Energy Efficient Outdoor Lighting

—Transcript of a webinar offered by the Clean Energy Solutions Center on 12 December 2012—
For more information, see the clean energy policy trainings offered by the Solutions Center.

Philip Jessup Director, LightSavers, Canadian Urban Institute

Neal Humphrey Global Research Associate, CLASP

Vickie: Hello, everyone. I'm Vickie Healey with the National Renewable Energy Laboratory and I'd like to welcome you to today's webinar hosted by the Clean Energy Solutions Center. Today's discussions will focus on rapidly growing technological advances and improved energy efficiency about your lighting and we are fortunate to have two great speakers today: Phillip Jessup and Neil Humphrey, who will be presenting today.

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One important note I've mentioned before we begin the presentation is that the — I have a little disclaimer I need to go over which is the Clean Energy Solution Center does not endorse or recommend specific products or services and information provided in this webinar is featured in the Solutions Center Resources Library. It's one of many best practice resources reviewed and selected by our technical experts.

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Before we begin, I'll quickly go over some of the webinar features that we have. For audio, you have two options where you may either listen to your computer or over your telephone and if you choose to listen through your computer, please select the mic and speaker option and audio pane on the right side of your screen. And by doing so, we will eliminate the possibility of feedback and echo. If you select the telephone option, a box on the right side will display the telephone number and audio type that you should use to dial in. And, we ask that you please move your audio device before the presentations begin. If you are having any technical difficulties with the webinar, take down this number. This is the help desk number for our webinar platform, and it is 888-259-3826 and you can call in for assistance.

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There's a couple of ways to communicate to us over this webinar platform and we welcome you to introduce yourself and you may do so by typing into the chat pane located on the right hand side of your screen. If you would like to ask a question, we ask that you use the questions pane, where you may type in your question and if you're having difficulty

viewing the materials through the webinar portal, you can find PDF copies of the presentations at cleanenergysolutions.org/training and you can go there and pull up the PDF presentations, follow along with our speakers through that. Also, I just want to let you know, we will be posting an audio recording of today's presentation through the Solutions Training page within a few weeks.

Next slide please.

And I will quickly go over the agenda that we have for you today. It's an exciting agenda, which is focused on the importance of efficient lighting. Phillip Jessup and Neil Humphrey will discuss the outcomes of case studies and other findings from the lightning between revolution, the rise of LED, LEDs and what it means for studies. This is a recent report, which was published by the Climate Group and they will also introduce a new street lightning evaluation tool that was developed through the street efficient equipment and appliance deployment at Michigan, also in [inaudible] [00:37:15] and that can be used by street lighting purchasers to evaluate cost and energy training.

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So, this next slide provides a bit of information, 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 and it's supported through a partnership with UN Energy. It was launched in April of 2011 and is primarily led by Australia, United States and other foreign country. Outcomes of this unique partnership includes supportive developing countries through enhancement of resources and on qualities relating to energy access and also no cost expert quality assistance and peer to peer learning and training tools such as the webinar you're attending right now.

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The Solutions Center has four primary goals. First, there's the clearinghouse of clean energy policy resources. It also serves as your policy best practices, data and analysis tools specific to clean energy policy program. The solution center delivers dynamic services that enable expert assistance, learning and peer to peer sharing of experiences and lastly, the center fosters dialogue on emerging policy issues and innovation occurring around the globe. Our primary audience is energy policy makers and analysts from government and technical organizations in all countries, but we also strive to engage with the private sector NGOs and also with civil society.

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Okay, in March we featured that the Solutions Center we provide is our expert policy assistance. We call this an Ask-An-Expert service and it's very valuable which is again offering free solutions center. We have established a broad team of every 30 experts from around the globe who are available to provide remote policy advice and analysis to all countries at no cost and I'm pleased to let you know that Christine Eagan, Executive Director of Class is our expert on standards and labeling policies for appliances and equipment and if you have a need for policy assistance on outdoor efficient lightning, standards and labeling or any other clean energy sectors, we welcome and we encourage you to use this very useful service. Again, this assistance is provided free of charge. And to request assistance, you can submit your request by registering through the Solution Center Ask an Expert feature at cleanenergysolutions.org/expert. And we also invite you to spread the word about this service to those in your networks and throughout organizations that you're in contact with. Some of the broad sectors covered by your experts include energy access, energy efficiency, renewable energy, smart grid, microgrid, clean transportation and regulation and utilities. And I'd like to ask, we're getting some feedback. If anyone is not on mute, we'd like to ask if you can kindly place yourself on mute at this time. That would be great. Thank you.

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So, there are several ways you can become involved with the Solution Center. We encourage you to explore and take advantage of the Solution Center resources and its services including the expert policy assistance. You can also subscribe to our newsletter and, again, what you're doing today, participate in webinars.

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We also have what we call our policy forum, which is a place where we have some very valuable articles, blogs, and things of that nature, which describes innovative policies occurring around the globe. So, we encourage you to read and comment on these blogs. And on our policy forums, there you'll find many interesting articles especially in the progress of clean energy policy development and improvementation in many countries worldwide. We also piled some more articles that were posted by our partners at the Renewable Energy & Energy Efficiency Partnership, Leonardo Energy, and we also have links of which podcast developed by Bloomberg New Energy Finance. Next slide.

And now, I would like to quickly introduce to you our distinguished panelist today. I am pleased to introduce Philip Jessup, who is director of LightSavers Canada at the Canadian Urban Institute. And next slide.

And also, today, we're joined by Neal Humphrey, who is a global associate at CLASP. And with that, I'd like to go ahead and turnover the proceedings to Philip. And, Philip, welcome. Thank you for joining today.

