CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

# Implementing Building Energy Codes: Implementation and Compliance Actions

—Transcript of a webinar offered by the Clean Energy Solutions Center on 11 November 2015—
For more information, see the clean energy policy trainings offered by the Solutions Center.

Webinar Panelists

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| **Meredydd Evans** | Senior Staff Scientist, Pacific Northwest National Laboratory (PNNL) |
| **Jonah Steinbuck** | Climate and Clean Energy Fellow, Office of International Affairs, U.S. Department of Energy |
| **Peter Graham** | Executive Director, Global Buildings Performance Network (GBPN) |
| **Sha Yu** | Scientist, PNNL |

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**Sean Esterly** — Hello everyone. I'm Sean Esterly 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 and Global Building Performance Network, also known as GBPN. Today's webinar will present lessons from G20 countries in successfully implementing and improving compliance with Building Energy Codes and case studies.

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

I just want to go over some of our webinar features for you. For audio you do have two options. You can call in by telephone or listen over your computer. If you do choose to listen to your computer please select the mic in speakers option in the audio pane. This will help eliminate any feedback and echo. And if you choose to dial in by phone please select the telephone option and it will display a number on the right side along with an audio pin that you should use to dial in. And if anyone is having technical difficulties with the webinar you

may contact the GoToWebinar help desk at: 888-259-3826 and they can help you out there.

We encourage anyone from the audience to ask questions at any point during the webinar. If you do have a question simply go to the question pane and type in your question and submit it there. And we will present those to the panelists during the question and answer session. If you're having difficulty viewing the materials through the webinar portal we have posted PDF copies of the presentations at https://cleanenergysolutions.org/training.

Also an audio recording of the presentations will be posted to the Solutions Center training page within a few days of today's broadcast. And we're also now adding the recordings 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: Jonah Steinbuck, Meredydd Evans, Peter Graham, and Sha Yu. These panelists have been kind enough to join us to discuss the current status and key areas for international collaboration and Building Energy Codes implementation and compliance. And before our speakers begin their presentations I'll provide a short, informative overview of the Clean Energy Solutions Center. And then following the first set of presentations we will have our first question and answer session. And then following the case study presentations we will have our second questions and answer session. And during the time the panelists will be able to address questions from the attendees.

This slide provides a bit of background in terms of how the Solutions Center came to be formed. The Solutions Center is one of 13 initiatives of the Clean Energy Ministerial which was launched in April of 2011. And it's primarily led by Australia, the United States, and other CEM partners. Some 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 no attending.

There are four primary goals for the Solutions Center. The first one is to serve as the clearing house of clean energy policy resources. The second is to share policy best practices, data, and analysis tools specific to clean energy policies and programs. And third it strives to deliver dynamic services that enable expert assistance, learning, and peer-to-peer sharing of experiences. And then finally the Center fosters dialog on emerging policy issues in innovation from around the globe.

And the primary audience for the Solutions Center is typically energy policy makers and analysts from governments and technical organizations in all countries. But we also strive to engage with the private sectors, NGOs, and civil society.

This slide shows one of the marquee features that the Solutions Center provides which 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 each available to provide remote policy advice and analysis to all countries at no cost. So for example in the area of buildings we're very pleased to have Cesar Trevino, leader of the Mexico Green Building Council serving as one of our experts.

So if you have a need for assistance in building efficiency or any other clean energy sector we do encourage you to use this valuable service. And again it's provided to you free of charge. If you have a question for our experts please submit it through our simple online form at cleanenergysolutions.org/expert. Or to find out about more about how Ask-an-Expert service can benefit your work please feel free to contact me directly, Sean Esterly 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.

Now I'd like to provide brief introductions for today's panelists. Our first panelist that we'll be hearing from is Jonah Steinbuck. Jonah is a climate and clean energy fellow in the Office of International Affairs at the US Department of Energy. He serves as the US lead for Building Energy Efficiency Task Group of the International Partnership for Energy Efficiency Cooperation also known as IPEEC. His primarily focuses on advancing clean energy and energy efficiency policy through international _____ such as the IPEEC, the Clean Energy Ministerial, and the G20.

