CLEAN ENERGY SOLUTIONS CENTER
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Large-scale Energy Efficiency in Indian Buildings: The Impact and Role of the Energy Conservation Building Code

—Transcript of a webinar offered by the Clean Energy Solutions Center on 2 December 2014—
For more information, see the clean energy policy trainings offered by the Solutions Center.

Panelists	Elena Berger, Science and Technology Fellow, U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, International Program Meredydd Evans, energy policy and finance expert Sha Yu, Scientist, Pacific Northwest National Laboratory Jyotirmay Mathur, Head of Centre for Energy and Environment, Malaviya National Institute of Technology, Jaipur Bhaskar Deol, Natural Resources Defense Council
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Emily Hello everyone. I'm Emily Evans with the National Renewable Energy Laboratory, and welcome to today's webinar, which is hosted by the Clean Energy Solutions Center in partnership with the Pacific Northwest National Laboratory. Today's webinar is focused on the Large-scale Energy Efficiency in Indian Buildings: The Impact and Role of the Energy Conservation Building Code.

One important note of mention before we begin our presentations is that the Clean Energy Solutions Center does not endorse or recommend specific products or services. Information provided in this webinar is featured in the Solutions Center's resource library as one of many best practices resources reviewed and selected by technical experts.

Before we begin, I'll quickly go over some of the webinar features. For audio, you have two options. You may either listen through your computer or over your telephone. If you choose to listen through your computer, please select the "mic and speakers" option in the audio pane. Doing so we will eliminate the possibility of feedback and echo. If you choose to dial in by phone please select the telephone option and a box on the right side will display the telephone number and audio PIN you should use to dial in. Panelists, we ask that you please mute your audio device while you are not presenting. If anyone is having technical difficulties with the webinar, you may contact the GoToWebinar's Help Desk at 888.259.3826 for assistance.

If you would like to ask a question, we ask that you use the "Questions" pane where you may type in your question. If you are having difficulty viewing the materials through the webinar portal, you will find PDF copies of the presentations at cleanenergysolutions.org/training and you may follow along as our speakers present. Also, an audio recording and the presentations will be posted to the Solutions Center training page within a few of weeks and will be added to the Solutions Center YouTube channel where you will find other informative webinars, as well as video interviews with thought leaders on clean energy policy topics.

Today's webinar agenda is centered around the presentations from our guest panelists Elena Berger, Meredydd Evans and Sha Yu, Jyotirmay Mathur and Bhaskar Deol. These panelists have been kind enough to join us to review the progress with ECBC implementation in India and analyze the economic impacts of ECBC-compliant buildings.

Before our speakers begin their presentations, I will provide a short informative overview of the Clean Energy Solutions Center Initiative. Then, following the presentations, we will have a Question and Answer session where the panelists will address questions submitted by the audience, then closing remarks and a brief evaluation.

This slide provides us with a bit of background in terms of how the Solutions Center came to be. The Solutions Center is one of 13 initiatives of the Clean Energy Ministerial that was launched in April of 2011 and is primarily led by Australia, the United States, and other CEM partners. Outcomes of this unique initiative include support of developing countries and emerging economies through enhancement of resources on policies relating to energy access, no-cost expert policy assistance, peer to peer learning and training tools, such as the webinar you are attending today.

The Solutions Center has four primary goals: It serves as a clearinghouse of clean energy policy resources. It also serves to share policy best practices, data, and analysis tools specific to clean energy policies and programs. The Solutions 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 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 engage with the private sector, NGOs, and civil society.

A marquee feature that the Solutions Center provides is the no-cost expert policy assistance known as "Ask-an-Expert." The Ask an Expert program has established a broad team of over 30 experts from around the globe who are available to provide remote policy advice and analysis to all countries at no cost. For example, in the area of Buildings we are very pleased to have Cesar Treviño, Leader Mexico Green Building Council serving as one of our experts. If you have a need for policy assistance in Buildings or any other clean energy sector, we encourage you to use this valuable service. Again, this assistance is provided free of charge. To find out if the Ask-an-Expert service can benefit your work please contact Sean Esterly directly at sean.esterly@nrel.gov or at 303.384.7436. We also invite you to spread the word about this service to those in your networks and organizations.

In summary, we encourage you to explore and take advantage of the Solutions Center resources and services including the expert policy assistance, the database of clean energy policy resources, subscribe to our newsletter, and participate in webinars like this one.

Now, I'd like to provide brief introductions for today's panelists.

First up today is Dr. Elena Berger. Dr. Elena Berger is a Science and Technology Fellow at the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, International Program, currently managing the portfolio of projects in renewable and energy efficiency in collaboration with India.

Following Dr. Berger, we will hear from Meredydd Evans. Meredydd is an energy policy and finance expert with over 20 years of international experience and has worked on energy efficiency and clean energy policies and projects in numerous countries.

Presenting with Meredydd will be Sha Yu. Sha is a scientist at the Pacific Northwest National Laboratory.

After Meredydd and Sha, we will hear from Jyotirmay Mathur. Jyotirmay is a mechanical engineer, with postgraduate degrees in energy from the Indian Institute of Technology, in New Delhi (India) and the University of Essen (Germany)

Our final presenter today will be Bhaskar Deol. Bhaskar is an India representative with NRDC's India Team and is based in New Delhi.

And with those introductions, I'd like to welcome Dr. Berger to the webinar. Dr. Berger?

Elena Thank you Emily for that introduction. So I'm waiting to see the presentation.

Emily And we're getting the slide up. Just give us one moment.

Elena Thank you very much and thank you for joining this webinar given by the US Department of Energy and organized by the Pacific Northwest National Laboratory (PNNL) with the participation of the Malaviya Institute of Technology (MNIT) and the Natural Resources Defense Council (NRDC). I thank you, our partners, at MNIT and NRDC for cooperating with us in organizing this webinar. Next slide please.

I would also like to acknowledge our great partners who helped us disseminate information about this webinar. Next slide please.

This webinar in our continuing work to support the adoption of building codes in India takes place within the framework of our bilateral partnership between India and the United States and in the recent meeting between Prime Minister Modi and President Obama the two leaders emphasized the commitment of the two countries in advancing the partnership in energy and climate change. Next slide please

The Partnership to Advance Clean Energy or PACE has three main components: PACE-D for deployment, PACE-R for research and development, and PEACE for energy access. Building codes belong to the deployment arm of PACE along with other energy efficiency activities, renewable energy, clean fossil, and clean energy finance efforts. Next slide please

The Partnership to Advance Clean Energy or PACE takes place under the umbrella of the Indo-US Energy Dialogue and its six working groups. The cooperation on renewable energy and energy efficiency technology are managed under two working groups: Power & Energy Efficiency and New Technology & Renewable Energy working groups. Next slide please

The Indo-US Collaboration for the adoption of ECBC is managed under the Power and Energy Efficiency working group. Under this collaboration DOE and PNNL have been engaged with the government of Rajasthan and MNIT since 2011 in two main efforts: training and institutional support and incentives. We believe that these efforts are very important to advance the main barriers that have presented the adoption of building codes in India.

