslaw Dera

But, going to a more formal type of research, Dr. Przemyslaw Dera of the Hawaii Geophysics Institute has been experimenting a lot and written very academic papers on TiO_2.

Slide 66: Cool Walls Intern at Hawaii State Energy Office?

And he was excited enough by our project to include us in a grant or an application that he is writing to the National Science Foundation. And, ideally, a grad student will be available to us this summer to conduct a whole lot of experiments. And I solicit ideas for experiments from you.

Slide 67: Follow up Research

And, finally, I have questions myself. Should shading be added to our calculations? You have seen what a difference it makes for me. And the reason the paint manufacturers didn't want to go to solar reflectance was I talked about TiO_2 and they said, "That will add to the cost." So, I would like to see studies of how much TiO_2 adds to the cost of, say, a gallon of paint versus the reflective effects of that. And then, finally, to give architects flexibility, should we exempt the north face of homes or buildings from the cool wall requirements?

Slide 68: Mahalo

And does that it for me. Mucho mahalos, which is Hawaiian for thank you very much.

Victoria Ludwig: Thank you, Howard. I learned some Hawaiian today. That's great. Thanks for your presentation and for all the work you've done there. It's really interesting to see some of the on-the-ground realities of how these things get done. And I think your advice, hopefully, will help some people on the line.

Questions and answers (Q&A)

Slide 69: Connect with the Heat Island Program

OK, folks. Now we are going to do the Q&A. I just want to remind you that we will try to answer everyone's questions. If you have a question that we don't get to, we will try to answer it and post it online in a written form. But, I think we can – I think we can do pretty good. We have about 15 minutes here thereabout.

And, so, I'm going to ask my colleague, Alexis, to read some of the questions and direct them at the appropriate speaker.

Alexis St. Juliana: Thanks, Victoria. Yes, we've had a good number of questions come in. And you are still welcome to continue to submit your questions. I think we're going to circle back towards the beginning of today's talk.

And I think our first question will be for George. And the question is "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: Sure. So, first off, there may have been a misinterpretation. The – 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. But, a lot of it – a lot of it had – you know 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. Right? And, so, you get more direct temperature reductions from walls than you do for roofs.

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

And would it depend on the height of the building? Yes, it definitely would. And it – you know, one thing that is mentioned in the write-up quite extensively on this project is that, you know, you can't really do a one-size-fits-all study. It's – you know, 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, as mentioned by the question – so, the building heights and the street widths and things like that – and then, also, just the overall baseline climate. And, so, I don't know that – you know, it wouldn't – 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.

Alexis St. Juliana: Great. So, George, we had two additional questions for you related to the amount of radiated heat, and I'm going to ask them both. So, one was "Why is the temperature outdoor going down when the amount of radiated heat increases?" And the other was "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: Yes. So, those are related questions. And to answer the first one, what we are looking at is – so, there was that slide that said that the amount of radiation leaving the canyon for cool walls is about 40 percent that of roof. Right? And, so, what we are looking at is sunlight that is reflected off of walls or roofs. And 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. And we did account for that in our calculations. But, it's not all of – it's not all of the reflected solar radiation. That's roughly half of it. And so, you know, 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. Right? We're not talking about increasing the amount of thermal radiation that's being emitted by surfaces. Right? We're talking about sunlight that's being reflected from surfaces, not thermal radiation that's being emitted from surfaces.

So, hopefully, that answers both questions. It's – we're – that figure that I stayed in and talked was sunlight being reflected, not thermal radiation. And, 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. And, so, the net effect is that you still get a cooling in the canopy even with that, you know, addition of sunlight being absorbed by pavements and walls because the net is that you're actually increasing reflected radiation. Right? So, that absorption of sunlight by other surfaces can somewhat attenuate the effects, but it doesn't reverse it.

Alexis St. Juliana: OK. Thanks.

So, we are getting a lot more questions filtering in and I'm having trouble keeping up with them all. But, I think, Haley, one question came in for you. And that is "Do you see any one metric being used to set requirements for codes?"

Haley Gilbert: Well, when we talk about metrics for walls and codes, we often – 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. So, for example, in ASHAE 90.1, we have a different metric, but we are working with them to change that metric to solar reflectance and thermal emittance. And those are the surface properties of the product, and those two properties would help to define its coolness. And, so, 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 specific a cool wall product.