Following Jonah we will hear from Meredydd Evans, a senior staff scientist at PNNL with over 20 years of international energy policy and finance experience. She has worked on energy efficiency and clean energy policies and projects in numerous countries and currently manages a program on international sustainable energy at PNNL that includes efforts on building energy efficiency codes and retrofits.

And then also joining us is Dr. Peter Graham, currently the executive director of GBPN. And Dr. Graham previously served as the technical advisor and coordinator of the United Nations Environment Programme's Sustainable Buildings and Climate Initiative. Peter has extensive experience working closely with the public, civil, and private sectors to assist the global transition to a more sustainable building and construction industry.

And then our final speaker today is Sha Yu, a scientist at PNNL. Her research focuses on developing and implementing energy efficiency and clean energy polices in developing countries such as India, China, Russia, and Vietnam. Building on her experience in Building Energy Codes development in implementation she is currently working with the State of Rajasthan to roll out the implementation of the Energy Conservations Building Code.

And so with those introductions I'd now like to welcome our first speaker, Jonah, to the webinar.

**Jonah Steinbuck** Good day to everyone. Thank you Sean and thank you to everyone for joining this webinar on Building Energy Codes implementation and compliance. I'm Jonah Steinbuck from the US Department of Energy. And I serve as the US lead for the IPEEC Building Energy Efficiency Task Group which supported

a project over the past year on the exchange of code practices and experiences that you're going to hear about today. As some of you are familiar IPEEC, the International Partnership for Energy Efficiency Cooperation is an international forum comprised of 16 major economies that are dedicated to accelerating the adoption of energy efficiency policies and practices through dialog and action within a range of different energy efficiency initiatives.

Collectively IPEEC economies account for about three-fourths of global energy use in GDP. And the IPEEC initiative focus on buildings is the Building Energy Efficiency Taskgroup or BEET. And it's through that task group that we've been working collaboratively with governments to research and support the development of effective building energy efficiency policies. The taskgroup was originally chaired by Australia starting in 2012. And it's currently co-chaired by Australia and the United States.

And it engages the members and guest governments of both IPEEC and also the G20. All of the member governments that participate in the Building Energy Efficiency Taskgroup are shown on this slide here. Over the past few years the BEET has conducted products on building energy rating schemes. There was another project on opportunities for international collaboration across a range of building energy policy areas. We've also looked at building energy performance metrics and the webinar topic today: Building Energy Codes implementation.

The codes project started in the fall of 2014 as a collaborated effort of the national governments engaged in the BEET together in partnership with the Global Buildings Performance Network and the Pacific Northwest National Laboratory. And this followed on an earlier project that showed that building codes were a key area of interest for international collaboration among IPEEC government experts. In the latest project we worked to identify key areas for international collaboration on Building Energy Codes implementation.

So essentially we wanted to better understand how to realize the energy savings potential in the building sector through codes which are a major policy lever. The first step in this effort we've been focused on sharing and Building Energy Codes approaches and experiences. We've launched a new web portal and the portal site address is shown here on this slide. The purpose of this is to support more efficient international knowledge exchange on Building Energy Codes implementation by providing information, experiences, and resources from around the world.

I encourage you to visit the portal and learn more about this new resource. We expect this codes project to continue and welcome your participation going forward through these webinars, through the codes portal, and other opportunities to collaborate together. And with that let me turn it over to Meredydd Evans of the Pacific Northwest National Laboratory for the next segment. Thank you.

**Meredydd Evans** Thank you and hello to everyone. This is the second webinar that we're doing. The first one focused overall on codes framework in the countries that have participated in the BEET. I apologize a little bit for my voice this morning.

Today we wanted to focus on code implementation and compliance. That is the topic that all the G20 and IPEEC countries expressed the critical issue that they're facing in terms of Building Energy Codes, how to better implement them given all of the challenges that they face.