On training, PNNL and MNIT have developed and delivered training workshops and stakeholder meetings in Rajasthan and have developed set of training materials on ECBC 101. On institutional support, PNNL and

MNIT have developed an ECBC roadmap in collaboration with the government of Rajasthan, and we have created an award to accelerate the adoption of the code by stakeholders in the state. You will learn more from my colleagues from PNNL that do provide in great detail and talk about these activities in Rajasthan.

More recently PNNL has collaborated with MNIT on two ECBC compliant pilot buildings at the MNIT campus and details about this pilot will be presented by Dr. Jyotirmay Mathur from MNIT during this webinar. Mr. Deol Bhaskar from NRDC will also provide case studies from successes in the state of Andhra Pradesh and I thank you NRDC for being a great partner all along in collaborating with us to disseminate the benefits of ECBC doing this webinar. I hope you really enjoy the information that we are trying to convey during this session and will be happy to answer questions at the end of this webinar. Thank you for your attention.

Emily Thank you Elena. I will now hand it off to Meredydd Evans and Sha Yu who will talk to us about the ECBC implementation, progress, lessons learned and options. Meredydd and Sha?

Meredydd Hi, thank you. While the slides are loading...great, I see them right there. I'd like to first say thank you for joining us and I'm looking forward to sharing a few thoughts with you. Next slide please

So, on ECBC implementation today I'll describe a couple of themes. First off is an introduction—why ECBC is important and what it is. I'll also talk about progress with implementation and some lessons learned in Rajasthan. Sha Yu will then describe tools for implementation and some takeaway points. Next slide

This slide you can see two figures that highlight the core reason for focusing on new buildings in India. They show projections that our institute has done using integrative assessment modeling. They present data on the likely growth in floor space in billion square meters, both in commercial and residential space, from now through 2095 as well as the linked increase in energy demand those buildings in a scenario where there are no specific building policies, like building energy codes. You can see there is a likely tremendous growth in the amount of floor space so by 2050 we are talking something like 35 billion square meters of new buildings. Energy use in those buildings would increase substantially as well. That could put tremendous pressure on India's power system as well as its overall energy systems and instead there is an alternative to save energy and to reduce the energy impact of those buildings while still maintaining comfort. Next slide please

So here you can see some analysis the business case for the ECBC. We show calculated savings for ECBC compliant buildings versus typical buildings in different cities in India. The savings are really impressive—

25%–40% of the energy can be saved, depending on exactly where the building is and whether it is a building that is used 24 hours a day or is used during daytime. Regardless, very impressive figures and what's more those savings are cost effective. Next slide

Which means that the savings themselves, the reduction in energy consumption, can pay for itself, can pay for the investments themselves. In addition, ECBC implementation can reduce CO2 emissions and it can accelerate deployment of energy-efficient technologies. Next slide

So, what is ECBC? Just a quick overview. It was issued in 2007 by the Ministry of Power and the Bureau of Energy Efficiency. It's mandatory in the states that have adopted it for all new commercial buildings with connected load over 100kW, basically for all large new commercial buildings. It's different from voluntary labels like LEED because it is mandatory and it applies to all buildings in those jurisdictions. ECBC addresses building envelope—so the walls, windows, etc., HVAC, lighting, electrical systems, hot water, and pumping. And it allows for three different compliance approaches: A prescriptive approach with specific levels of say insulation or specific types of windows allowed, a trade-off option with slightly more flexibility, and a whole building performance approach that requires the use of sophisticated building simulation software. So just to recap a couple of the differences between ECBC and green building labels such as LEED or GRIHA, ECBC is mandatory and it covers presumably all buildings in the jurisdictions that adopt it. ECBC covers only the energy provisions, so not other energy issues, other non-energy issues like water. ECBC is not score based but rather it's based on engineering principles. Next slide

Here is a little bit of information on the implications of ECBC for different stakeholder groups. I know that the next speakers will talk a little bit more about this so I will go over it quickly. For example, local governments or ULBs will need to add code requirements if they have not already done so in order to make ECBC effective. They also need to be involved in ECBC enforcement, for example, involving their party inspectors as one option. Manufacturers will likely see an extended market for energy efficiency products and materials. Real estate and construction companies will need to ensure code compliance during building construction for new buildings. Developers, like architects or engineers, need to make sure they integrate the code into their building design and that they document compliance for code authorities. Next slide

So, today ECBC has been adopted by a range of states in India. You can see the Bureau of Energy Efficiency lists the states and their status in terms of whether they have issued formal notification to make it mandatory or they're in some other stage of the process. The number of states is growing all the time and it is at that level that ECBC then becomes mandatory. Next slide

Focusing on Rajasthan, a few of the milestones there with the ECBC implementation: In March 2011, the Rajasthan government adopted ECBC with minor additions. In September 2011, then ECBC entered into force. Compliance became mandatory. Then in June 2012 another important step was that ECBC incorporated into the local bylaws, which made it formally a part of the process for approving buildings. Since 2011, DOE and PNNL have worked with the government of Rajasthan and MNIT to support roll out of ECBC and build capacity among stakeholders. Next slide

Finally, on my side, a couple of lessons in terms of the barriers of implementation. In a nutshell, it's capacity. In particular, state and local governments lack, in many cases, the capacity and resources to implement and enforce the code. ULBs would typically be the primary enforcement entities, lack technical expertise and staff to implement ECBC effectively in many jurisdictions. So that is an important barrier. Sha will talk about some alternatives that can help boost this capacity. In addition, building professionals, while their experience with ECBC is growing rapidly, many still lack capacity and/or access to energy simulation programs that are required for the whole building compliance test. So that is one reason we are really excited to hold this webinar and share a little bit of information, raise interest in ECBC. On a slightly different topic there is somewhat limited capacity for testing building materials and equipment, which is essential to make sure that those materials actually match what is required under the code. Overall, stakeholders cited the lack of code training as the most important barrier for ECBC implementation. Fortunately that is something that we can actually address together. With that I'd like to turn it over to Sha.

Sha Thank you Meredydd. Next slide please.

