Global Cool Cities: Tools for Cooling Urban Heat Islands

—Transcript of a webinar offered by the Clean Energy Solutions Center on 13 June 2012—
For more information, see the clean energy policy trainings offered by the Solutions Center.

Vickie Healey: Hello everyone, I'm Vickie Healey with the National Renewable Energy Laboratory. And welcome to today's webinar hosted by the Clean Energy Solution Center. Our focus today is on tools for cooling urban heat islands through the recently released Cool Roof and Pavements Tools Kit.

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Before we begin, I'll quickly go over some of the webinar features. For audio, you have two options. You may listen through your computer or over your telephone, or, if you choose to listen through your computer, please select the 'Mic and Speakers' options in the audio pane, and this will help eliminate any feedback and echoes. If you select the telephone option, a box on the right side will display the telephone number and audio PIN you should use when you dial in. We ask that you please mute your telephone or your computer before the presentation begins.

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If you would like to ask a question, again, you have two options. You may select the questions pane and type in your question. And also, we will be opening up the audio to those of you who would like to ask a question over the telephone today. So if you would like to present a question through the audio function, just click on the little raised hand icon and we'll see that you would like to ask a question via the telephone, and at the appropriate time, which will be at the end of Kurt Schickman's presentation, we'll open the audio to you. Also, if you are having difficulty viewing the material through the webinar portal, you will find PDF copies of the presentations at http://cleanenergysolutions.org/training and if you go to that particular link, you'll be able to follow along as the speakers present. Also, an audio recording and the presentations will be posted to the Solution Center training page within a few days, so you can go back and review the slides and also listen to an audio recording of the presentation today.

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One quick note before we review the agenda—I'd like to mention that the National Renewable Energy Laboratory, where I work, is the operating agency for the Clean Energy Solution Center. We

have a brief presentation prepared for you today that is focused on mitigating urban island heat effects through the use of cool roof and pavement materials. We are very fortunate to have Kurt Shickman, Executive Director of the Global Cool Cities Alliance (GCCA), presenting today. Kurt will also provide information on the GCCA's recently launched urban heat island and cool surfaces knowledge base. Before Kurt begins his presentation, I will provide a short informative overview of the Clean Energy Solution Center and describe services offered through this initiative. Following Kurt's presentation, we'll have a question and answer session where you'll be able to participate and ask questions.

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Okay, this slide provides a bit of background in terms of how the Solutions Center came to be. The Solutions Center is an initiative of the Clean Energy Ministerial (CEM) and is supported through a partnership with UN Energy. It was launched in April of last year and is primarily lead by Australia, the United States, and other CEM partners. One of the outcomes of this unique partnership is the support of developing countries through enhancement of resources on policies relating to energy access, small to medium enterprises and financing programs.

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The Solutions Center has four primary goals. First, it serves as a clearinghouse of clean energy policy resources. It also serves to share policy best practices, data, and analysis tools across countries. The Solutions Center delivers dynamic services that enable expert assistance, learning, and peer to peer sharing of the experiences. And, lastly, the Center fosters dialogue on emerging policy issues and innovative policies occurring around the globe. Our primary audience is energy policy makers and analysts from governments and technical organizations in all countries. But we also strive to provide resources and engage with the private sector in civil society.

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Ask an Expert is a valuable service that I'd like to speak to that is offered through the Solutions Center. We have established a broad team of experts from around the globe, including our presenter today, Kurt Shickman, who are available to provide remote policy advice and analysis to all countries at no cost. If you have a need for clean energy policy assistance, we welcome and encourage you to use this valuable service. Again, this assistance is provided free

of charge, and to request assistance, you may register and submit your request through the Solutions Center Ask an Expert Feature at http://cleanenergysolutions.org/expert. We also invite you to spread the word about the service and to those in your network and organizations. Just to mention, some of the broad sectors covered by our experts include energy access, energy efficiency, renewable energy, clean transportation, regulation, and utilities.

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Other services provided through the Solutions Center cover a range of learning and training opportunities, like today's webinar, which you are all attending. *[Inaudible]* developed in collaboration with our partners such as Leonardo Energy, for example, we also offer a broad range of training materials including videos, presentations, and curriculum, and we recently watched a policy forum that includes a series of blogs on key policy topics. We encourage you to participate in these blogs by logging on and contributing to the discussion.

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There's some really good blogs to read about what's going on around the world in clean energy policies. The Solutions Center has a vast library of technical resources and tools for policy makers. Some examples are listed here, and they're related to finance and investment, renewable energy, emerging clean energy policy topics, and solar power opportunity.

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We encourage you to explore and take advantage of our resources and services, including the Expert Assistance, subscribe to our newsletter, and participate in the webinars and policy forum. We also welcome your suggestions of additional resources we can add to the site, and opportunities to partner to improve resources and services. And now, it is my pleasure to turn over the webinar to Kurt Shickman. Kurt, thank you for joining us today.

Kurt Shickman: Well, thank you for having me, Vickie, and GCCA is very happy to be a partner with the Clean Energy Solutions Center. So is my screen appearing okay for you?

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Vickie Healey: Yes, it is, mm—hmm.

Kurt Shickman: Okay, great. So, as Vickie mentioned, the slides of this webinar, along with the text, will be available on the CleanEnergySolutions.org website, but also on our websites, which are CoolRoofToolkit.org and GlobalCoolCities.org.