So today I will talk about first why Building Energy Codes are important, just a little bit of background. If you want more background I recommend that you go to the GBPN website that Jonah had mentioned. Or you can also look at the previous webinar that we did that should be on the Clean Energy Solutions site. I'll begin with why Building Energy Codes are important and then move on to common elements of implementation systems and also options for implementation. Not all countries have the exact type of system. I'll describe what types of options may occur in different countries.

Then compliance evaluation; I think that's worth a little bit of special attention. It's something fairly new in the codes framework but I do think it's an important topic to consider for improvement implementation frameworks and then briefly on challenges and also opportunities for international collaboration. The BEET3 project really focused quite a bit on how countries can collaborate to better improve their Building Energy Codes implementation. We'll share that. We'd really welcome your feedback on that as well and on specific topics like what might be a good topic for a future webinar.

And then some conclusions to tee off our first discussion section; after the first discussion section as Sean mentioned we'll have a couple of case studies.

Why are building codes important? Buildings today account for over one-third of global energy consumption. And this number is growing. So as countries develop buildings tend to consume a larger share of the total energy mix. The example is in the US where building account for nearly 40 percent of total energy use. And again that number is still growing.

Benefits of codes are many. They can reduce energy consumption obviously. They can help countries, families, and businesses improve their economic performance so that the savings allow them to keep a little bit more money in their pocket and have—if it's a business—greater competitiveness. They can reduce CO2 emissions and other pollutants. That's probably one of the main reasons this has taken on great attention on the international stage.

But the multiple benefits together are really I think quite important. And in many countries the non-CO2 emission reduction reducing other types of pollutants to improve air quality is also a major benefit of codes. Improved energy security as well; as you reduce energy use you need to import less. But of course in order to achieve all these results you have to actually implement the codes. And that has a lot of challenges because each building is unique. At the bottom of this slide you can see some sources of information.

There are I think some good sources overall to learn more about codes. One is the GBPN website where we put a lot of other references as well as detailed information on all the countries that have participated. Another is the

energycodes.gov website is a US website but it has a lot of great resources that people might be interested in.

Moving on: common elements of implementation systems. Not all countries have all of these and they may have differing degrees of them. But these are things that very typically show up. First is capacity building and education. That's the most common element I would say. Most countries have made some efforts to build capacity. And they could be training. They could be programs to develop detailed certification for third parties who may do checking. Maybe web resources and so on and so forth.

The compliance checking systems: this is the heart of implementation. How do you check the buildings at the design stage, at the construction stage? And then increasingly some countries are starting to look even at the very end of construction at commissioning and other sort of end of pipe tasks. Most jurisdictions I think it's important to note, if they do this kind of checking they only check building design. But there's a growing understanding of the need for more extensive, but yet cost effective checks to produce energy efficient buildings.

And those are difficult tradeoffs, particularly because its local governments typically that have to provide the resources for this in some way or another. Third is compliance checking tools which can help mainstream compliance. This includes compliance checking software. Also it's having really clear rules. If you are going to do simulation—building energy simulation—to help with code compliance they have really clear rules for how you do that simulation in complying with the code. That's another example of a tool.

User guides that help make the code easier to understand for people is another example. Another example might be—and we'll hear about this later from China—they have what's called an acceptance code which is a detailed set of guidelines on how to inspect building and what kind of documentation is needed.

Next building material testing and labeling. This is kind of like the foundation for a lot of energy efficiency policies in buildings. It's the test protocols, the independent labs possibly, clear labels to make compliance easier so that when your code says you need a window with these characteristics you have a clear label that tells you, "Okay this window has those characteristics." And it's easy for everybody to check.

And then finally is evaluation of the overall process which is something as I mentioned earlier it's fairly new to the codes world. There are growing numbers of evaluations around the world but it is still the rarity. And it seems many of the evaluations that do exist are not always in the public domain because of sensitivities. So on the implementation process here again I think—I'd like to describe this as options because not all countries have all of these elements—and also the potential roles.

Plan review, also the design phase, is the most common as I mentioned. In many countries the local government will do the plan review at the design phase. That includes for example in the United States, in New Zealand, in

Spain. Some countries will have third parties check the design to make sure it matches the Building Energy Codes. China is a good example, and France. And then when you look at onsite inspections there are many countries that don't do those. Or if they do do it they will only randomly select a few buildings to inspect.