As Meredydd mentioned earlier, there are several barriers for ECBC implementation and fortunately there are approaches and tools that can help tackle these barriers and [inaudible 22:57] the ECBC implementation. One important aspect is to raise capacity of relevant stakeholders through training, trainer-to-trainer programs, and potential use of certified third parties in the states. ULBs, in particular, is critical for adopting and enforcing ECBC and monitoring the progress. So, raising awareness of ULBs and building their capacity will help roll out implementation and increase compliance. At the same time, testing and rating of energy efficient materials is important and is actually an important building block for all building energy policies, including ECBC. So, the best testing and rating system will help and guarantee that building contractors meet all of the design specifications. Finally, there are several software tools that could make compliance easier for designers, for ULBs, for consultants and I will further discuss the software in the later slides. Next one please

There are three major tools or approaches that I'm going to discuss today and that would be the potential use of third-party assessors in ECBC implementation and some training and capacity activities that have been

done and in the end the compliance software in India or other countries. Next one please

As discussed earlier, limited capacity and human resources of ULBs is one of the major barriers for ECBC implementation. The potential use of third-party assessors could help alleviate burdens on local and state governments and help improve capacity irrevocably. For developers, this approach could potentially reduce permitting application times and make it faster. It also provides a signal to view the market in earnest in general. These third-parties have been done in several other countries, including US, China, and some European countries, in code implementation and it's proven effective in building capacity and maintaining code implementation. For example in China by using third parties they have been successfully increased compliance rates from around 50% in 2005 to close to 100% today in major cities. So it is a huge improvement in the past 8 years, and the use of third parties, largely contribute to this progress. Third-party factors could be architects, engineers, and other consultants that have past experience in building energy efficiency and certified. Currently the Bureau of Energy Efficiency is developing a national certification system for third parties through a National Productivity Council. So people that have experience in building energy efficiency might be qualified as third-party assessors after taking exams and certified by the Bureau of Energy Efficiency and National Productivity Council. I think in Rajasthan we are discussing the potential of using third-parties and in Andhra Pradesh, as I will discuss later, they are also looking at the third-party approaches. Designers, developers and ULBs potentially could work with third-party inspectors during the design and construction stages and this might have some potential growth of third parties during both plan review and construction and inspection stages including, for example, in plan review you need to check building plans, review materials, and specification, as well as calculations. Next one please

As discussed earlier, there are several benefits of using third parties such as building capacity, increasing market opportunities, and foster permitting process. However, it may also slightly increase the cost of developers by paying third parties. The third-party system also requires multiple checks and balances to guarantee a fair process. Several factors that need to be considered when designing a third-party system this would include: a robust third-party training and certification program, which the Bureau of Energy Efficiency is doing right now; and random checks of approved projects; and also there might be penalties involved if there is a violation. Next one please

So, while ECBC has mandatory energy requirements for all building components and it affects plan review, design, construction, as well as equipment installation. So to raise awareness of stakeholders, PNNL has been collaborating with MNIT to develop training materials and conduct ECBC training for different stakeholder groups in Rajasthan. The training

materials we developed complement the existing training materials developed by US AID and BEE group and covers both general introduction information about ECBC and specifications for different building components. It has been found in the US and elsewhere that training is multifactive when targeting specific stakeholder groups. So in light we have conducted separate training for architects, for ULBs, and for engineers in Rajasthan. We will share a link of all the training materials we have developed with this presentation later. Next one please

Here is an example slide we took from the Code 101 training that MNIT and PNNL developed. Code 101 training in general includes the general knowledge of building energy efficiency, specific information about ECBC, and relevant compliance rate with a comprehensive approach, like prescriptive, trade off, and whole building performance. In particular, Code 101 talks about how ECBC is relevant to you as an architect, engineer, government official, or developer. We also include a few case studies showing energy things and economic benefits of ECBC compliant buildings. Later we'll show a concrete example of how the building will perform if it's an ECBC compliant building based on our pilot on the Pacific Northwest campus.

In general as Meredydd talked earlier, ECBC sets minimum requirements for building systems. For example, much of building energy use comes in the form of cooling and ventilation in India so ECBC set minimum criteria for the HVAC system and equipment taking into consideration the energy amounts of the building space. Architects, builders, and developers together all need to collaboratively implement ECBC during the building design and construction process. That will be including meeting all the code requirements including ECBC requirements within the budget constraints. Also, that would affect the material selection and installation. For example, by doing or installing proper insulation of materials and correct efficiency replacings. The next one please.

There are several useful tools that could facilitate the compliance checks and code implementation. Here in this slide we give some examples of compliance software. For example, ECOnirman Prescriptive, developed by USAID and BEE, based on a contract to use in the US. It is a web-based to provide compliance check software for both prescriptive and trade off approaches. The software could help compute compliance results for building components and will help generate reports that could be reviewed by ULBs and code officials later. Next one please

So as a conclusion slide, we learn from the experience in Rajasthan that there are benefits of implementing ECBC. As Meredydd talked earlier, in general it can save you 25-40% off energy and it is cost effective. Building code is mandatory once it is adopted. It is definitely requirement energy for building systems. Learning from Rajasthan, there are some common problems in code implementation such as lack of capacity and lack of building materials [inaudible 32:14] systems but there are potential tools

that could help address this problem, including the use of third parties. Some useful tools are software and the continuing of training programs in multiple places for different stakeholder groups.

Going forward there are priorities we feel important in administering ECBC implementation. Important stakeholders like ULBs are critical to building capacity and through training and awareness raising programs and because they are critical in terms of adopting ECBC and checking the progress and also for the design professionals it is also important to increase their capacity through training and other activities. They are part of the design process but they could also serve potentially as third parties. The last one. Next one please.

In the end of the presentation we actually pulled together a few of the resources you can further refer to after the presentation and thank you for listening today and now I will turn over to Emily.

Emily Thank you Sha and Meredydd for that excellent presentation. Now I'd like to hand it over to Jyotirmay who will talk about the ECBC impacts and the experiences from the ECBC pilot building in India. Jyotirmay?

Jyotirmay Thank you very much and thank you all the participants who are there online with us for joining and seeing how we try to implement ECBC and the pilot building at MNIT. I'm also thankful to my co-presenter, Tarush Chandra, who is a colleague of mine and he was also the architect of this building. He will also be available to answer any questions related to the architecture of this building.

So the overview of my presentation is first of all I would like to describe the project, then a little bit about the climatic conditions on the site for those that are not in Jaipur or around, the benefits of code compliance buildings, how we proceed and how we convinced our administrators and finance persons to take decisions, specifications of components and systems, simulation results, and summary of our experiences. Next slide

So this building was already existing as a single floor, partially air conditioned building of about 4,000 square meters. Then we decided to have one floor on the top of it. Once the work started another receipt was taken, which was quite important. One more floor was to be added and then third addition was to make a major retrofitting on the ground floor itself, which was partially conditioned initially.