Philip Jessup: Vickie, thank you very much. And thanks to the Clean Energy Solution Center for inviting me to participate in the webinar. What I'm going to do in the next 15 to 20 minutes is to give you an overview of the results of the two to three year project called LightSavers undertaken by the Climate Group with 10 cities around the world including several in India, Australia, United States, U.K. and China, to pilot test LED street lighting and find out what the performance of that lighting is in the real world. I've been working on lighting issues for about five years now. My background is actually as a generalist. I was, for almost 10 years, director of the State of Toronto's climate agency called the Toronto Atmospheric Fund, and worked on a variety of issues. But lighting really attracts me because it is such a very significant consumer of energy around the world, about 19 percent of the world's electricity is accounted for by lighting use, and also, lighting accounts for a very substantial chunk of greenhouse gas emissions worldly. About 70 percent of the cars on the road, the emissions from those cars, are about equal to the amount of emissions that come from street lighting. Just in Canada, where I live, we have almost three million streetlights. And if we were to convert those over to LEDs, you are looking at a $1 to $2 billion investment and, really, significant potential economic development resulting from that since the LED supply chain in Canada is pretty robust and that would create quite a lot of jobs. So, lots of economic opportunities as well as the possibility of reducing greenhouse gas emissions.

Just a very quick background on LEDs. We're in the midst of a third lighting revolution, which started with the inauguration of LEDs in the marketplace just 10 years ago. We went to from gas and oil to electricity in the early 1900s. Later, around 1960, we went to high-intensity discharge lighting, which is what we primarily have in our streets now. Each of these revolutions are –

Vickie Healey: Phil?

Philip Jessup: Yeah?

Vickie Healey: Hi, it's Vickie. We're not able to see your slides. Are you – are they not yet open?

Philip Jessup: Yeah, they're up on the screen. Maybe we should go to the backups if that's –

Vickie Healey: Yeah. We'll take over control of the slides, if that's okay. And then, adjust them for you? Would that be okay?

Philip Jessup: Okay.

Vickie Healey: All right, then.

Philip Jessup: Yeah, I'm on slide number three.

Vickie Healey: Okay. Hold on. There we go. We'll advance to slide number three now.

Philip Jessup: Let me know when you're ready to go.

Vickie Healey: Okay. Is that the correct slide? Do you see it?

Philip Jessup: Yeah. Do you see the Eiffel Tower?

Vickie Healey: Okay. Great. So, all right. So, we're ready. Thank you.

Philip Jessup: Okay. Great. Super. So, we're in the midst of the third revolution as a result of the commercialization of LED, which are basically semiconductors, which push electrons across a quantum gap. And when they make that jump, they release photons in the form of light and it's a much more efficient way of creating lighting than the previous ways of creating lighting earlier, last century. Next slide, number four.

Some of the key benefits of LED lighting – one of the key benefit is that it's very highly energy efficient. On the market, now, we have LED devices at 165 lumens per watt. Your typical fluorescent light is probably around 60 or 70 lumens per watt. High-pressure sodium lights on the streets are, the most efficient, would be around 100 to 120 lumens per watt. So, LEDs have already assumed greater energy efficiency. They are also quite directional so you can put the light anywhere you like. It's quite uniform. You can see from this photograph here on the left. You have LEDs on the right. You have high-pressure sodium. You can see how you got hotspots on the right but the blanket of light on the left, with LEDs, it's much nicer. We're looking at longer lifetimes, much longer lifetimes. LEDs are very inherently rugged. There's no filament, ready to drop them. They're excellent for bridges, any kind of overpasses where there's lot of vibration. And the key one is that they're infinitely dimmable. You can control these electronic circuits very efficiently. It can create lots of innovative uses. Next slide, slide number five.

And there are some really key greening benefits of LEDs. In particular, compared with high pressure sodium light which gives off a very orange-ish sort of color, LEDs can provide a very good quality white light on streetscapes, and we found in the trials that we undertook that people much preferred the white light from LEDs. And in this one particular trial in Central Park, we found – surprisingly, the people were out picnicking at 9PM at night as you can see here in the LED trial area, and this is quite a surprise because Central Park is noted for its crime. And so, New York

has now retrofit all of Central park with this lighting. They're very, very pleased with it. You can reduce peak electricity use particularly in garages where lighting is on 24/7. You can use the savings from LED street lighting to create charging opportunities for electric vehicles. They're very environmentally sound. There's no mercury in LED lighting as there is in fluorescent lighting. So, they can be recycled and you don't have the environmental problems associated with it. And when you use adaptive controls with the lights, you can come up with all kinds of new innovative uses like emergency warning systems and so forth. So, that's the area that many cities are exploring. The LightSavers project started in Toronto about four to five years ago. LEDs were recognized by the climate agency, that I was director of, as a one of the potential leading technologies reducing greenhouse gas emissions. And – but those were very early days. We have first generation products on the market but there was a lot of concern that the performance wouldn't be there and there would be massive failures. So, we organized a project called LightSavers Toronto, and we're able to gain cooperation from a number of other municipalities in the region, and setup a whole trial process with a rigorous protocol and program to pass the parameters of lighting that we're concerned to lighting asset manager such as whether the light would remain consistent over time and whether the color temperature would remain consistent over time. And we also wanted to confirm, which into the time like really outrageous, energy savings with 50 percent or more. That project went forward and on our website, lightsavers.ca, you can see reports. You can download the reports if you're now in that project.

Subsequently, we scaled up the project with the Climate Group, where I was director of the lighting program, and recruited the cities such as you see on this map. This is page six. And they included cities in North America and Europe, but mostly in Asia. Several cities in India joined the program, and we set up trials in Kolkata, and some other cities there as well. The main aim of the LightSavers program is to transform the market. And in market transformation, we usually use the S-curve to describe the conditions over time of market penetration of different products, and it starts our slowly as you can see at the bottom.

We're now in slide number seven. And as people gained knowledge about the technology, more people use it, and we go up the S-curve. Then eventually, we reach that market saturation and things slowed down, and that's what results in the S-curve. So, what we've been trying to do is to shift that S-curve, and particularly the tipping point area is 15 to 20 percent of the marketplace, coming up with the measures that would help binding us at boundaries, overcome their concerns and the barriers to adaption of the technology. Next slide, number eight.