But in addition, just like the design phase, there are different institutions that may play this role. The United States primarily relies on local government the same Canada, Australia, and also Spain. Although even within some of these countries increasingly there's a move to third parties with the understanding that local governments have difficulty building up their capacity that quickly. China, France, Germany, and Italy mostly rely on third parties when they inspect buildings.

And then again some countries don't inspect building at all. Commissioning, which I have at the bottom of this chart, is not required in a lot of countries. But increasingly there are some requirements. So an example blower door tests. France has new requirements for blower door tests. The US also does for commercial buildings. Commissioning of HVAC equipment; many European countries, for example, require commissioning or checks on their furnaces and boilers.

And then energy auditing requirements. Some codes will say you have to go back and periodically audit buildings every so many years. Those particular provisions I think are not always enforced. But you can get the sense that increasingly countries are thinking about not just moment the walls are sealed, but a little bit beyond as well. So in terms of the property _____ that you're checking for—the energy efficiency properties that you're checking for.

I thought it would be helpful to break it down into some of the key things that are important to building energy efficiency at the design and construction phase. Their U-value which is thermal loss through the walls, the roof, the windows, air leakage but I'll stay with U-value for a moment. With U-value you can check it in several ways. You can review the building design and the actual construction making sure that they match the code, match what you say you're going to build.

You can look at the material labels. I could also use an infrared camera. As far as I know countries do that for audits but I don't know of any countries that use infrared cameras to check if a building has the proper thermal loss, as specified in the code. Probably, because by the time the building is fully constructed and operating it's late to be fixing that. And it's expensive if there are problems. I mentioned these end of pipe checks because I think countries are trying to think outside of the box.

Are there ways that are less labor intensive that we could still get the same results? With air leakage there I think the end of pipe test is quite robust—the boiler door test. And it is increasingly in use. The other way you can check for air leakage is just reviewing the building design and the actual construction. But with air leakage I think blower door tests are the sort of

gold standard. Solar heat gain—There you can review the building design and the actual construction, also building materials

I've heard of cases where people can do a simple small flame test with like a lighter on a window to check if there's a film that would prove solar heat gain; although I don't know of countries that use that in practice. And again this in the category of if you wanted to think outside the box with end of pipe tests. Equipment efficiency—there again it's review of the building design and the construction. Look at the labels on the equipment and commissioning.

Commissioning is quite important to make sure it's properly installed, properly operating within the building. So what are the roles of the different types of checks? The design review ensures that the proposed design meets the code requirement and is very important in that sense. Then the construction review checks—It matches the building materials and the labels and the actual construction to see if it matches that proposed design that was already approved.

It also checks the installation to make sure the installation was done properly. And the commissioning and other end of pipe tests really are checking for proper installation. So these different checks have slightly different roles.

Moving on to compliance evaluation systems. You know these types of systems are designed to not check the individual buildings but to say hey how is our system doing overall? Do we have a high compliance rate? What types of things are people having difficulty with so that you can better design capacity building program, training programs. You might tweak the code if you see certain provisions people are just getting confused about, and so on and so forth.

Compliance assessments are focused, as I said, on the system level. And as a result they require more of a statistical approach. You may just sample buildings instead of checking all of them if you're doing a compliance assessment. They can be useful for learning and improving both the implementation and the code itself. Not many countries actually do compliance assessment to date. And when they do it oftentimes it's not publically available. There are some methodological issues regarding compliance evaluation. How do you accurately represent the compliance rate? How do you sample buildings?

Should you weight the measures based on their importance for energy? Or if there's anything at all wrong with the building does the entire building count as a fail and so on? Another thing that some countries are increasingly interested in—and we had some discussions around it in the BEET project—was the idea of measuring performance against code compliant design to use as an opportunity to learn about implementation systems and so on. It would be an option for taking evaluation one step further.