So the present status is that currently the first floor and the second floor, they are ready. The first floor is already operational in one half of it. The second floor is undergoing some furniture fitting. It will also be functional very soon. Ground floor is at the finishing stage so we very soon will have this building functional. A simulation of this building is performed on the basis of design and specifications of the installed systems. The simulation will be revised after the ground floor is also finished because of some

decision, if it is taken, till the time of completion of the ground floor that would require us to move [inaudible 36:06]. So the results, which I present today, might be slightly different than finally after results will be after final completion of the total building.

So the building is basically used, or going to be used, for an office purpose and a computer center. So the building operates 8 AM to 8 PM as an office but the computer laboratories they work around the clock and also on the weekends partially. All the number of floors is G+2. The total carpeted area now on the three floors is 11,306 square meters and most of it is conditioned now. The window to wall ratio of this building is about 27%.

If you Google Design Center MNIT you will find an image, which is there on the left hand side and on the right hand side I have a circle, which is showing the design center building. On the further right of this building is the next project, which we are working on, and this is the lecture theater complex. We call it Vivekanand Lecture Theater Complex. We can review the results of this theater later.

The climate conditions of Jaipur, which falls in composite climatic zone. As for the climatic classification of India, it has a latitude of 26.5, longitude 75.5, we have elevation 390 meters, cooling degree-days are relatively high: 5,732, and heating degree-days at 141. So as on the right hand side we have shown that the monthly mean temperature is reading from maximum of 35 to minimum of about 15. The humidity is also reading quite a lot. The minimum is about 18%, which is very dry in April to a maximum of a quite high value. This is the rainy season.

On this graph I tried to show the relative humidity in a pictorial way and, in a sense, this humidity and dry bulb temperature as well. The dry bulb temperature, these dark red points, represent very hot time in a year. That is from April to the mid of July. We have very cold, as per Indian definition; we call about 2 degrees, 3 degrees, 4, degrees as very cold temperature. They are in the month of December as on the chart. Dry weather is in the month of April and humid weather is in the month of July.

For the features of Design Center Building, we have going to the east side of the building, which is the main entrance, we have an entrance, which is projected and self-shading, and I will show a picture of how the building is of self-shading time. We have on the south side of staircase and a corridor and a facility area, which is the toilet block. The reason for doing this was to reduce the heat from the south side. On the west side we have this projected area as a ramp and this ramp is designed with a feature that when we have evening low altitude sun this ramp actually shades the left side of my west facade. Similarly if it is on the left hand side that is toward the south it shades the right hand side of the facade. This ramp is actually helping us in shading the facade. There are fence, and we are also

using fence on the sides, including north side, because again for the low altitude sun these fence are useful for the solar ingress to the windows.

We have a courtyard that was already existing in this building. We have retained this courtyard as its feature. These are the four photographs. On the east side, as you are seeing, this is the front elevation of the building. This is going to the main entrance of this building. We have the north side and the fence. You can see the fence on this photograph. We have the south side. We have the pilot block. We have the corridors. We have the staircase. This is the ramp area, which is shaded, so you can see that this part of the building, the left part of the building, is shaded by this ramp.

Some more pictures—this is the finished part of the front entrance and the glass is completely shaded as you can see. Even the shading is coming to the lower part of the down floor. On the right inside picture you can also see that shading—the facade is shaded and some of the windows are completely shaded because of the self-shading nature of the building.

Motivation for us to go for code compliance was first of all the notification issued to us by the government of Rajasthan, which mandated implementation of ECBC. Then, major motivation was not the code actually. It was less operating cost of the building and less connected load, which also reduces our demand charges. We have reduced capacity of transformer now in this building as compared to a conventional way. We have reduced our capacity of electrical panel and circuit breakers in this building and acceptable payback and internal rate of return of energy conservation measures were also motivation to go beyond ECBC. So in this building we have not stopped. We started to look at ECBC level but then we thought that the paybacks were quite attractive and there is a margin we could go beyond ECBC and that is what we have done. Additional purpose for going for this building was also to learn by doing it, to build capacity, and showcase energy conservation measures.

The first thing we did was to be supplied the applicability check through various definitions under the scope of ECBC. So if it is a non-residential building of more than 100 kW and there is an addition of two floors in this building, the ground floor is also undergoing major retrofitting, and therefore it is coming under the coverage.

After we were done with the compliance check, we decided to go for whole building simulation and not prescriptive route. There were three reasons finally—flexibility in selection of elements and systems. We had a non-standard design of shading fin. We had to curve the design of fin for integrating the ground floor with the extended second floor. So the first floor was integrating the ground floor with the second floor through a curved fin. There was no way in a prescriptive approach we could have the compliance with this fin. Ground floor wall insulation, because it was already existing, was difficult to implement the insulation on the ground floor. That is also another reason we did not go for the prescriptive route.

The features of envelope are we have used XPS insulation on the roof and tiles on the terrace. We have 1.5" sandwiched insulation in the wall. We have double glazed unit with low E-coating on surface number 2 with UPVC frame. We have vertical fins and also overhangs.

The HVAC system is VRF type. We have used heat pumps also in areas with high occupancy. Duct insulation is with PU foam. We have dimmable LED lights with daylight integration and in addition we have 150 kW peak of solar implants. This is not a requirement of ECBC but still we have done it. I will cover it slightly later.

If you compare with the prescriptive requirements of ECBC, which are also–to be fair–in the standards rates of modeling, the wall insulation requirement was wall U-value of .440. Whereas, we have stopped at .72 because we have other payback limitations. Going for a higher insulation was requiring an unacceptable payback period and there we opted out. On the roof, on the other hand, what we have done was the code was .409 but we have gone for .35. The reasons are as listed below. We have under deck insulation on this roof because our construction people and construction agency was not very confident about providing us waterproofing guarantee. We agreed .409 insulation and therefore to compensate for the lesser effectiveness of under deck insulation we have provided excess insulation through inverted earth pots on the top side. We have also taken the decision about insulation on wall and roof not only based upon the payback but also we have included the cost of avoided tonnage. A lot of rounds of simulation were done and the U-value of roof, as I said, is finally lower than the U-value of the code.