So, I'm going to give you some of the summary of the report published as a result of this project undertaken by the Climate Group. The report is

called, “Lighting the Clean Revolution: The rise of LEDs and what it means for cities.” And if you logon to the Climate Group website, you can find this report and download it. The report was very generously sponsored by HSBC and Phillips. And we’re very grateful to their support for us to be able to put that report together. I was one the lead authors of the report and it incorporated the results of trials with the cities as well a broad review of market information at the time particularly in China and India. So, first of all from the report, this gives you a sense of the energy efficiency of white LEDs. In the year 2000, the efficiency of this technology was quite low and barely registered on the radar. And you can see with the green line on the right, we are on slide number nine, that the energy efficiency of products in the marketplace has increased quite significantly compared with other technologies that are available, which are pretty much frozen. The most energy efficient technology currently in use in street lighting is sodium vapor. There’s both high pressure and low pressure. Not many cities use low-pressure lamps anymore, even though they are highly energy efficient because the monochromatic light from that technology is pretty awful. So, white LEDs are now a good deal, more efficient than all the other incumbent technologies that are available. Next slide, number 10.

LED is offered in developing countries in particular very significant economic opportunities. There are ranges of specializations along the supply chain that local industry can get into and manufacture. And marketing has been – indicate that we are looking at a global lighting market of $160 billion by 2020. So, it’s not inconsiderable market opportunity for countries that have senescent lighting industries, and many of them do. Just to give you an idea of LED streetlight scale up in North America, where I live, in Canada we have 200,000 streetlights now, that have – that they’re in the process of being installed that have one tenders, of the largest being Mississauga, which is just outside of Toronto, about a $49,000 – 49,000 unit of tender was awarded a few months ago. The largest retrofit in the United States is Los Angeles. They retrofitted over a hundred thousand LED streetlights at this point and quite a few other cities in the US are also scaling up LED streetlights. A lot of the funding for the streetlight retrofits in the US has come from the Economic Recovery Act, and so, some of the retrofits might be slowing down because those subsidies are no longer available. But the price of LEDs has come down quite remarkably. So, I think the continued pace of retrofits in North America would run in, see it continue. So between Canada and the U.S., I think we’re looking at probably about 500,000 LED streetlights either in the process of installation, or completed tenders, or already installed. Just to give you a sense of the trend in the prices of LEDs over the long term, the price of LED devices themselves has come down about 50 percent just in the last two to three years, and we’re now seeing multiple to just two or three compared with incumbent high-pressure sodium technology in terms of human installation. So, given the longer lifetime of the technology,

we're coming into the ballpark where this new technology and the old technologies are reaching parity. This shows the energy savings from some of the cities who were in the LightSavers project globally. And the average savings across all these cities was about 60 percent and this is the result of energy measurements taken in the field, at the pole, over a period of a year, averaged together. And so, we're able to confirm that very significant energy savings are really available with this technology. And in those cities where adaptive controls were used, for example, you see that the Sydney results over in the right. Two of those three were with adaptive controls. We're seeing another 20 percent savings or so. Most of these trials, the light produced was equivalent to or greater than the light from the baseline incumbent technologies that were tested in those trials. Next slide, number 14.

A key concern of lighting managers is whether the light output from LEDs streetlights is going to maintain an adequate level to meet compliance with local standards over time. 50,000 hours seems like an outrageous period of time as to 12 to 15 years depending on the operational characteristics of the streetlight system. What we found in our trials that probably two-thirds of the city is the performance over a year to a year-and-a-half was really quite good when you annualize. And in fact, half of the trials we saw, the light output increased over that period of time. So, this isn't intended to predict that those, that 50, 000 hour of lifetime, is going to hold up. But they were very good results. And, indeed, in the 500 luminaires that were in the project, we saw only six failures altogether. And the failures of those particular units weren't because of the LEDs. It was because of the particular driver or surge-protecting device that was in the luminaire, so very good results in terms of light output and color shifting over time in the trials. Next slide, number 15.

I'll show you just some results from Kolkata. We had a project in Kolkata with the Kolkata Municipal Corporation, and there we saw a very significant savings of 52 percent, the LED lights compared with the baseline lights. And the chart over on the left – this is slide number 15. The red is the LED. The blue is the high-pressure sodium baseline. Roughly, equivalent light outputs on the street from the LED, about 50 percent savings. On the right, you see a metric that we use to measure the system efficiency of the LED streetlights. The amount of lumens on the street averaged together per watt. And so, we saw that the LED lights produce twice as much light, 2 lumens per watt on the street, compared with the baseline. And this is really what – this is where the efficiency savings primarily come from. It's from the directional qualities of the light. The LED lights are able to put more light on the street than the incumbent technology. And as a result, we're seeing as much as 50 percent savings in this case in Kolkata. So, summary, just some of the key things that we learned in the LightSavers project, we found that the market is maturing and the technology has pretty much reached maturity. That

having been said, there are a lot of products in the market and many of them are very core products that don't meet some of the technical standards that lighting managers are going to ask for. In North America, both in the U.S. and in Canada, we find that there is very strong awareness of LED technology and also acceptance of it in our network. Here in Canada, we have over 50 cities. And when we started the project, which launched last March, we thought we would be doing a lot of awareness building but were not having to do that at all. The lighting managers are really aware of the technology. The problems now are overcoming the barriers that are there and that comes down to procurement, and financing, and dealing with sometimes hostile utilities. We are able to confirm the 50 to 70 percent energy savings from very rigorous trials all across the world. So, those are real savings that were there and the considerable lifespan of the technology, 50 to 100,000 hours. We need more test in tropical countries where there is more hot and humid weather. But the trials in Hong Kong were very encouraging, and also in Kolkata. Financing is the very key. The Kolkata project is being scaled up now with funding from the Asian Development Bank. And we need those international financing institutions to step in and to help the test. There were quite a few surveys undertaking with the public in the LightSavers cities, and almost universally, everybody loved LEDs.