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So I'll do a quick introduction of my organization, and some of our partners, very quickly. And then we'll explore cool surfaces by discussing the growing problem of urban heat, then, how cool surfaces work to reduce urban heat, and the multiple benefits of adopting cool surfaces, and some proven strategies for accelerating the adoption of cool surfaces worldwide. Each of these topics is covered individually within the cool roofs and pavements tool kit, and I'll provide some details on that tool kit in a moment. And perhaps if we have time at the end, I can—and if there's interest—we can walk through the website itself. But I want to leave the bulk of our time today to have discussion and question and answer periods. So please feel free to ask questions along the way, and we'll try to answer them as we go, or, save them till the end.

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So the Global Cool Cities Alliance, the Clean Energy Solutions Center, and a group called Regents20—or R20—they've developed this webinar to help our members achieve their goals. And while there is a great deal of diversity amongst our members, we do find common themes. People want to live, learn, and work in more comfortable, productive, and resource—efficient places. They want healthier, more enjoyable urban areas, and they want to be as resilient as possible to the effects of global climate change. Reducing urban temperatures by using cool surfaces is a cost effective and straightforward way to achieve these goals.

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So just a quick note on R20; R20 was established by Governor Arnold Schwarzenegger to help subnational governments, so states, counties, provinces, that level of government, to develop, implement, and communicate low carbon, climate—resilient economic development projects, policies, and best practices. They have 24 members, 24 member states, 43 partners, and two observers. And the R—20's activities connect more than 560 subnational governments and local governments around the world. So they're another pathway to the implementation level, which is the urban sort of state level governments where this activity can really be put to use.

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So just really quickly, here's a map of R20 member locations. Again, just stressing the global diversity not only of R20 and GCCA but also the Clean Energy Solutions Center.

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So the Global Cool Cities Alliance is a non—profit that grew out of the work of the Heat Island Group at Lawrence Berkley National Laboratory in California. They're a leader in Cool Surface and Urban Heat Island Research. And we work with cities, regional and national governments and other stakeholders, that develop policies and programs to accelerate the adoption of cool roofs and pavements. And this graph at the bottom here shows how we think about doing that. First is by trying to grow the number of cities, companies, regions, and individuals that are deploying cool roofs and pavements. These are people that we call 'program implementers'. We also try to link those potential implementers with the technical and policy expert community to ensure their efforts are effective and efficient, and one way we do that is through the Clean Energy Solution Center. We also work to share research, data, best practices, project documents amongst both groups, and try to network the expert community both across topic areas but also geographically to ensure that research is disseminated broadly and to provide a simple entry point for implementers.

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So just a quick word on the tool kit itself. As I mentioned, or actually, let me quickly back up here, sorry.

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I wanted to mention GCCA's relationship within the Clean Energy Ministerial. GCCA is the operating agent for the Cool Roofs and Pavements working group within the GSEP or Global Superior Energy Performance Partnership Initiative. The working group includes the US, India, Mexico, and Japan, and we have participation from Brazil and South Africa. Together, these participants include 8 of the world's 20 largest cities. And right now, the working group is focusing on codes and standards for cool surfaces. And looking at improving the thermal comfort of affordable housing, which is obviously a very important new area of construction growth. And finally, a knowledge exchange on cool pavements. We welcome additional members in this group, so

if you're interested in participating, whether you're a government or an NGO or an industry participant, we welcome your participation, so please let me know at the end, and I'll have my contact information, if you'd be interested in being looped into our activities.

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So as I mentioned, this webinar is a summary of the Cool Roofs and Pavements Toolkit. The tool kit is available for viewing or download at www.coolrooftoolkit.org, and you can actually get there through the Clean Energy Solutions Center website as well. The tool kit currently includes an introduction to the science, benefits, and cost of cool surfaces, as well as an implementation guide that not only looks at best practices from an outcome perspective, but also the steps that were taken that made this policy successful. These are distilled from around the world. We also just launched a knowledge base, which Vickie mentioned, that includes research, best practices, code and ordinance model language, and simple program materials, and soon an expert forum. We welcome your feedback on the tool kit. We're constantly trying to add to this. So if there are modules that would be useful for your activities, please let me know, and we'd be happy to explore getting those set up.

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Okay, so if there aren't any questions at this point, we'll go ahead and start our review of cool surfaces, starting with the problem of urban heat.

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It is clear from the data that the world is heating up. This is a NASA heat map of the annual mean temperature between 1950 and 2008, and it shows that with very few exceptions, temperatures are increasing markedly around the globe.

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And this warming trend is especially pronounced in cities. In fact, urban areas are warming at two to three times the rate of global climate change. And those effects are additive. On average, cities are about 3 to 4 degrees Celsius warmer than the surrounding rural areas, but the difference can be much higher in specific cities. For example, in the northeast quarter of the United States, there are some cities that have heat islands that are 9 to 10 or more degrees Celsius, versus the rural areas around them. Human activity and

dark and permeable surfaces, which make up about 60 percent of the land area of an average city, are the main contributors to the urban heat island effect.

Higher urban temperatures result in more demand for air conditioning, and thus more energy use. Higher temperatures also tend to result in lower air quality, due to the fact that compounds that form smog cook more readily on hotter days. Quality of life decreases in hot cities because they are less enjoyable to be outside in, and to be social in, and also can present serious health risks when prolonged or severe heat events or heat storms occur. Addressing urban issues will be increasingly critical as the planet is in the midst of a rapid urbanization. By 2050, it is estimated that 80 percent of the world will be urbanized, up from about 50 percent today.