Glazing selection was also done through the help of simulation. So the U-value of 3.3 at required by the code, we have 2.2 as U-value. SHGC is a little higher and there was a very specific reason of doing this. As I've listed in the slide again, what happens is SHGC and VLT, they are linked with each other. If we use the SHGC below a certain level the daylight ingress to the building also reduces. What we have done is try to see effectiveness of different glazings and we stopped at .28 level because this was offering us a glazing of .39 visible light transference and we were getting an optimal combination of the daylight usage and keeping the building cool through this combination. Also, there was another reason that we added shading to fins and overhangs. If we apply shading adjustment factor to the U-value of .28 I would anyways be having a value of less than .25. We did a total calculation because we did not have a conversion factor for the curved fin. So we took the average length of fin and then we did the rough calculations and we were convinced that this building was going to be code compliant. It may be lower than the prescriptive value but the sim was based upon simulations.

A special care, which I will finally recommended through this webinar is that when you decide about window glass, that time only we should go for the decision about lighting type. That is what we did about this building

because we were investing a lot of with glazing. If we do not use available light in our interiors, the investment in glazing would go waste. That is what we took care of in this building, that we took both the decisions together. We also took another decision that 30% of the window area was kept open-able so that the building can also operate in mixed mode, although we have not modeled this in mixed mode because presently we are operating it as fully conditioned and non-open window conditioning.

The light condition the ECBC requires is 10.8 watt per square meter LPD, whereas we have gone with efficient LEDs—an LPD of 5.38 dimmable with daylight integration. We have a combination of square 2x2 lights with 6" round down-lighters in the building. As you can see on the right on slide there, there are two pictures. These are the square lights and these other down-lighters, which are in the corridor. With the help of simulation we have decided on these low LED. We measured the levels and they are sufficient and acceptable as per ECBC requirements.

We have VRF systems and they are multiple units. There are 54 numbers of units installed variable refrigerant machines where the standard says that the chiller would be a screw type, with a COP of 3.05. This table has been given because we have modeled the standard HVAC system according to this table, whereas the design case has been modeled after VRF.

There were certain reasons for going for VRF. Limited availability of water was forcing us to use air-cooled systems. The building is likely to have a large diversity due to vacation of students, exam periods, seminars and training programs. Some of the sections would be totally closed. The third reason was that discernable, exact uses of the building, as I explained in the beginning of this presentation, that it was taken in steps. This was forcing us, all of these three reasons together. It was forcing us to use VRF systems.

An additional feature that is not ECBC but we've gone for it is 150 watt kW peak of solar plant on this. So there are three units of 50 kW each crystalline units. We have 6 of the number of models, 50kVA*3/inverter, and in a string there are 15 modules and there are 14 strings. What we have also taken care of is that, because on Saturdays and Sundays most of the offices in this building would be closed, and some for the slab would be utilized and therefore power exported to load the local grid. All this is there in the system.

The simulation results are showing energy savings, significant energy savings, in two areas mainly. One is the lighting because we have roughly half the LPD. As you can see these yellow bars in the standard case are double the height of, nearly double the height of, yellow bars in the design case. The air conditioning load, the air conditioning cooling load, is also quite low. It is high in my standard case and these blue bars are low in the design case.

So if I compare the month-by-month energy consumption, this line is basically my energy line as per the standard case. This line is as per my design case.

I come to the summary of the numbers. So if I pay the total energy consumption it is 2,192.40 MWh on annual basis. The purposed case is 1,704.80. All in all we are saving 487 MWh on an annual basis, which in terms of EPI 194 KWh per square meter per annum was the standard case, 151 in the purposed case, saving about 22% of saving beyond ECBC level. If we talk about the demand reduction we could reduce the demand level by about 15%. The photovoltaic system was able to give us about 16% reduction in energy savings.

This is the monthly generation of electricity from solar photovoltaic plants. As you can see, the generation is considerably less than 15% only.

Coming to the lessons that we have learned and the summary, whole building performance method was basically providing us flexibility in decision making based upon the techno-economic. As I said, one insulation we had reduced and we had stopped even at the lower insulation, this is required as per ECBC, but as we have gone in some of the things—like glazing, lighting, and HVAC—beyond the ECBC requirements. Maximum energy savings in our case came to three areas: glazing, efficient lighting, and HVAC system. Decisions are to be taken in an integrated manner is what we have learned through this project. Standalone incidence may give us a wrong picture in terms of payback period or in terms of internal rate of financial investment and because they influence each other's performance greatly. There exists a significant potential of exceeding the level of energy building code. Another lesson we have learned and, this might be useful for the next version of ECBC—that is there is an absolute necessity of human [inaudible 52:05] of ECBC and we are setting off another 22% annual energy savings potential. Solar Photovoltaic integration was giving us yet another 15% energy saving. All in all we are crossing 50%, more than 50%, energy savings level through this building.

Before I end I would like to acknowledge the contributions of Dr. Vishal Garg in improvising the slides of this presentation, Shivraj Dhaka, and Ashok Dhayal who have helped me a lot in collecting the specifications of this building and simulating this building.

Thank you very much for your time. Over to you Emily.

Emily Thank you Jyotirmay for that excellent presentation. For our final presentation I will now hand it over to Bhaskar Deol. Bhaskar, if you'd like to take it from here?

Bhaskar

Sure, hi. I'm just waiting for the presentation to come over. Great, good evening everyone. Thank you so much for joining us this afternoon. Before I start let me also echo Jyotirmay and the presenters that have gone ahead before me in thanking DOE as well as PNNL in organizing this webinar. I think we have already had a very good set of presentations discussing various aspects of the energy conservation building code. What I thought I would do today is specifically focusing on the experiences we've had implementing the Energy Conservation Building Code in the state of Andhra Pradesh and then leave my presentation, sort of finish it off, talking a little about some other work that we have been doing in the area of energy efficiency, specifically highlighting the financial payback. The excellent analysis that Dr. Mathur just discussed already makes a very strong case for energy efficiency in buildings in general and also ECBC. As we will see towards the end of my presentation, this is also something that our analysis has shown, specifically when you look at a payback period from the perspective of a building owner or real estate developer.

Just quickly looking at the agenda for my presentation. I will start off with a quick introduction to our organization, the Natural Resource Defense Council. I'll focus the bulk of my presentation on the Energy Conservation Building Code implementation in Andhra and Telangana states. We've already had very good discussions about the benefits of energy efficiency, what are some of the key barriers in terms of we heard from Sha, for instance, about capacity building for ULBs is an issue. Also, the third-party assessors being a model and also Meredydd also talked specifically about how the building sector is growing. So I would complement that talking a little bit about how the process of adopting ECBC to a particular state looks like and how has Andhra Pradesh gone about doing that.

Just a quick introduction—NRDC has been working with the Administrative Staff College of India. ASCI is a pioneer management and research organization established in Hyderabad in 1956 and is currently working with the Bureau of Energy Efficiency as well as the state designated agency in Andhra Pradesh on capacity building for local government real estate developers and architects about ECBC. At NRDC we have a clean energy and climate change initiative and building energy efficiency is one of the main areas where we have been working along with our partners.