I'll close just with a slide, number 17. Interesting. Some advice to policy makers. And I think that the key role that municipal and state governments can play in expanding the adaption of LEDs is through a procurement, because these governments own a lot of these lights. So, if they go out in the market and retrofit, they're going to create a market demand that can be satisfied by both local and international manufacturer. So, we need more aggressive retrofit activity undertaken by governments that own light, both of the municipal and the state level. We also need to standardize the technical procurements specifications. It is very complex, procuring LED systems. These are complex electronic systems particularly if they contain adaptive control circuitry. And so, we need to have some standardized approaches to procuring internationally. In some developing countries, there are real barriers to the ability of foreign-owned companies to bid domestically in the market. And we need to see more competition internationally so that domestic manufacturers could learn from the competition and can benefit from the best technology being up on those poles. We also need to modernize roadway lighting standards. And I know in India, the Bureau of Energy Efficiency is looking at this issue and it's undertaking an effort to bring up-to-date the standards that are there, that are decades old. And this is true of many countries even here in Canada. The North American RPA hasn't been revised as our local roadway standard in over 10 to 15 years. And for new urban development, we need codes to mandate LEDs, and we need domestic laboratory testing facilities so that LED luminaires and products can be tested locally and don't have to be shifted to another country to verify their quality. So, I'd

like to thank you very much and I'd be happy to answer any questions by phone or email. That's how you can contact me. This is slide number 18. And, again, thanks very much. You can turn it over, Vickie, to the next – to Neal, if you wish.

Vickie Healey: Sure thing. Thanks, Phil, so much. We have quite a few questions that have come in but I think we'll hold those until the end. So, with that, I'd like to turn the presentation over to Neal. So, Neal, thank you for being with us today.

Neal Humphrey: Thank you very much and thanks also to the Solution Center for letting me to present. So, today, I am going to be taking specifically about a tool that the Super-efficient Equipment and Appliance Deployment Initiative developed for a setting street lighting option. So, quickly, what we're going to go over today is a little about what SEAD is as well as their purpose of developing a street lighting tool, what's some of the features of that tools are, and what our plans are for the growing use of that and in trying to help improve the process of selecting streetlights. So, quickly, the SEAD Initiative is an initiative of the Clean Energy Ministerial, and it engages government and some private sector to tolerate market transformation for equipment and appliances in terms of their energy efficiency. So, essentially, there's a bunch of the free and participating governments encourage to work together on things for energy efficient equipment and appliances, and the initiative that they did, the projects that they do are things that are mutual interests to those country. So, the Street Lighting Tool was – and street lighting in general was something that was now be of interest to the all the countries that are in the working group for procurement. So, besides being generally in street lighting, why develop a selection tool in particular? And essentially, this comes to the problem that Philip touched on in his presentation about this new technology. So, with new fixture choices, things like LED lights, a lot of those savings is really actually dependent on the distribution of light and the directional characteristics of LEDs doing that, rather than having a single bulb with a reflector where it's going to design a reflector to get the lights with the appropriate distribution on the road. We can use individuality and have a lot more control over where that light goes. What that means, however, is that any particular specific road on has much more dependency on how much savings they will get based on which specific fixture you choose. And with lots and lots of fixtures out there, you need to analyze a lot them to find the ones that are actually going to suit your particular road. If you have a slightly different pole spacing or you have a slightly different road width, the particular fixture that works best for that road, so you can get the most savings, might be quite different. And it might be hard to tell that without sufficient photometric analysis. So, the SEAD Street Lighting Tool is intended to be of screening tool, to quickly assess a lot of fixtures all at once, particularly for a retrofit scenario. So, you can enter the basics of a single road configuration, for example, the road that you have

currently with the pole spacing and that you have currently, and run a lot of fixtures at once to pre-screen and figure out the fixtures whether it worked during follow-up analysis on.

It's a simple five process that's meant to be easier for people that are unfamiliar with lighting analysis and also simpler for, just during a pre-screening, for people that do know how to do traditional lighting in office. Let's see if I can switch slides. There we go.

So, the tool is a free software tool distributed by the SEAD Initiative, and it analyzes both the energy use as well as the light quality and lifecycle cost information. So, the tool can be used for batch calculation of dozens or even hundreds of fixtures at once, which is particularly usual for retrofit scenarios where you're trying to figure out this right fixture without necessarily changing the location or the station of the poles. It's a streamlined analysis process used in the initial stages that has limited configurations of the road that you can use of only the straight road, lane sections and such, no intersections or anything, but then you can use for, during the first kind of pre-screening process, and it can be an introduction to a photometric analysis for first time users that haven't done that type of analysis before. So, quickly, the kind of – these over here are some of the features, that the core purpose of this is, as I said, is really integrating the photometric analysis, light quality analysis of the batch of fixtures with the energy consumption and lifecycle cost. So the – it's based on Excel. So, you open as an Excel document but it uses macros and Visual Basic to form along the calculations, and it's compatible with 2003 or later versions of Excel. It's available in English, French, and Spanish. And they were built to allow for additional translation and they can support during additional languages. If there's a need for a particular country, the partners can help to get, figure out how to do the translation. And you can download it from superefficient.org/sltool. When you open the tool, we'd laid out the steps for an analysis, one by one, from the first step of converting your road, the first step in running an analysis. As I mentioned, we limited the road configurations to make it more streamlined for an initial analysis. So, currently, we have two, four, and six-lane roads with user specified lane width. Three of the most common pole configurations, either a single-side of the road, staggered across the road or two fixtures on a single median-mounted pole. And then, you can just enter the information on pole height, spacing, etcetera.

For fixtures, we've included several generic fixtures, 37 to be specific, but these are really meant to be more for learning how to use the tools than they are for during analysis. It's such a wide variety of the performance of fixtures that it's difficult to include enough of them and also to keep current with changing technology. So, users can also add their own fixtures by uploading the IES data, which is the information that was provided by the manufacturer about the light distribution of that fixture.

And that image down there shows the type of information that would be included, which is the light output of the fixture at various angles. The fixture calculations are done using the IES methodology. So, there's two main methodologies done by The Illumination Engineering Society of North America and that like on CIE, which is used more often internationally. But they use very similar calculations, just slightly different input assumptions. So, currently, we all may have the IES method, although, we are looking at and planning very soon to implement adding the CIE calculation method. [Rascal] [1:15:00] results show, which fixture meets your light level or uniformity targets, made outputs in two different formats, so one is per kilometer per year equivalent cost of electricity and some net present value calculations. So if you're doing just a single fixture, you can quickly just compare a baseline fixture to an upgrade by selecting which fixtures you want to put on that road. And we can see that both energy and light performance information as shown here. But more importantly for a large number of fixtures, the tool is designed for looking at a batch of fixtures all at once. So it's, when you're trying to find which fixture is appropriate for a roadway, being able to analyze a lot at once really accelerates that process and letting managers find which fixtures are worth in-depth analysis a lot quicker. So, this is the example of how we present the energy use of fixtures filtered by which of these fixtures actually meet the lighting criteria that the users input. And we did our basic financial analysis in there, and this critical example shows the net present value of the lifetime cost. It includes maintenance cost, energy cost and installation cost.