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So here are some examples of the heat island at work. The map on the left of your screen is a thermal image of London, and, as you can see, the low—density parkland indicated by that arrow there is significantly and noticeably cooler than the urban core around the Thames River, the redder areas there. On the right is a similar look at Atlanta, both a standard satellite image and a thermal image, and you can see again that the downtown core, circled here, is noticeably warmer than the areas around it.

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Extreme heat events are a potent killer, even in countries where air conditioning is prevalent. Cooler cities can be more resilient to heat events. This chart shows the ten worst heat events that have been recorded. A few interesting things to note on this chart that I'd like to bring your attention. The first is that heat events can happen and can be deadly even in traditionally cooler and more temperate climates. As you can see here, Russia, Belgium, Switzerland, and Germany are near the top of this list. Second, I would note that the ten deadliest heat events have occurred since 2002, and this is in keeping with what we're seeing in terms of greater rates of heat storms and extreme heat events. And finally, I would mention that these numbers are being revised upwards, even as we speak. There will be several thousand additional deaths attributed in Italy and France. So as bad as these numbers are, they're actually worse, because of the way that certain deaths were counted and how some weren't. So this is certainly an area of focus for why we want to make cities and urban areas cooler. So are there any questions at this moment?

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Vickie Healey: We don't have any submitted at this point, or any hands raised.

Kurt Shickman: Okay. So let's turn our attention to the detail on how cool surfaces work to address these issues of urban heat.

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But first, let's talk about what we mean by 'cool'. A material's 'coolness' is a function of how much light it reflects, or its solar reflectivity, and how quickly it radiates away stored heat, or its thermal emissivity. Reflectivity is the more important variable in determining coolness. When sunlight hits a roof or any surface for that matter, some of it is reflected back into the atmosphere as sunlight, and those are the yellow arrows here on the left.

Vickie Healey: Kurt?

Kurt Shickman: Yes?

Vickie Healey: Oh, we do have one question that just popped up, if you'd like to take it now. Or we could wait till the end, whatever you want.

Kurt Shickman: Let's take it now.

Vickie Healey: Okay, it's an audio question, so I'll open up the mic. Woops. They put their hand down, so I guess you may have just answered it for her. So, okay. Sorry, go ahead.

Kurt Shickman: No problem. So, again, where was—Okay, so some of it is reflected back in the atmosphere as sunlight, so it's actually this yellow arrow here. Some heats the atmosphere, which is the red arrows. Some is degraded into heat on the rooftop, which is the orange arrows, here. And most of that heats the surface of the roof and is blown by the wind to heat the surrounding area. Some also heats the building itself, which is the purple area. And the amount of heat that heats the building is dependent on the amount of insulation the building has, if any. Now, white roofs, which is displayed on the right here, have a high solar reflectance, hence, can significantly reduce the amount of light energy that's converted into heat.

This diagram shows two roofs which are identical, except for their color. The white roofs generally reflect about 50 percent more sunlight than dark roofs, and have temperatures that are 36 degrees cooler–and that's at a constant temperature of about 37 degrees Celsius. So what we're seeing here is that the white roof is able to

reflect greater portion of the light back into the atmosphere, and back actually out past the atmosphere, so it doesn't—There is some heating of the atmosphere, but about 10 percent, but the vast majority is reflected back out into space.

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So here are some common roofing materials to help you give you a sense of their impact on surface temperatures. I won't go into this slide. I think there's a better slide on this a little bit later. But just to give you a sense of the temperature rise versus solar reflectance of some materials, from standard metal, which would be for instance a galvanized metal roof for example, all the way up to a white metal.

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So here are some example roofing types and their cool alternatives. This is just a few of the many roof types and cool alternatives that exist, so for a full list I'd recommend checking out pages 24 and 25 of the tool kit. I think the important takeaway here is that for nearly every roof type, there is a cost effective, cool alternative. And particularly in markets where cool materials have been in the marketplace for a while, those alternatives are cost effective, cost neutral, or, in some cases, cost negative.

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So far, I've been talking a lot about white roofs. But actually, there's a wide variety of cool colors, as you can see here at the bottom of this slide. These colors work by reflecting the solar energy in a part of the solar spectrum that is invisible to the eye, which is called the near infrared. But about 50 percent of the sun's energy is transmitted in that invisible near—infrared spectrum. So a cool color absorbs in the visible spectrum, which lets you see it as a blue or a green or a red, but it reflects more in the infrared. As you can see, these performance numbers here at the bottom aren't quite as good as what you'd get from a white, but they're significantly better than traditional cool—traditional colors. And we find that these cool colors can help address issues like aesthetics, cultural considerations, or, in some cases, glare issues. So it's an important thing to note that talking about a cool roof doesn't necessarily just mean a white roof.

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So as we've discussed, a cool roof can help reduce heat flow into a building during the summer, but that reduced heat flow may also

require the building to use more heating energy in the winter. This is called the winter heating penalty. But even in cities in cold climates, like Chicago, there's a net positive cost savings to adopting cool roofs. And there are a number of reasons for this. Typically, summer cooling is done with electricity, which tends to be more expensive than natural gas driven heating. The sun is generally at a lower angle in winter months than it is in summer months, which means that the sun has a reduced impact on roof conditions during the winter.