Alexis St. Juliana: Great. And, then, another question then came in for Haley and maybe Howard and Victoria might also want to add her two cents. That was just people wanted to know how they could get involved in the code-making process.

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

Howard Wiig: Yes. Thank you. I did outline that in a couple of my slides. I deal with the IECC because that's our code of choice. But, 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. And if you email me, I can detail them for you.

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

Alexis St. Juliana: OK. Great. Thanks, Howard and Haley.

So, I don't know, Ronnen, if this is – I think you'll be able to answer this question. I don't – I don't know that it was specifically directed at you. But, "When we are talking about cool walls, are we talking about just paint to make a cool wall or paint plus insulation?"

Ronnen Levinson: Cool walls in this case just refers to the ability of the wall to reflect sunlight. So, we are not proposing increasing insulation or making other structural changes to walls, just modifying the nature of its surface.

Alexis St. Juliana: OK. And then, I think, Ronnen, you might also be able to speak to this question. "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: Sure. We have, in fact, done some building-to-building interactive modeling. It seems like the crosstalk between buildings is pretty modest. And the reason is that if a building is close to its neighbor, that wall that – in the central building that's in the sun tends to be shaded by that neighbor. And 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. And that turns out to be a big win for energy savings.

Alexis St. Juliana: That’s really interesting. Thanks for adding that.

We had another question come in for Howard. And it mentioned that he showed the pictures of temperature variation over the exterior surfaces of buildings. Are there – are there data on the temperature changes inside the building?

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

Alexis St. Juliana: OK. Thanks, Howard.

We have another question that I think, Ronnen, you might be able to attest to. And it says, “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: Sure. Well, 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. So, 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.

But, I would say that 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. So, if somebody has basically 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.

Alexis St. Juliana: Great. Yes. And Victoria’s – if you click on – Victoria’s name is on the screen right now. But, if you have, you know, additional questions or want to get in touch with our presenters, you can click that link and email Victoria and we will connect you with our speakers.

So, we had another question come in here for Haley. And this is “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. And it’s one that we are working with individual code entities on. And it depends on the code itself. And you have specifics that vary depending on building type, residential versus non-residential. And we also include things like climate zone.

So, you will find that certain measures are in certain climate zones. They are appropriate for certain building types. And you put in language as well that can offer paths to compliance.

With cool walls, you also see it often included in measures to say you can have either shading – and that's provided by an awning or a tree or some sort of shading on a wall or you can have a cool wall. So, you often find there are different paths to compliance with the same idea of reducing the solar heat gain into the building. So, 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. And, then, depending on if we're working in California or on the national code, again, we will work with that entity to kind of best tweak and alter the language so it fits the context as needed, not a one size fits all, I would say.

Alexis St. Juliana: Yes. That makes sense. Thanks, Haley.

So, before I turn it back over to Victoria, we did have a couple of questions about learning credits or continuing education credits for today's webcast. And, unfortunately, we are not affiliated with any organization to offer those types of continuing education credits. But, if you do need record that you participated, we can provide that. Just contact Victoria.

Victoria, I am turning it back to you.

Victoria Ludwig: Thanks, Alexis. Well, we are at 2:30 already. Time flies when you're having fun. I want to thank our speakers, Ronnen Levinson, Haley Gilbert, George Ban-Weiss and Howard Wiig for joining us and lending us your time and your expertise. And I want to thank the participants – the attendees, especially those who stayed on until the end.

And I hope after listening to all these presentations you now understand our cute little title for the webcast that cool walls are here and they are only going to advance more. So, if you don't see the writing on the wall, you need to listen to this webcast again.

So, quick reminders. We will – sorry we couldn't answer all the questions. The ones that we couldn't get to we'll try to write answers to and post on our website as well as we are going to post a transcript and an audio of this webcast and the PowerPoint presentation. It will all be up there. It will take a couple of weeks. And when it's posted, we will email all of you that registered for the event as well as anyone on our newsletter signup list. If you're not on the list, please sign up. And you can use that link there or go to our website.

And before – when you sign off, you will see a feedback form pop up or you can click on the link here. We encourage you to fill that out so that we can find out what you thought of our event. And we hope you join us again for our future webcasts. As I said, we most likely will be having another one on another heat island topic before the summer.

So, thanks, everyone. I am going to end the webcast and wish you all a good day.

Operator: This concludes today's conference call. You may now disconnect. Presenters, please stand by.

END