Going forward with the tool. Right now we have the version one of the tool that's available for download for use. It's functional and we have done a bit of an analysis and implementation of it. We're looking for, during some implementation partnerships, and actually we're during our first one of those starting in January with LifeSavers Canada and with Philip Jessup, who just presented previously. We're also looking for additional locations to do this info. If you're interested in using the tools and found them very useful to your location, we'll be happy to help you out more with doing that, if you want a big implementation partnership. What we're trying to do with those is really to get feedback on the tool, find out the usability of it by actual lighting managers, lighting in real world projects, and to those get feedback, look at ways we can modify it as well as get assurance to future users by having them used it in real projects and show them how it can be done. The information from these partnerships will be used to inform upgrade to the tool, improve usability, make sure that the inputs are [indiscernible] [1:17:54] and readily apparent to the new user, make that it's very beginner friendly.

Now, improving the financial analysis and then, as I mentioned, we're getting ready to add the CIE calculation method to make it more directly applicable internationally. In addition to, parallel to doing a software tool,

we're going to continue dissemination of the tool. Particularly of interest, we're going to be working on to improve training and documentation on how they actually use the tool. And then, going forward from that, SEAD, in general, is interested in improving the selection process for streetlights and helping lighting managers understand what their choices are and how to best choose fixtures. And so, we're looking at maybe considering some additional projects besides the Street Lighting Tool, whether just other barriers in that process.

So, just quickly on these tool implementation partnerships. I had mentioned the first location, the LifeSavers Canada beginning next month. And we are looking for additional locations from the benefit of doing that [powered art] [1:19:12] from direct training on the tool, some assistance in performing an analysis for your project, and then the output will be a case study report on that experience in during an assessment of the lighting situation in that particular location. And the things were looking for from partners for that are, locations that during an initial planning stage, during an installation of streetlights, particularly new LED ones or upgraded fixtures of some type. We want this partner to provide a feedback on how usable the tool is, what features they like, what they don't. And the partners need time to be available – there's time available for helping and conducting those analysis. So if you're interested in that, just email. You can get information or you can visit the same website where the tool is located and its sltoolkit@superefficient.org.

And that concludes my presentation. I know, I think that we're going to have questions for both Philip's presentation as well as mine at once. So, Vickie, if you want to back control and see if there are any questions.

Vickie Healey: Okay. Thank you, Neal and Philip, for the great presentations. And I – we do actually have quite a few questions that have come in. I believe this is something I should direct to you. I know you have a slide on markets in developing countries but we have a question asking specifically if you have market shares of LEDs in different economies available.

Philip Jessup: Yes. I think if you take a look at the report, there is some market information internationally. China is the biggest market right now. They are about 700,000 or more streetlights installed, LED variety, in China. So they have a large part of the global street lighting market. Most of that product is manufactured in China because there are various restrictions to foreign companies selling their products there. But there is some pretty good market information in the report. It is about two-years-old now. But if you're interested in knowing where to get further market information, I can steer you to the consulting companies that do that research over time.

Vickie Healey: Okay. Thank you. That is perfect. And, okay, next question. I'm just waiting for it really quickly to make sure I state it correctly. The average

elimination level required on A1 category road is 30 lux as per IS 1944. By using LED street lighting, can we reduce 30 lux, as LED has better CRI?

Philip Jessup: Yeah, Neal might want to kick in on that one as well. I don't see. I don't think that CRI would be used as the parameter for measuring compliance with roadway standards. It would primarily be the average illuminance and uniformity measured with the light meter, so topic of measurements, not to get too technical here. But, yeah, the Kolkata slide, which I showed, I think the incumbent technology was around 30 lux average and the LED luminaire that was there also produced about the same amount. So, it is possible to meet 30 lux average illumination standard and say 50 percent energy and that was what Kolkata was able to show.

Neal Humphrey: Yeah. And I think, if I understood the question correctly, reducing the load that –well, first of, it depend on the regulations. Philip and his presentation mentioned the need for standards to take into account the benefits of [indiscernible] [1:23:49], characteristics of LED lights. That's more to do with the color and the temperature than it is to the color rendering index or the CRI. So, currently, I don't know of any standard that right now lets you reduce that light level. Some locations, if they're using those standards for guidance rather than as law, they can reduce it and achieve equivalent performance, and there is some research available that does indicate how much benefit you get from that color temperature. But currently, I don't know of any standards that actually take that into account, although, there are often discussions about getting that into some of these standards.

Philip Jessup: Yeah, just to add to that. The British roadway standards actually do allow on local neighborhood streets, a factor for white lighting that enables you to ratchet down the traffic pedestrian conflict levels, so if you take a look at the British standards, you'll see something in there. And increasingly, municipalities are taking matters into their own hands because in trials that are being held locally, people living in neighborhoods are saying, "Please, give us more this kind of light. We like this and we much prefer it to high pressure sodium lights." So, Ottawa in Canada, for example, it's a city that has incorporated a 50 percent reduction in the amount of the topic elimination required on certain streets, which is in their local code. The LightSavers did a study of policies in Canada and there is a report on our website, which takes a look at some of the innovations that were occurring maybe two years ago in terms of these questions. So if you go to the LightSavers.ca website, and look for that policy study, that will give you some examples.

Vickie Healey: Okay. Thank you both. That was really great question, good answers. So, the next question is focused on the manufacturing sector, and the question is regarding opportunities for local manufacturers. In LED streetlighting,

is there a reasonable minimum annual production volume that would be needed for local manufacturing to make a sell, to build sufficient design RMD kit capacity and how is some economy is to go? Or is it likely that most manufacturing will end up with [geomassive] [1:26:45] such as in China has the current with CFL?