And in some areas, snow cover makes the underlying roof color irrelevant. So snow makes every roof white. Finally, heating loads and expenditures are typically more pronounced in the evenings, especially in residential buildings. But the benefit of a darker roof in winter is mostly realized during daylight hours. So this chart here shows the differences between the cooling savings and the net savings, to give you a sense of what heating penalty is in some cities, mostly, unfortunately, focused here in the United States.

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So again, white roofs are only one option for using the roof as a driver of sustainability, and this chart helps compare the benefits of a few sustainable roofing technologies. Green roofs are a great amenity for a building with an accessible roof. They can help manage storm water runoff, which is of critical importance in many cities, and can also provide some local cooling through what they call evapotranspiration. And the mass of most green roofs provides an insulating effect that reduces heat flow into a building, so it acts as another form of insulation for the roof of a building. But green roofs are also much more expensive to install and require a great deal of maintenance in the early years.

Solar photovoltaics, or solar PV, don't address urban heat, necessarily, but it is a source of clean energy, and it is important to note that PV and white roofs are very complementary technologies—that's because solar panels are more efficient at cooler temperatures. Since most solar arrays don't cover all of a roof's surface area, it would make sense to pair solar and white roofs to help keep the roof temperatures down, and solar panel efficiency up. Insulation increases the thermal resistance of a roof and can help lower the heat that is transferred into the building from the roof. So comparing white roofs with the—cool roofs with the right amount of insulation can help produce a high performance building envelope that maximizes building efficiency, urban heat island mitigation, and global cooling.

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So pavements are also a major part of urban land area. So I just want to talk about them very briefly here. Pavements can also be made cooler through two basic approaches. Similar to roofs, you can have a lighter color pavement that will reflect more light and therefore absorb less heat than a dark pavement. This can be achieved by applying a coating, using lighter aggregate, or using a product that is naturally lighter in color. You can also achieve some cooling on pavements by allowing water to pass through it—these are so—called 'permeable pavements' or 'pervious pavements'. And this cools similarly to how a green roof cools, through evaporation. There's a great deal of research and field testing going on around the world to assess the durability and impact of these types of technologies and long term maintenance requirements and that sort of thing.

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So I'm just going to pause again here quickly, and ask Vickie if there's any questions or that sort of thing before we move on.

Vickie Healey: Yeah, we do have one question, but it's more geared towards a discussion topic, at the end of your presentation, which is now. So I'm just going to toss this out to you—a discussion topic that has been requested is discussing what is the role of traditional architecture and building practices in cooling cities such as light colors, thick walls, wind towers, water features, and also complex technical solutions where convert excess heat to refrigeration.

Kurt Shickman: Mm—hmm. Okay, if it's okay, maybe we could hold that till the very end, and talk about it then–

Vickie Healey: Okay, that's fine.

Kurt Shickman: Cause I think both of those are using what's there and using the architectural community and looking at vegetative canopy and that sort of thing, and thinking about those things holistically is critical. So we're certainly supportive of all those approaches, but maybe we can save that for the discussion period.

Vickie Healey: Absolutely. Oh, that's fine. That sounds great.

Kurt Shickman: Okay, so we've covered how cool roofs work, and so now let's explore the many benefits of cool surfaces and how they may be desirable to implement in your region or where you are.

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So this is a rather busy slide, but I'll try to break it down here. Cool surfaces deliver benefits at the building level, at the city or urban scale, and at the global level. So first, at the building scale, we've seen up to a 20 percent reduction in cooling demand on the floor below the roof of buildings that have air conditioning. And, again, this will vary depending on the amount of insulation that the building has. In an unconditioned space, like a home or a warehouse or an industrial facility, cooler temperatures can make the building far more comfortable and productive. And we're also seeing roofs that are lasting longer because of reduced thermal expansion on the roof. One anecdotal story I can share there is the University of California at Davis has had white roofs for about 30 years now, which is significantly earlier than most, and while the average lifespan of a roof is anywhere from 15 to 20 years for a standard roof, their white roofs are still in service today at 30 years.

So it's one data point, but it is indicating there are some benefits to reducing that thermal expansion on the roof. At the urban scale, studies indicate a cooling potential in summertime temperatures of 2 to 4 degrees Celsius for an average city. So if you remember back earlier, that would essentially eliminate the urban heat island effect through the use of cool surfaces. This translates to huge opportunities to improve air quality, to reduce peak electricity demand, and to improve the resiliency of urban citizens to heat events and climate change. Just a quick number here, in the US alone, studies indicate that the air quality and energy benefits are potentially worth about $10 billion per year.

Now, globally, there's a potential here to really help forestall the worst effects of global climate change by raising the reflectance of the earth. If we raise the reflectance of the earth by about 10 percent, now, that's the effect of changing gray roofs white in hot climates, in temper climates, where it makes sense to do so—you can offset the warming effect of 500 coal power plants over the 20—year life of the roof. So just to be clear on that, and we'll go into this in a little bit more in a minute, that's the cooling effect of those white roofs offsetting the warming effect. So while you'll get some direct mitigation of CO2 or GHG emissions through efficiency, this is actually offsetting the warming effect of existing CO2 in the atmosphere.