Moving on to challenges, there are many challenges with implementation. It's not easy because unlike in a manufacturing setting buildings for the most part are built one at a time. Even if they're built from a design that's used in many cases the actual people doing the construction are doing it one building at a

time. So you have to think a little bit differently than you might with other types of policies. And a lot of that comes down to the local level—the local officials who have to have the capacity, who have to have the resources to be able to adequately either supervise an implementation system of actually do the inspections themselves.

We find in many countries there's a gap between the policy goals at the national level where there's strong support for Building Energy Codes in many places. But then the resources available at the local level don't necessarily match that. And then in addition—sort of corollary to this—is the capacity particularly at the local level may be constrained. They don't have enough staff. They don't have enough training. And it's hard. Given that these same people have to inspect buildings to see whether they'll fall down or to see whether they'll catch on fire.

Things that people prioritize in making sure that energy efficiency is also given that same level of priority can be difficult. Coordinating among all the different stakeholders is also a challenge. There's the local level, the national level. There may be third parties involved. There are various industry organizations that are involved. So there are many people who have to coordinate to be able to have a strong implementation system.

In some cases there can be conflicts of interest. I mentioned when there are third parties if they are getting paid for by the developer they might not inspect the buildings as thoroughly. There could also be conflicts of interest if a local government has a close relationship with a developer. So thinking about the systems to make sure that they're robust is important.

International collaboration I think can provide some opportunities to help countries learn from each other and possibly speed up improvements in implementation. During the BEET project we interviewed to points of contacts from a range of I think it was 17 or 18 countries and got their thoughts on where they might benefit from collaboration. The first was learning about code compliance checking and the effectiveness of different approaches to enforcement.

How do you do this given limited budgets at the local level? Then this issue of measuring performance against code required design, the software, and tools that can support code implementation and collaborating around that. And then finally incentives: innovative ways to incentivize the private sector on code compliance particularly for above code measures. Not when it's the basic code but maybe when a country is first starting to consider implementation and making a code mandatory, or if it has ways of incentivizing above code performance.

A couple of conclusions. You know I think countries are increasingly recognizing the need to strengthen implementation in order to achieve their goals. Code have become much more stringent in most countries and more complex over time which is great from an energy efficiency perspective. But it can also make implementation more difficult and requires more attention on the implementation.

Most jurisdictions require review of building designs for compliance but not always inspections of the actual buildings. Some counties—And universally in all the countries we spoke with they all felt there were not enough resources for checking buildings and for implementation. Some countries have local building code officials conduct the reviews while others may rely primarily on certified third-party reviewer. So there are some different models.

And the final thing I would like to pose as we open up the discussion session—a couple of questions you might consider are how can countries learn from each other and what kinds of materials and information will be most useful for people to share and to learn from each other? Thank you and I look forward to hearing questions.

**Sean Esterly** Great. Thank you very much Meredydd and Jonah for the presentations. We do have a couple of questions that we'd like to start with, the first one being: how countries can learn from each other and what kinds of materials and information would be most useful for people to learn from?

**Meredydd Evans** So Sean I think that is the—We can share some thoughts but we would love to hear feedback from the audience on this as well. In the previous slide I had gone over four different topics where we heard countries expressed a lot of interest. They're fairly general topics and it would be great to get more details on what people feel would be the most helpful and the kinds of resources people would like to learn from. Thanks.

**Sean Esterly** Yeah definitely. And our audience—if you want to provide feedback on that you can submit that through the question pane. Meredydd we do keep our audience on mute so we won't be able to have an open discussion about that. But if anyone has any insight on that and wants to share it with the panelists you can send those in through the question pane and I can bring them up here. But we'll move on then to a couple of questions that did come in to us through the question portal.

The first one for both Jonah or Meredydd is can you give estimates of compliance rates in different countries? So they're wondering about US, Denmark, India, and China. You may not have those exactly but do you have any insight onto compliance rates in any of those countries?

**Meredydd Evans** There have not been enough studies done that we can definitively say. In the US the few studies that have come out I think indicate that there's quite a range of compliance rates. I don't think any country is exceeding 90 percent is my personal opinion. Denmark has done more evaluation but what I've seen they've done it more to learn from the process as opposed to sharing a specific compliance rate. Denmark I think would probably have a relatively high compliance rate—above 50 percent in a general sense.