Let me just take a second to reiterate what Meredydd already talked about in a good amount of detail. India has been seeing rapid growth in the real estate sector over the past several years. We all know that this put significant drain on the electricity grid and what that means is energy efficiency in buildings is really a low hanging fruit. That is the case that we are trying to build here. Of course, looking at the key trends that we have been seeing in the real estate sector wind buildings are slowly gaining in popularity. The Energy Conservation Building Code is doing its part and a number of states have announced or are at various stages of implementing it. Then the flip side of it is that in general if you look at the

typical building you do see that there is a trend of increasing energy intensity. That means that the efforts that our organizations are putting in are very much required. There is a strong need to make the case for investors or real estate developers or homeowners who are investing in buildings or building houses to focus on what are the cost savings that can be achieved through efficiency. Then probably appeal to their desire to have a greater market share if they are real estate developers.

With that let me just jump into the current status of the Energy Conservation Building Code of Andhra Pradesh and Telangana States. This work really started back in 2009 and 11 and I would really look at those couple of years as laying the ground work for the state adopting, getting familiarized with the Energy Conservation Building Code and then starting its process of implementing it or adapting it to the local requirements. Then between 2012 and 13 was a series of intensive stakeholder discussions but with the government making a formal announcement that it would start the process of implementing the Energy Conservation Building Code. I would say key aspects of that period—first of all having a steering committee, which was constituted of stakeholders that came from the necessary different groups that included real estate developers, architects, as well as local government, as well as civil society. And in coming together, to see how ECBC can be helpful for Andhra and specifically how can that be translated into the local bylaws. We did also have state bifurcation into Andhra Pradesh and Telangana states, which happened in February or earlier this year. The advantage of having this process underway already was that as the state had already announced it would be enacting ECBC both states have now inherited the code. So that's definitely good news.

If we look at where we are today, that is the green arrow at the moment, the stage where Andhra Pradesh and also Telangana are at right now is to empanel the architects. Sha touched upon capacity building for ULBs so this is really the stage where ASCI has been working with support from the UNDP [inaudible 1:00:28] program to train a number of district officials and state urban local bodies as well as real estate developers and architects. The target is the reach 400 stakeholders that would be trained. About half way the trainings have been completed with mainly the government folks having been trained. Over the next couple months more trainings will be held for real estate developers and other architects. The final dates announced for the code being operationalized are August 2014 for Telangana and early next year, in February 2015, for Andhra.

The next slide is basically to show a little bit of the key roles of various agencies that come together at the national level, the state level, and the local level in adopting ECBC specific to a particular state. I won't dwell on this too much but the key methods that I want to leave the webinar participants with is that it truly is an integrated effort and one of the most important aspects of it is really how the ECBC is translated to the local level and how it is kind of tweaked as in where necessary to the needs and

requirements of the local agencies, as well as the real estate developers who interact with these agencies on a regular basis.

We also had a good discussion about what ECBC constitutes so I will just focus on how the interpretation of ECBC different than the code announced by the BEE. So first of all, and this is not really a difference, is that it is applicable to commercial buildings, offices, hospitals, and IT parks but unlike the ECBC, which has a connected load as the threshold which figures a building to configure to ECBC, under the base of laying down this in the square footage of the building rather than the connected load. The main reason for this was because for the municipal administration department is accustomed with dealing with building designs. They thought that it would be a lot more comfortable for them to look at the total area rather than the connected load as something that triggers whether or not ECBC should be applicable. Of course, the state code takes into account that there are some building categories, which may not meet this threshold in surface area but would still be an energy intensive building. So for those there is a special mention in the code of the government order, which talks about multiplexes, hospitals and hotels needing to comply with ECBC, irrespective with how large they are. As we already discussed under our third party certification and validation system and then there is an assessment that is carried out at two stages. Sha talked about this in her presentation. So, it also specifically looks at first how to find the design and then having a construction approval, which then required for the occupancy certificate. I'll talk about that in a minute. The other key difference is also of the AP ECBC operates a star rating system based on the energy savings. We have discussed earlier during this webinar the three different mechanisms with which ECBC can be complied with so developers who choose to go with the whole building approach can demonstrate that if their buildings go beyond the minimum requirements they get additional stars for energy savings. Also, if the building goes beyond one star then there is the added benefit to the developer of fast track approval for their building permissions.

This is what the current building approval process looks like. It is pretty much the two-stage process that I mentioned earlier. First there is a local body issuing construction approval based on a third party assessment of the building design. Once the building developer has the construction approval, they go ahead and start the construction. Upon finishing the construction, they again seek certification by the third party about the building being constructed by the design specifications. With that the urban local body issues to the owner an occupancy certificate and afterwards the building can be occupied. Both the third-party assessors as well as the urban local bodies are being monitored and pretty much the entire process is overseen by the state designated agency that's the Bureau of Energy Efficiency based in Telangana and Andhra states as well as the municipal administration departments.

With that, what are some of the key capacity building activities that are envisioned or currently being carried out to states? First of all, and this cannot be emphasized enough, capacity building for planning officials and also elected representatives. There is a series of programs that I mentioned earlier but also the kind of resources that PNNL has developed along with Professor Jyotirmay Mathur at MNIT. They are extremely valuable in spreading information and building awareness and capacity about how local bodies can comply with ECBC. The empanelment of consultants is an activity, as I mentioned, is currently underway. What this process entails is having workshops. First of all, the selection of empaneled design consultants who are architects and can review and provide certification for buildings being made to specification and then also carrying out workshops and training sessions across major cities spread across the two states. Some of the cities where these trainings have been carried out by asking for support from UNDP [inaudible 1:07:48]. Similarly, other activities, like train the trainers, which were mentioned and Professor Sha and Professor Mather have been instrumental and also awareness building activities and a couple of pilot projects. Two that I would flag here is the BEE demonstration project where the Bureau of Energy Efficiency has extended technical guidance for design of dormant buildings so that they are ECBC compliant and also pilot project so that they extend support to the municipal corporation to effectively implement Energy Conservation Building Code.

So here is what the national map looks like of key states currently working or at various advanced stages of the Energy Conservation Building Code. I do apologize for not having the interstate boundaries between the Telangana and Andhra.