So taking that down to a more manageable level, that means that every 10 square meters of cool roof is offsetting about a half ton of CO2 per year, and again, that doesn't include the direct reductions from improved efficiency. So as you can see, taken together, cool surfaces represent a cost—effective first step to both mitigating

and adapting to the effects of climate change. It will buy us some time to see other mitigation techniques and other clean energy strategies take hold in the marketplace.

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So I just wanted to quickly take a look at a growing trend that we're seeing in rapidly developing countries, and that's the rise of residential air conditioning units as a first option to home cooling. This is an example from India where they are experiencing 14 percent growth in air conditioning units each year, and will likely have nearly 50 million units online within about 20 years. So growth on this scale is already seriously taxing electrical grids and requiring the contemplation of a significant amount of capital investment in new electrical capacity. Deploying cool roofs first can help forestall the need for air conditioning and help slow this trend.

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So this is a graph from New Orleans, but it's common to most air conditioning dependent locations. This is looking at the maximum daily temperature and the average electric load in megawatt hours for that day. So you can see it at a particular threshold temperature, cities experience a significant increase in electricity demand, as you can see here on the right hand side of this graph. This is, again, the most expensive and peak energy, and often the electricity that causes congestion—brownouts, blackouts, congestion pricing, and so on—and it requires additional utility investments in peaking power supply. So reducing days like this on the right hand portion of the graph can translate into hundreds of millions of dollars in energy savings per year, or more, at the city level.

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So we see a similar graph here when we're looking at air quality. This is looking at smog formation. The formation of smog, again, is highly sensitive to temperatures. The higher the temperature, the more likely smog will form. And this is because the compounds that form smog do so by cooking. If you can reduce urban heat, those compounds don't reach their cooking temperature. To date, especially in the United States, we focus mostly on the ingredients for smog, and regulating and managing the ingredients to smog, but the other component here is the temperature at which they're cooking. So this is an additional opportunity to help reduce the impact of—reduce the issues of air quality.

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So as I mentioned before, studies indicate that increasing the reflectivity of the earth can partially offset the warming effect caused by greenhouse gas emissions, but I wanted to show an example of where this effect is actually happening on the ground. This is an aerial view of the Almeria region of Spain. It's in Southern Spain. And there's a tradition in this agrarian region to white wash their greenhouses about once a year. Field tests show that, as a result of this unique approach—so they've had weather stations in this region taking data for about 20 years now, and what they've found is the region has experienced declining temperatures of nearly 1 degree Celsius per decade, compared to the regions around them, which don't have the same whitewashing traditions.

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Okay, so are there any questions at this point, on the benefits or anything we've talked about so far? Okay, hearing none. We've talked about – So that covers how cool surfaces reduce urban heat, and some of the benefits that are accrued from doing so. I guess now the question is how do we effectively deploy cool surfaces?

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So the Cool Roofs and Pavements Tool Kit identifies two main kinds of actions. There's foundation activities, which help lay the groundwork for success by building relationships, improving technical knowledge and capacity, and gathering key information. Implementation activities follow from that. And by 'implementation activities', we're talking about two basic areas. One is policies and programs that we use to drive adoption of cool surfaces, and I'll explain the difference when we get to those. But let's start with foundation activities.

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So the first step is to research what is already going on in your area. Many cases, cool surfaces are incorporated into existing sustainability strategies, climate adaptation plans or strategies, building codes, laws, utility or other incentive programs – that sort of thing. So you want to find out if there are already – Perhaps you have some cool roofs already on your buildings, and, if so, are they high profile buildings? Identifying who has already made this decision will help you develop a stakeholder group to move forward on a broader scale. So to answer these questions, we recommend that you identify the following resources. Things like

finding the existing sustainability strategies, looking through your building and energy codes at the local level and the regional level, identifying utility incentives, and any local regional or national incentives or finance programs or local laws. You may also want to take a look for aerial or satellite imagery or thermal maps of your area. This will really help you pinpoint where your hotspots are, and then help sort of lay the groundwork for how you address those hotspots. The tool kit includes a number of sites where such imagery is publically available. One example would be the NASA ASTER program.

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So another early step is to gather as much relevant data as possible to help determine the local potential for cool roofs and pavements. Information like building type, pavement types, climate and weather patterns, air quality statistics, heat and pollution related illness statistics, energy costs, and market availability of cool materials and installers is a good place to start. I mean, ultimately, you'll need to develop the economic case for adopting cool surfaces, and this is the type of information that you'll need to do that. Again, the tool kit includes a number of online resources that can help you find this information for your area, or, in the case where that's hard to find, we can help suggest a local resource to start with, whether that be a regional technical institution or a green building NGO or something along those lines that may help you with this process.

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So we've listed lasting foundation activities, but it's arguably the most important thing you can do early on, and that is to ensure a cool initiative and success – to insure a cool initiative and successful – is to build a support network. Public—private partnerships with key representatives from a broad range of interests can really accelerate a project or initiative. If you identify any existing cool buildings, reach out to the owner, facilities manager, and developer to understand their experience and to access their peers. At no surprise, but identifying funding sources is critical, and should be the early focus of your efforts. We found that a broad base of support from a number of different areas will open up funding opportunities that maybe a single stakeholder would not have access to otherwise. As interest for an initiative builds, reaching out to technical resources to support the process will be important. And several such resources are listed in the guide and would be a good starting point. You may find that you

need to build local technical capacity, and technical contacts from the guide can help you do that.