Philip Jessup: I'm not sure I can answer that question directly because I'm not that familiar with the economics of manufacturing. But I do know that we – LightSavers work pretty extensively in India, and the first workshop that we held there in Mumbai for manufacturers in the city is – the manufacturers who brought their products in that conference were – they were mostly small firms, sometimes family firms, and they came with all kinds of sort of weird and strange designs. And the major lighting companies in India had knocked up into this area as yet. And then, a year-and-a-half later when we did the procurement process, working with Kolkata Municipal Corporation, the KMC, we saw a number of really good proposals from them, from Indian lighting companies. And in a subsequent procurement process was there. The product got even better. In Kolkata, the product that won the tender was Western product, actually, a Canadian-made product. But [Paudiya] [1:28:06], which is the court of Kolkata, when they did their procurement with us, it was an Indian company that won the bet. It was really an excellent luminaire. So, I think that the companies that make lighting products can adapt very quickly if got smart scientists and managers, and potentially through joint ventures and other heights of arrangements can acquire and licensing IP, that's necessary to go forward. It's basically an assembling process, like making automobiles. You acquire the LED devices from one place. They're probably going to be – it's going to be probably the U.S., or Malaysia, or Europe, and you're going to acquire the driver in someplace else, but a lot of the work, the circuitry, the luminaire itself, the casing, all that can be done locally. And as we saw in India, the companies, they are adapting very quickly to the market.

Vickie Healey: Thank you. Well, thank you so much for that. The next question is focused on payback period. The question is, "What is the payback period if we install LED street lighting in place of 250 watt high pressure sodium vapor?"

Philip Jessup: Neal, do you want to answer that given the financial analysis you can do with the SEAD Tool?

Neal Humphrey: Sure. So, a lot of that, the main driving factor that's going to be the price you can actually get the LED lights for. And so, you know, because of the idea of doing analysis with the SEAD Tool is you can look at putting input of what the cost is going to be for how much it costs for you, for your local labor for installation, how much it costs for you for the actual purchasing of fixtures and then how much energy, [inaudible][1:30:23.4].

It can vary very widely depending on what you are able to do. One analysis option that we're trying to add to the tool right now that is not quite yet available, but it will be soon, is to actually show the curve of what costs you would need to procure the lights for to get a particular payback. So if you need 5 year payback, the initial analysis would show you for any particular fixture given its energy use what cost you would have to achieve from manufacturers to get that, and those input from Phillip about how [inaudible][1:31:12.6] We're adding that feature to the tool. In terms of, in general, the typical payback, Phillip, maybe you can share how that came out in these pilots that you did. What are some example paybacks work that you have available?

Phillip: Sure. I should just first say that the key variables in payback are the avoided cost of electricity. In locations where electricity price is high, the payback is going to be a lot faster. Where it's low, it's going to be much slower. That's a very important factor in simple payback, it's just the avoided cost of electricity. In some cases, I know in India we found that savings had nothing to do with electricity consumption because the city was paying a fixed fee per pole. So, saving energy didn't actually cause any energy cost savings. It required some negotiation with the utility in order to factor that in.

The second important variable is, maintenance cost. And, you'll find, if you look at the markets where LEDs are really succeeding currently, it is in markets where in the maintenance cost are very high. So, bridges, tunnels, any place where it's expensive to change a bulb, you're going to find that the economics look much better. For example, in New York, the urban roadway there FTR drive, their maintenance costs are a hundred dollars per pole, roughly, and much higher than actually the electricity cost savings would be. The economics look pretty good for them even though the cost of the luminaries were fairly high. So, you need to take a look at those two variables. When Toronto originally undertook its project, when you download some of those reports, if you do, from Toronto and the neighboring municipalities, you'll see paybacks of 10-15 years. That was 3 or 4 years ago. And, those were luminaries that would have been bought in small batches. We're now seeing paybacks of 5 years, 5-7 years where electricity cost are around 7 or 8 cents per kilowatt/hour. We have a city here in Ontario which, North Bay, which registered all of its 6,000 streetlights and a payback of 5 years or less.

That third variable, as Neil mentioned is the volume. This is where the government, state governments and state governments could step in. If they can develop an aggregate procurement model so that they can buy in volume, pre-qualifying the best luminaries ahead of time, and that's where the seed tool I think could be very, very useful. And then, purchasing on behalf of municipalities, I think that makes a lot of sense. I know India has some history in this aggregate procurement for other technologies. We're

currently finding that the capital cost in Canada and the US for volumes of say 4, 5, or 6,000, we're seeing the cost of luminaries only twice as much as upgrading the existing poles with high pressure sodium. We're coming close to [inaudible][1:35:11.8].

Interviewer: Great, thank you. Next question is focused on Africa. The question is: are there any African countries participating in the program and if not is it because there's a lack of awareness of the program or are there other reasons?

Phillip: Currently, there aren't any African countries or cities participating in the Light Savers Program. That would be primarily because of funding. There hasn't been funding available for that. But I'm sure that Neil and the folks working on the C tool would be keen to work with some African cities. Neil, you want to address that?

Neal Humphrey: Yes. That's true. We're doing the analysis with the C tool. We're certainly interested in working with African countries that are interested in looking at doing some analysis for their specific situation and we'd be happy to help them understand how our tool works as well as any additional needs for resources that might be there for really getting some street lights installed.

Interviewer: Great, thank you, Neil. This next question is a little vague but I'll present it. The question is, is it possible for a company or an individual to apply to expand the use of this methodology or must it always pass through the government in cases where they need street lighting?

Phillip: Neil, you want to try that one?

Neal Humphrey: I'm not sure I understand the question.

Interviewer: It was a little vague. I will ask if the requestor of that question re-submit it with a little bit more detail and I'll present it to our panelist again after you submit that. Let's see, next question is directed actually to you Phil. [inaudible][1:37:41.5] has the best street lights installations, is it most sufficient in India and better maintained. [inaudible][1:37:55.7] city received 4 national awards during the last 4 years. I think the question is, have you done any analysis on that particular location and how would it compare to the Calcutta example?