With that the key takeaways and learning from implementing ECBC in Andhra Pradesh, I would say first of all, in order to create political will it is extremely important to have senior government buy in for energy efficiency. In the case of Andhra Pradesh the critical power shortage situation helped create that and then helped generate the momentum so that there was a lot of alignment within the state of bureaucracy as well as the leaderships. Energy was really low hanging fruit and could provide significant benefits without any major upfront costs. The process that Andhra took, which included formation of a steering committee and also some technical committees brought together key stakeholders, so that included real estate developers, government officials, architects. Then in that it really ensured that the key issues of implementation could be addressed early on and that certainly was instrumental in helping Andhra achieve the speed that which the code was implemented. Taking into account the local body functioning and I think the example of this is really how the Municipal Administration Department felt that using a threshold, which was based on size of building rather than the connected load was useful. Also, the importance of flexibility both on the part of the municipal

departments as well as the government to provide soft benefits like fast track approvals for projects that were ECBC compliant.

With that I will take a minute to talk a little bit about some of the work that NRDC is doing along with our partners to showcase the business case for energy efficiency. The way we've been doing it is really through a series of case studies, reports, factsheets and resources, which showcase different aspects of energy efficiency. I'll just talk about a number of buildings that currently exist and have shown demonstrated results and demonstrated energy savings. The ones highlighted in green have been converted into case studies. I'll share links to these at the end of my presentation. Clearly as we can see, for each particular building use building type energy efficiency does provide an attractive investment return and a quick payback in addition to improved quality, indoor quality, and occupant comfort. With that, here are the links to the information that I mentioned earlier and thank you once again and I will turn it back over to Emily.

Emily Thank you Bhaskar for that excellent presentation and thank you to each of our other panelists for everyone's outstanding presentations today. We have lots of great questions from the audience. We'll use the remaining time to answer and discuss. We'll get to as many questions as we can.

The first question is for Meredydd and Sha. Is ECBC applicable for 100 kilowatts or 500 kilowatts? The ECBC document says 500 kilowatts. Which is correct?

Sha Thank you Emily. I'll take that question. This is Sha. I think the person who had the question is partially right. In 2007 the original ECBC does cover the 500 kilowatts and above but there was an update in 2008 and to include the buildings with 100 kWh and above. Right now it's 100 kWh.

Emily Thank you. Alright, our next question is, what is the renovation rate in India for old housing and commercial buildings and how can we improve this?

Jyotirmay Can you repeat the question Emily?

Emily Sure, I'm happy to repeat the question. What is the renovation rate in India for old housing and commercial buildings and how can we improve this?

Bhaskar Emily, I'm going to jump in really quickly. I do not have the figures for this rate in India at the moment for all houses but it does appear anecdotally that the bulk of the construction activity going on at the moment is focused around new buildings. What you do see specifically in the housing sector is when a building gets to an age of about 20-30 years it is more likely that it is torn down and constructed new rather than being renovated. Other panelists might have another opinion.

Emily Thank you.

Jyotirmay Just to add what Bhaskar was say...Emily, can I?

Emily Please.

Jyotirmay In commercial buildings what has been noticed over the past few years is that commercial buildings are doing renovation and retrofitting for two reasons. One is for aesthetics because now the trend of large glazing and better interiors and so and so forth they are there. So commercial buildings are going for this reason, aesthetic reason, but when they are going for retrofitting for aesthetic reasons they are also doing it energy efficient. Some buildings are doing retrofitting just because there is tremendous change in technology, for instance, lighting technology has changed a lot, air conditioning has changed a lot. So they get a business sense of it and that is why they are doing retrofitting. Recently one IT company approached us and they are doing retrofitting in all of their 6 offices throughout the country. That is just an example of how retrofitting is going on.

Emily Great. Thank you very much. The next question, is there any effort to improve reporting of public energy consumption data, even if it's at an aggregate level?

Meredydd This is Meredydd. So there are requirements for public buildings, for new public buildings, that they have to meet GRIHAD standards and that includes some measured data. So, that is some progress. At the same time I think it is step-by-step because there are still many buildings without extensive energy efficiency measures and without extensive metering capabilities.

Emily Great. Thank you very much. Alright, our next question is, what are the market barriers in implementing energy efficiency products and services?

Meredydd This is Meredydd again. So I think that if we flip the question on its head, building energy codes in particular can serve as a huge driver for building energy efficiency for the market for building energy efficiency products. We've seen this in many countries around the world and I think we are starting to see it in India as well when you look at the glazing market, HVAC market, and household insulation. Obviously cost is an important issue and codes basically say, look, you need to consider your entire cost, not just your first cost. To help you with that we are going to tell you what measures you need to install that will allow you to consider full cost.

Sha And just adding to that...

Meredydd Go ahead.

Sha A lot of the activities we've done to implement ECBC will also help to address the barriers in general for implementation to energy efficient products and equipment.

Emily Great, thank you Meredydd and Sha. The next question is for Jyotirmay. Specifically how much is the incremental cost for this project including SPV?

Jyotirmay Including SPV the project cost is nearly double as compared to a normal project, which is non-ECBC compliant. For the reason that photovoltaic system itself costs a lot. In fact, now the costs have come down but when we had ordered the photovoltaic systems they were relatively costly. So if I redo the project now it would be something like 1.5 to 1.6 times, including SPV.

Emily Great, thank you. The next question that we have is, how can we initiate ECBC norms in northeast India?

Meredydd This is Meredydd. I think the first step is to adopt ECBC and to make sure it is included in the local ULB bylaws. So while the state can adopt it, the local ULBs actually have to insert it and then after that build the capacity to implement it, either by building the capacity of local urban bodies to check building plans or by allowing private third parties to serve that role and building the capacity of ULBs to oversee them.

Bhaskar Hi this is Bhaskar. I would just like to add to the excellent response by Meredydd. I would say there is a significant body of resources and information that is available for any state wishing to move forward with implementing the Energy Conservation Building Code, both in terms of technical capacity with the likes of Dr. Mather who is here with us today, Professor Michelle [inaudible 1:20:02] in Heidelberg, and then a number of others but also just in terms of publications as well as the exact process that the state needs to go through be it how the implementation should look like, you know, what all needs to be done in terms of the bylaws. The other thing I would say on that is also like the experience in Andhra Pradesh showed it is extremely important to have key local stakeholders come together and really try to understand what ECBC means for the state and then think through how it would be better to integrate it into the building bylaws and start from there and use the excellent body of information and resources that's already there. Through the Bureau of Energy Efficiency, the state bureau agencies, and other organizations like IIIT and MNIT, ASCI and others.

Emily Thank you. Thank you for elaborating. The next question is, are there any provisions for energy efficiency in electrical installations, i.e. upsizing cable to reduce joule losses. If so, how are they regulated and how is it enforced and verified?

Jyotirmay Can you repeat the question Emily?

Emily I'd be happy to repeat the question. Are there any provisions for energy efficiency in electrical installations, for example, upsizing cable to reduced joule losses? If so, how are they regulated and how is it enforced and verified?