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So now we have a solid foundation laid, we can now turn our attention to the policies and programs that will drive adoption of cool surfaces. Let's go ahead and start with programs.

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Programs refer to initiatives that support the development of cool surfaces. These are typically developed to complement policies which we will cover shortly, and can include awareness raising, demonstration projects which serve to raise awareness and provide data, volunteer programs, and contests. Engaging industry and NGO partners can help fund programs and can bring technical resources to bear. Measuring the impact of the programs quantitatively wherever possible will be critical to maintaining the sort of political and public support for these programs.

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Perhaps the most important way to gain traction with an initiative and leverage the effort of other stakeholders is to focus an effort on education and training. We discussed awareness raising to the general public in an earlier slide, but similar outreach is helpful for local technical institutions to become resources. Programs that educate designers and contractors and architects, who are, after all, the front line of cool surface adoption, are critical if you want the program to grow. One good example of this is in Houston. Houston developed a cool roof ordinance, a cool roof code requirement, and then spent significant effort in educating architects and developers on how that would work, how that would be enforced, and it significantly improved the uptake within the community and the enforceability of the code in the long run. And, again, we provide helpful training resources and examples in the tool kit to help get you started there.

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So are there any question so far on programs? Okay, if not, let's turn our attention to policies.

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So policies are often the force that really drives the market for cool surfaces through mandatory initiatives like codes, ordinances, and

procurement policies, as well as voluntary initiatives like incentives. Mandatory policies have proven to be quite effective at building the market for cool surfaces, and California is a great example of this. In California, a building code requirement for highly reflective flat roofs has led to millions of square feet of new cool roof added each month. And this has led to cost parity with dark roof materials. And actually, even cheaper in most cases for white roof products. Though getting cool roof surfaces and codes can be a heavy lift requiring time, analytical support, and a strong network of partners and political support, examples are appearing worldwide.

The tool kit includes specifics on good cool roof codes and laws in the US and elsewhere, and the new knowledge base actually has some model language that's based on some existing codes that we think are good, great examples of where we should be heading. Would mention though that a transparent system of product testing and rating and enforcement is needed to ensure that good codes have the intended effect. This may require coordination with national government and stakeholders. This is a key area of activity within the working group, within the Clean Energy Ministerial – so if this is an area of interest for you, or an area where that may be lacking in your local area, please contact us and we can discuss how to solve that.

Utilities can be an important partner in these efforts. They often hold the customer data, and they have the existing relationship with the customer. In many places, the utility will offer rebates for cool roofs based on the opportunity to reduce peak electricity demand, or to meet energy efficiency targets. I'd also mention – I mentioned financial incentives, so I want to call out one program in Mexico. The federal mortgage lender there is called Infonavid, and they run a very successful green mortgage program that includes cool roofs as one option for meeting the requirements to achieve a green mortgage. Incorporating cool roofs into financing programs like this are a particularly high impact way to drive market uptake. And, additionally, there is leading by example. Procurement or leasing specifications that incorporate cool roof requirements for governments and other stakeholders are an effective way to build awareness and to improve market availability of materials. They may also create prime buildings for additional field—testing.

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So, as I mentioned, there are many case studies scattered throughout the tool kit to highlight the real world behind many of

our recommendations. But I wanted to point out just one, since it captures several points we've discussed. New York City has been a leader on cool roof deployment. This effort started at the top, with a commitment by Mayor Bloomberg that was specific. First, it was to convert 1 million square feet of roofs per year to a white roof from a dark roof, and ultimately to cool New York City by 1 degree. They estimated that by doing that, by cooling by 1 degree, they could save the city $100 million in energy costs per year, and reduce their greenhouse gas emissions by 300,000 tons each year. They built strong partnerships across city agencies, and with industry and non—profit implementers.

Some of these implementers, or some of these industry groups, actually provided discounts for materials and that sort of thing, so there was a financial incentive to be involved. And they supported volunteer efforts that not only raised awareness of cool roofs, cool surfaces, but also targeted buildings that the private market may not have prioritized. In January of this year, the city passed a cool roof ordinance that was based on California Title 24, which is the building code there, that required new and replacement roofs to be highly reflective, and they are now working on a sophisticated plan to monitor and measure the impact that their cool roof program on the temperature of the city. This is a good example of how foundation—building efforts, along with programs that support the development of policies, can equal success.

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Okay, so that's really the end of the webinar in terms of my presentation. So maybe if there are any clarifying questions I can answer before we jump into a discussion?

Vickie Healey: Yeah, hi, Kurt, this is Vickie. One question that came in for you is – Are there any concerns with adding reflective surfaces on an urban scale that could create unintended consequences? And, if so, could you speak to what those unintended consequences might be?

Kurt Shickman: On an urban scale?

Vickie Healey: Yeah.

Kurt Shickman: I would say that the one issue – Well, I would first of all mention that there is always a balance between talking about this at a global scale and also sort of understanding the local market. The way cool surfaces will be deployed will depend on a number of factors – things like labor market, what's available in the marketplace, what traditional materials are used, the climate, the orientation of the

city – There's a number of factors that need to be addressed at the local level when you're coming up with a plan, so there isn't a one—size – While there are certain programs that can be easily adapted, there really isn't a one—size—fits—all solution here. So a lot of that type of issue needs to be addressed with local discussion and local information, a lot of which is available but it needs to be pulled together.