Phillip: Yeah, the Light Savers Program in India focused primarily on just a few cities, that was Calcutta, Haldia and Tani, which is a suburb of Mumbai. The funding that was available just allowed the climate group to work in those 3 locations. Subsequently, I think that the climate group received funding from the British government through their prosperity fund to expand the program to other cities, to workshops and some technical assistance. I'm just not familiar with whether they've been able to reach

out to [inaudible][1:38:57.9] at this point but the initial cities were Tani, Mumbai and Haldia. The report on the trial from Calcutta should be available publicly in about 3 or 4 weeks.

Interviewer: Great. Thank you, Phil. Next question is: how do we deal with [ianudible][1:39:28.3] in cases of sodium vapor versus LED lighting?

Phillip: I think both Neil and I can address that. I think when you're procuring LED lights the key technical report you need to ask the manufacturer submitted is the IES, Illuminating Engineering Society of North America, LM-79 report. In those reports by independent testing laboratories, it will tell you what the luminous efficacy of the luminair is, in other words, the amount of light output per watt. Using those reports, the LM-79 reports which should be required in the procurement process, you can compare one product with another and compare that product somewhat with the efficiency of high precious sodium but you do need to do some very quick field testing to compare. Sometimes the lab reports don't actually predict what the field results are going to be. There may be some design differences between the 2 luminar products that aren't accounted for in the laboratory tests. We sometimes found that in the trials we got quite different reports in the field than what were shown on the lab tests. Neil, do you want to kick in on that with the tool results?

Neil Humphreys: Sure. I guess with the tool, what an analysis would let you do is if you get a photometric data and in connection [inaudible][1:41:31.5] you can compare the lumens that come out of that fixture could actually mean for your roadway in terms of actual light delivered to the road way. That really let you put them on [inaudible][1:41:46.5] comparison. Instead of just looking at your lumen output, you are able to look at light delivered to the road way. That's hopefully one way to make it a little bit easier to compare between the 2 technologies.

And then, one other thing that I did want to add that Phillip's comment reminded me of, maybe not directly answering this question, but it is important to note that besides the information that you get just about the photometric performances that you would use in this pre-screening that we're suggesting with the C tool, you do want to do some good diligence on the quality of the products and the LM-79 report that Phil just mentioned is definitely one of the key tools for that.

Another really useful resource to be aware of is, each year in the US the Municipal Solid State Lighting Conversion (MSSLC), they built a model specification which is tailored for the US but a lot of it could really be applied internationally. If you look through the details and modify anything as necessary, it's a good model for the basics of things to request from a manufacturer to get a better chance of getting a high quality fixture. I recommend people take a look at that resource and consider applying

some of the elements of that model specification if they're looking at procuring LED street lights.

Phillip: I'll just add to Neil and say that Light Savers Canada is going to be publishing a model specification for LED street light luminaries in January, in about 4 weeks or so. We took to look at the US models back and also at some very good procurement documents developed by some Canadian cities. We've developed something specific for the Canadian market but there may be some elements of that spec for Canada that may be useful for others, so take a look at our website in about 4 weeks, lightsavers.ca and download that. Perhaps it will be useful.

Interviewer: Great, thank you. So back to the—we have a little clarification on the previous question which is, is the methodology really only limited to government implementation or can individuals or companies apply that methodology?

Phillip: Neil, I guess the C tool could be used by both private companies and government, couldn't it?

Neal Humphrey: Yes, definitely. It's to run regardless of the user. Based on the inputs of what your road is like, what your fixtures are like or what your potential fixtures look like, what performance you'll get. So whether that analysis is done by a manufacturer to supply a potential project, a potential costumer or whether it's done by government, or whether it's done by a third party, that's all useful applications of the tool. Certainly, take a look at it and see if it's useful to your application.

Phillip: In Canada, I see a very good use for it by private companies in many Canadian cities when there are new subdivisions built by developers. They are responsible for installing all of the new infrastructure, which includes street lighting as well as sewage. These developers could potentially use the C tool for modeling out what the benefits and costs would be of installing conventional street lighting versus LED lighting. I think the new urban developments that are undertaken by private companies, the tool could be quite useful.

Interviewer: Great! That's great. Thank you. The next question is geared toward justifying investment in LEDs. The question is, in India the payback period of LED street lighting is 8-10 years. The question based upon that is, how do we justify investment with that long of a payback period?

Phillip: I think both Neil and I can answer that. I think increasingly in North America, lighting asset managers and financial officers are looking more at return on investment (ROI), to compare what their return is going to be over time for their investment rather than looking at simple pay back. The problem with looking at simple payback is you are not really capturing the

total life cycle benefits of LED lighting, which might last 10-20 years. You're just seeing what the initial simple payback is going to be. When you use ROIs as method of comparing investments, which is how the private sector works, you are able to incorporate those sorts of benefits. But even that having been said, 8-10% simple pay back is about a 10-12% return on investments, probably in that range. That's not a bad investment.

Interviewer: Right.

Phillip: Neil?

Neal Humphrey: I would also say, looking at ways to bring that 8-10 year pay back down through looking for a wide variety of fixture choices and maybe trying to get some competing bids on fixture process for an installation like that would be useful. The idea with the C tool is being able to look at more fixtures so you have more choices and look at the finances for them. You can say, if we need to bring the cost of them to a shorter pay back, what's the price that we need to get and use that to actually work with manufacturers. Part of that process might also be trying to see if there's ways to lower that. I know another element might be with looking at, as Phil mentioned, sometimes if there's a fixed utility cost per pole or if there's a non [inaudible][1:49:01.3] light fixtures, street light fixtures on metered cost per kilowatt/hour is not necessarily directly used in most of these arrangements. That can be difficult process to negotiate with utilities but there are some examples of that being done to have the cost of the electricity be in line with the actual energy being used. That can also bring pay back down.

Phillip: I'd also like to add here that pay back is very, very location specific. You have to be careful about making generalizations. Just in one city for example, if you have a neighborhood that has poles and lighting that are 30 years old and the paint is the only thing that's holding them together and you need to upgrade the whole system with new poles, and arms, and not just the luminaries, the pay back is going to be much shorter because the incremental cost of the LED technology on top of all the other infrastructure upgrade is going to be much less. In a neighborhood where you're replacing older infrastructure compared with a neighborhood where you're upgrading thoroughly new technology, the pay back is going to be much better. It's all very location specific and I'd be careful about making broad generalizations about pay back. What you want to do is to figure out where your best economic benefit is going to be and prioritize them based on age, and other types of factors and then proceed accordingly.