Jyotirmay Okay, let me try to answer the question. Well, in ECBC there is a complete section on electrical power and there are broadly you can say three requirements. First of all they specify the minimum required efficiency of transformers and motors. Then there is a limitation on power losses. So power cables, if I can remember correctly, the power cables should not register more than 1% of loss so there is definitely a provision of addressing this issue in ECBC. There is a separate section in ECBC for addressing this.

Emily Thank you very much. The next question is for Bhaskar directly. Could you elaborate on the set up in Rajasthan...sorry...I'm sure I'm getting it wrong...the ordering of implementation and it's reporting that have emerged during the 16/17 months of ECBC in India? Also, please inform how one can become a third-party assessor having cleared the EAEM Certification of the BEE. I'm happy to repeat that if you need Bhaskar.

Bhaskar No, sure. I'm guessing that Jyotirmay may want to weigh in on the first part of the question but do maybe jump straight to the second part. I would say that in the case of Andhra Pradesh and Telangana states there is an RFP, request for proposals, which was put out. If an existing organization or an architect is already empaneled with the Bureau of Efficiency then they automatically qualify as being a third-party assessor for the Andhra Pradesh state.

Emily Great, thank you.

Bhaskar And I think that the first part of the question was specifically addressed for Rajasthan so I don't know if Jyotirmay if you wanted to talk a little bit about that?

Jyotirmay Yeah, so in Rajasthan the mechanism for defining third parties is still under development and therefore I am not authorized to say this is the mechanism but yes, it is going to be pretty much similar to what is there in Andhra Pradesh.

Emily Great.

Meredydd In terms of the monitoring and implementation in Rajasthan, so I think there are a couple of different approaches. Mostly it is ad hoc at the moment because implementation is fairly new. The Rajasthan Renewable Energy Corporation oversees the entire system and provides the opportunity for stakeholders to give feedback. There is some data, as you have heard, about pilot projects on the performance of given buildings compared to the code, as well as some information on the number of permits being pulled that are ECBC compliant.

Emily Great, thank you very much. Our next question, does ECBC apply to multi-family apartment complexes that have an aggregate demand of over 100 kilowatts?

Sha I think the answer is no. ECBC only applies to the commercial buildings, not residential for now.

Emily Thank you very much.

Bhaskar Some of the states have actually clarified this. Like in Rajasthan there is a separate document, which has been released by the government, which is known as Energy Building Code Directives. There they have spelled out that this is clearly applicable to commercial buildings, so to say non-residential buildings.

Emily Great, thank you. Our next question is, how is ECBC compatible with ISL 50001 and LEED Green Building Requirements?

Jyotirmay Well the green building requirements if you talk about LEED rating system approach is in line but values may not be the same as what they require because LEED by and large follows ASHRAE 90.1 values rather ECBC has values which are different than the ASHRAE 90.1 values. So the philosophy is the same but the values may be different. Whereas, if you go for ECBC rating system, they give an option for compliance through ASHRAE values or ECBC values. Another fact is that most buildings still go for ASHRAE building values for ECBC rated buildings as well. There is another rating system, which is GRIHA rating system, and that other rating system is totally aligned with ECBC. So ECBC requirements is sort of a prerequisite for GRIHA.

Sha Adding to that part of the LEED costs more than other features like water, land use, and back to the ISL 50001 question. ISL 50001 mostly covers energy management so that's linked to the operational stage. ECBC covers most of the design stage.

Emily Thank you both. That is much appreciated. A final question and I apologize to the audience. We have more questions than we have time to answer. What is the cost of construction per meter for the new commercial building? What was the per meter cost for the MNIT building for the new construction?

Jyotirmay As I said, the cost of new construction I would request my co-presenter, architect Tarush, to correct me if I'm wrong. The typical cost of construction these days for a commercial building is considered to be 2,000 INR per square feet. As for our building, as I said, it was about 4,000 INR per square foot but I would like to inform that there were also a lot of restrictions. One was definitely the solar photovoltaic panels. Another was, because this was an existing building and we were doing retrofitting and the attempt was not to disturb the functioning of the ground floor when the first floor becomes functional. Then we shifted to first floor. Then the construction of second floor and first floor retrofitting wall started. It took much longer and therefore the labor cost, as well as the material wastage, has been significantly high in this project. So I would suggest not to take this value as a benchmark value, but this is definitely on the higher side. If you go for a fresh project it would be much lower than 4,000 INR SVP.

Meredydd In the US typically you are looking at cost, incremental cost, much greater energy savings than available in ECBC that would be typically well under 10%. It would be much closer to 5% or actually positive net present value when you look at the lifecycle cost of those measures.

Jyotirmay Yes, thank you very much for pointing that out. Our incremental cost is also for the reason we are going 22% beyond ECBC. If we just stop at ECBC level it has rightly been said that the incremental cost would not be 10% even. In fact there can be a net saving if a reduction in tonnage is discounted and that is normally the mistake that people do. Building costs as the fabric cost and other costs are separate. If everything has been counted and reduction of tonnage is also counted you may end up saving some money in the overall cost.

Emily Great, thank you both for that answer. It is much appreciated and thank you all. Now before we take our quick evaluation I'd like to provide the panelists with an opportunity to provide any additional or closing remarks that you'd like to make before we conduct the evaluation and close the webinar.

Meredydd I'd just like to say thank you to everyone for participating and we look forward to staying in touch with several of you. You will see our presentation online and please let us know. Thanks.

Emily

Thank you, Meredydd. Great, and now Andrew, if you could please to the attendee evaluation. I'd like to thank the panelists again and now I would ask the audience to take a minute to answer a quick evaluation on the webinar you have viewed today. We have three short questions for you to answer and your feedback is very important to us as it allows us to know what we are doing well, and what we can improve. The first question is, the webinar content provided me with useful information and insight. Please take a moment to answer. Thank you Andrew, if you would like to display the next question. The second question is, the webinars presenters were effective. And, Andrew if you would please display the final question, overall the webinar met my expectations.

Thank you all for participating in the evaluation. On behalf of the Clean Energy Solutions Center, I'd like to extend a thank you to all of our expert panelists, and to our attendees for participating in today's Webinar. We've had a terrific audience, and we very much appreciate your time. I invite our attendees to check the Solutions Center web site if you would like to view the slides and listen to a recording of today's presentation, as well as previously held webinars. Additionally, we are now posting webinar recordings on the Clean Energy Solution Center YouTube channel. Please allow about one week for the audio recording to be posted. We also invite you to inform your colleagues and those in your networks about Solutions Center resources and services, including no-cost policy support. Have a great rest of your day and we hope to see you again at future Clean Energy Solutions Center events. This concludes our webinar.