One issue that I didn't highlight – So we talked about the urban heat island effect, or rather we talked about the winter heating penalty, which can be an issue. But the – One other one that needs to be considered on a building by building or neighborhood basis is the issue of glare. So if you have a lower building surrounded by a bunch of taller buildings, and you make the roof white, there is a chance that that might cause glare into another building. So there are solutions to that. You can go with a green roof there, you can go with a different color roof. So there are cool solutions, but that's something that has to be addressed at the local, again at the local or even at the project level.

And I would also stress, and this isn't directly to the question, but that cool surfaces really need to be thought of as one part of a broader sustainability plan. They are very high impact and a great first step, but they need to be integrated with other efforts in the city, because frankly their benefits cross so many different aspects of the city, from healthcare to energy use to water management and that sort of thing – so it's important to think of this in the broader scope of urban sustainability when these programs are being planned.

Vickie Healey: Great, thank you. That was a terrific answer to that question. And, Kurt, I'd like to – if you have a little time, I'd invite you to, if you'd like, to open up the actual website and do a little demonstration of the tool kit so that –

Kurt Shickman: Oh, sure.

Vickie Healey: Okay, great, thank you.

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Kurt Shickman: Okay, so hopefully you can see this on my screen here as – I hope that's big enough for folks to see.

Vickie Healey: We can see it, yes.

Kurt Shickman: Okay. So this is, again, www.coolrooftoolkit.org, and there are, as I mentioned, sort of three main parts to this. First, we can go to the

guide itself. And you can see here that you can download the guide as a PDF, either the entire guide or individual pieces of the guide, and there is also an executive summary, which is an even shorter version, to give you sort of a flavor of it. The other option is to read it here on the embedded player, which you can just click on. And then sort of scroll through. And you can increase the size of the screen if you like. Oops. This is what happens when you leave a technologically un—advanced person to run these things. But in any case, the whole guide is available through the website if you prefer not to download it and just to read it online.

So this includes the first two pieces, which, again, is the primer, which has a lot of the basic materials that I just went through, and you'll actually notice a lot of the graphs come from there. There's also the implementation guide at the very end of this guide. And there's also a glossary of terms that sort of helps you get into the understanding of what people mean, both on the research side but also some of the implementation terms that we see. I'd also point your attention to this additional resources section. Each of these links is available in the tool kit itself, but we wanted to call it out separately for those that would rather just quickly go and download, or go and find resources.

So what I mentioned in the latter part of the webinar that there were links to organizations that can help them at the local level, this is one place to start looking for those. And finally, what we have just added is the knowledge base. So here, this knowledge base is meant to be a repository for not just scientific research, but really also aimed at the program implementer, either a city sustainability officer or an NGO or a company facilities manager or that sort of thing, to provide not only the background and the research, but also presentations, case studies, model language for codes and laws. Sample documents, so if you're interested – Let's say, for example, you wanted to set up a volunteer program similar to New York's.

You can go on here and actually find the RFP that they used to find an implementer, so you can use that to help create one for your area. Or to find things even down to the area of what were the requirements that they had for buildings to participate in the program, or what was the insurance waiver form – what did that look like? So it really helps to streamline your activities to be able to replicate what others are doing without having to spend a lot of time reinventing the wheel. So there's a number of different ways to use the search. You can simply enter a key word or phrase in this box here or here, and that will search it. There's also these pre—made categories that each entry is tagged with. So if you're

looking for, for example, you just want to pull only scientific literature, you can click here, and then refine your search throughout here.

So usually the way it searches is it will only pull up an item that is tagged with both items. So it restricts the search rather than expanding it. There's some most used documents and popular key words if you're looking to browse around. But we've also created this section here called 'featured topics', and this will change periodically. So this will focus on, perhaps, an organization that's doing interesting work, on a particular program that's out there that we might want to show some data from or some materials from. It might be something like a recent conference. So you'll have all of the pictures, all of the presentations, summaries and so on will be there, and you can easily get all of them by clicking on that. So let me give you an example. We pulled together what we're calling essential reading.

So you click on that, and we'll update this and curate this as we go, but you can see here that there's a little brief blurb on describing what it is, and then some examples of entries that we thought were interesting or we thought were a good place to start. So for example, let's just click on one here. Just to give you a sense of what these entries look like. So each of these entries will have the author and the organization that they're from – if there's additional authors or organizations, we include them here. There's a brief description of what it is. In some cases, it's the abstract from a scientific paper, or we try to give a brief summary of a presentation, that sort of thing.

Here's – If you just want to get a quick sense of it before clicking to download it or link to it, you can do that here. And then, when you get the file, you can download an actual PDF, or, in some cases, if you can't get the PDF, or the PDF's not available, you can go to the website and get it directly from the website. And this here shows how that was tagged within the system, so what categories were tagged or what specific issues are covered here. So that just gives you a bit of a sense of how this works. And you can always go back to the start by clicking on Knowledge Base Home and it will take you back to the front of the Knowledge Base.