Interviewer: Thank you, both of you for that great answer. This next question is probably the million dollar question that we all would like to consider. It is, do you have any thoughts on how long it would take to replace conventional lighting with LED?

Phillip: Neil, you want to take that one first?

Neal Humphrey: The S curve from your presentation might suggest that.

Phillip: Yeah, I think that the market will evolve fairly rapidly after 2015. I think that once LED prices come down and reach parity with conventional technologies then it will just be the replacement will definitely speed up. I think the quicker that we can get to higher energy efficiency the better. We have huge greenhouse gas emissions coming out of electricity systems worldwide. We don't have a lot of time, the Arctic is melting and we're already seeing some very devastating results from global warming. The faster we can get the technology in the market, the better. That's where the government comes in, government through standards, particularly through procurement, through providing funding for trials. The fewer energy efficiency in India has been very, very forward looking in terms of working with cities to promote the technology. Government when it steps in can speed up the adoption of technology in the market place. It doesn't necessarily have to involve huge subsidies.

Neal Humphrey: From the seed perspective, what the seed initiative is really trying to do is first with this tool, potentially with some other future projects, is how can we make the process easier? And if we make the process easier for locations that has streetlights and that have heard of the technology and may be considering doing it, then they can do that a lot faster. There's really a lot—enough awareness, I think, at this point that we are getting to a tipping point where there could be some increase installation of these rather than just being featured, case studied and featured. Example, showcase installation could be a little bit more mainstream, and they are something that are in most cases a cost effective choice to make and they do require a little bit of capital investment so there's always the competing concern of what else could you do with that money. But we're hoping that by making the process easier that can really help accelerate it.

Interviewer: Okay, thank you so much. Next question is a 2 part question really. The first part of the question is, does the program provide any funding for capacity building activities such as seminars and or workshops. The second part of the question is, are there any programs to develop testing labs and research centers for LED technology in India?

Phillip: In terms of Light Savers, I'm director of Light Savers Canada, we do have funding that we're quite grateful for from the government of Canada, Natural Resources Canada, and also from the Ontario Power Company, here in Ontario where I live, to organize workshops, provide technical services and so forth to our network of professional lighting asset managers. We have 50 cities in our network and we're actually conducting a major workshop in Vancouver in January. If any of you in Asia are interested in coming to that, we'd be happy to have you attend that

workshop. I'm just working in Canada, I'm not aware of what the climate group is now doing in India, but if you contact [inaudible][1:55:44.4] in the Climate group's India headquarters, which is I think in Delhi, she would be able to tell you about the workshops and so forth that are available there.

Neal Humphrey: For the seed initiative, we're certainly very interested in partnering with locations in India. I guess the specific of what—I'm not sure what the person asking the question was thinking of in terms of funding for workshops and such, but we're certainly interested in working in locations in India both for the tool of specifically incurring information on that and working with other locations as well as other street lighting related efforts. Whoever was asking that, feel free to email me. I didn't have my email out there, I apologize. But anyone who has further questions, my email is N as in Neil, Humphrey, H-U-M-P-H-R-E-Y @clasp, C-L-A-S-P, online.org (nhumphreys@clasponline.org) or the SL tool kit @superefficeint.org that was up on your screen earlier. And, you could see on the seed website when you download the tool is also a good way to get in touch with me to talk specifically about any workshops or efforts in any of these countries.

Interviewer: Great, that's great information for everyone. We're almost out of time and I would be mindful of everyone's schedules. I think we have time for one more question before we wrap up. This is also a question coming in from India. The question is, assuming the effectiveness of LED lighting, it largely depends on the 5 conditions such as pole height, the difference between the pole consistency and things of that nature, taking the case of the Indian municipalities' road where you don't find such a supportive scenario, would you recommend the road for LED lights by replacing the high pressure sodium vapor and sodium vapor lighting?

Neal Humphrey: Again, this could be the key reason for considering the seed tool for analysis because of all the factors that were mentioned of the pole heights and such, and really what we think is, at this point, with the [inaudible][1:58:31.3] quantity of fixtures available in the market, there should be one appropriate for, and it really gives energy savings compared to high pressure sodium and is worth investing in for any particular road configuration. During that analysis, the best way to find the one that work for a specific situation but I do think that there certainly will be a fixture help there that works well for any given road.

Interviewer: Okay, thank you, Neil. Phillip, did you have something to add? I wasn't sure.

Phillip: I think it just come down to whether you are able to save money, improve the quality of lighting on the street, white lighting is certainly more neighborhood friendly than high pressure sodium lighting is. If you have

the cooperation of the utility so that you can realize those energy savings then LED lighting is something you should definitely look at.

Interviewer: Okay, thank you. Thank you both. Since again were running up to the time limit of the webinar, I just want to say on behalf of the Clean Energy Solution Center, I really want to extend a hearty thank you to both Neil and Phil for this great presentation and all the terrific information you provided today to the attendees. Also, I would like to extend a thank you to our attendees for taking the time to participate in our webinar today hosted by the Clean Energy Solution Center. You've been a terrific audience, you've presented great questions and we very much, again, appreciate your time. I invite the attendees to check the Solution Center Website over the next few weeks if you would like to view the slides and listen to a recording of today's presentation. You can also find previously held webinars, slide presentations and audio recordings at that site. Additionally, you will find information on upcoming webinars and other training events. We invite you to please inform your colleagues and those in your networks about the Solution Center Resources, the services including the no-cost policy support that I mentioned earlier. With that, I would like to say I wish you have a great rest of your day and we hope to see you again at future Clean Energy Solution events. This concludes our webinar. Thank you!

Phillip: Thank you.

Neil: Thank you all.

Interviewer: Thank you. Bye.

Phillip: Bye.

Female Speaker: The organizer has ended the session and this call will be disconnected. Goodbye.