So I think that covers most of the tool kit. Again, I'll mention that we look at this as a living website. Not only are we adding to the knowledge base, which is by the way already the largest source of urban heat island and cool materials information in the world right now, but we're also looking to add additional components or tools to this tool kit. We have some ideas. We want to set up an expert

matchmaking service that's specific to urban heat island – so that's one area that we're looking at. We're also looking to add some tools, some modeling tools. But as you're – but with your experience and interest, and this will get us, I think, back to the discussion portion of this –

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We're looking really to build tools based on what you need, rather than just to create tools. So as you're sort of developing plans or based on your experience if there are things you don't see there that you would like to see, we would very much welcome your input. And, again, at the end, I'll display my contact information so you can easily reach me. So was that – Vickie, did that cover the website in good enough detail?

Vickie Healey:

Oh, really well. Thank you, Kurt. It's so well organized and developed, and thank you so much for showing us how to sort of maneuver through it and navigate it. And actually, I found some great resources I think will be very appropriate for the Clean Energy Solutions Center. So thank you again for that. And now, I think what we're going to do – We're going to try something a little bit different from what we typically we do, but we're going to open up the audio to the whole audience, so we can get a discussion going, and people can ask questions by phone or over their computers, rather than having to type the questions in. So we're going to do that now, and I will remind the audience, if you're not speaking, to keep your audio device, be it your telephone or computer, on mute, so we don't get feedback and echoes and hear other noises that might be going on around your environment. So we're going to do that now, and if you'd like, Kurt, I can go back and review or recap on the discussion topic that was suggested.

Kurt Shickman: Yeah, that'd be great, actually. Thanks.

Vickie Healey: Okay, great. So the suggested topic is the role of traditional architecture and building practices in cooling cities – such as light colors, thick walls, wind power, and water features. And then the second part of that is also complex technical solutions for convert excess heat to refrigeration.

Kurt Shickman: Okay. So – Is someone jumping in?

Vickie Healey: No, you're good to go.

Kurt Shickman: Okay, so if I understand the question correctly, we're talking about the two ends of the spectrum here, which is how existing traditional "urbanscapes" can help play a role here, and how newer technologies can now play a role. So I would, again, stress that it's important to sort of take into account the local materials and labor conditions and things like that when planning cool surfaces programs. I mean for example, we have – there are some programs out there that are highly sophisticated using state of the art codings or state of the art roofing materials, but there's also very successful programs that date back millennia – for example, white houses in Greece, or the annual whitewashing that many homes in India do on their roof surfaces, that are equally effective and are appropriate for both the materials that are available, and labor costs, and sort of traditional labor.

So I would also stress that, again, we've sort of focused narrowly on roofs and pavements for this webinar. But water features, shade from urban plantings, is a critical component to this. And sort of thinking about urban planning and incorporating green space in that urban planning is certainly one way to help cool a city overall. So obviously, that's not going to be able to take – it won't be the majority of the city, or else it wouldn't be a city. So cool roofs and pavement will be a component of that, but certainly green space and green planning if you will – green vegetative planning – are an important component of this. In terms of the impact of more complex technologies, and I think you mentioned the sort of converting heat into HVAC – I mean currently those are high tech solutions that will work on large buildings and class A commercial buildings or government buildings, and those are great.

And I think certainly plans, sustainability plans that incorporate how to get those installed when there's opportunities to change out chillers or change out HVACs – those things are important. That said, there are also opportunities to do this faster, when a roof is being waterproofed, or actually even when a roof is in good condition. You know buildings where it's harder to justify huge expense on new pillar or a HVAC plant, we want to keep in mind that cool roofs are an option, they're an economic option that can help achieve urban heat island mitigation and global sustainability goals that are also economical or cost effective. Were there any other –

Vickie Healey: Go ahead.

Kurt Shickman: Go ahead.

Vickie Healey: I was just going to invite the audience to comment on anything you stated, or ask questions.

Kurt Shickman: I would also encourage – We have a series of questions here, some of which may be applicable and some aren't, but this is definitely a two—way knowledge exchange for us. That's how I look at it, because like I said, the local issues are important to how this gets done, and for it to be done right, there has to be a strong local flavor to this. So understanding your goals and obstacles can really help us in our efforts. So I'd be curious to hear what obstacles – If this is an issue that you're familiar with, or this is something that you have been tackling, what are the obstacles that you've faced? Or what are the types of things you've tried to do to overcome those obstacles?

Vickie Healey: Does anyone have anything to share on that with Kurt?

Kurt Shickman: And if folks would prefer to just catch up with me via email or telephone to discuss that, that's fine with me, too. These are sometimes hard forums to have discussions in.

Vickie Healey: Right. That's true. So we welcome anyone that thinks of anything that occurs to them later, or has questions later, to feel free to contact Kurt. And we'll be displaying his contact information on the next slide.

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So Kurt, thank you so much, again, for this terrific presentation. It was chock full of information and very informative, and we really appreciate you doing the demonstration of the tool kit itself, as well as the website. So real quickly, we'll wrap things up. And I just want to say that on behalf of the Clean Energy Solutions Center, I just want to thank everyone in the audience and especially Kurt for participating in today's webinar. If you'd like to, again – We will be posting, in a couple of weeks, actually, the slide presentation plus the recorded audio of today's presentation.

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So you can feel free to log onto the Clean Energy Solutions Center training page to review that at any time. And also, please feel free to share this information with your colleagues and those in your networks. So, with that, we'll wrap things up, and I just would like to wish everyone to have a great rest of your day, and we hope to see you soon at future Clean Energy Solutions Center events. Thank you, everyone!

[End of Audio]