India is still at the stage of adopting the code in most locations. So the compliance rate is going to be quite a bit lower because most states in India have not yet adopted their code. So it's probably closer to something like 10 percent or possibly even lower. China does do evaluations of compliance in the largest cities. I think the methodologies are different than you might find

in some other countries. Basically when they find buildings that are not compliant they typically will fix it. And then that counts as a compliant building as far as I understand.

So they report compliance rates sometimes of 98 percent and above but in my conversations with Chinese experts they feel that the compliance rates really have improved a lot in recent years. But they aren't probably actually 98 percent. They're you know maybe something 70 percent in the biggest cities, maybe overall, because they don't have codes for rural areas at all. And in the smaller cities the compliance isn't so great. It would be lower than that. But it would be great to have a better understand. We don't have enough information.

**Sean Esterly** Great, thanks Meredydd. In absence of inspection codes how can third parties perform the verification and submit the report to the energy ministry? Any insights on that?

**Meredydd Evans** Could you repeat the question?

**Sean Esterly** Yeah they're wondering in the absence of any inspection codes how can third parties perform verification? What are some other methods that perform verification and submit reports to energy ministries?

**Meredydd Evans** Okay. First in most cases the energy ministries are not involved in code implementation. So the reports would typically get submitted to local governments in most countries. In terms of how you inspect another example—China has a robust system. Sha will go into that later in terms of the detailed requirements of what you need to check. Other countries will more typically us like a check list system where the inspector would print out a checklist of things that they should be checking during that inspection.

And they'll go during their visit and look at those specific items. Hopefully those rotate a little bit so people don't just decide to pick the items they know will always be checked. And hopefully those items will also contain some of the more important things in terms of energy outcomes of the building. In the United States some states allow Home Energy Rating inspectors—so HERS third party inspectors to use their methodology that they've been certified to use in checking buildings.

And then I know in several European countries they have a certification system particularly for the design phase where they have specific rules for how they check the building against the design. I could be wrong but I'm not aware of rules in European countries for third parties to check the buildings against the design in the construction phase. I think it would more likely be a checklist as I mentioned.

**Sean Esterly** Thanks again Meredydd. We have a few more questions that we'll keep going through. If any of these though are better suited for the second question and answer session just let us know and we can proceed onto the next one. And just a reminder to the audience we will be going to the case studies presentations after this. And then we will have a second question and answer session as well. This next one asks: how much should we raise the Building

Energy Codes standard each time? And when should we raise it? I'm sorry they say Building Energy Codes standard which I took to mean Building Energy Codes standard.

**Meredydd Evans** I think it depends on a lot of factors. You know each country has to be able to do the analysis to figure out what makes the most sense for them based on their climate, the materials available on their market, the cost and cost effectiveness, or in Europe what they call cost optimal options for improving energy efficiency. And then also I think it's quite important to think about implementation. It really doesn't make sense in my humble opinion to adopt and extremely rigorous code if you have no implementation capacity.

And you might be better served by applying it to only large building at first or having a plan to roll out a more rigorous code. But make sure that you're getting implementation done as well. You have to consider that in the mix. And then in terms of how frequently, you know countries have increasingly been revising their codes. Most countries do not have a fixed revision schedule. But we see many countries that will revise their codes every three years, every five years. Sometimes it's every ten years.

You know I think it depends on their own circumstances and the rigor of the codes can vary from one country to another. There is not set percent that you have to improve every time you change. It really depends on how much more opportunity you have and how much more ability you think you have to implement that code I believe.

**Sean Esterly** Great, thank you Meredydd. We do have quite a few questions coming in. So I'd like to just do one or two more for now and then go on to the case study presentations. Then we can address the rest of them during the second question and answer session if that sounds good to you.

**Meredydd Evans** Sure.

**Sean Esterly** Great so this next one we have: setting compliance checks or code benchmarks varies from country to country. Is there methodology that can help in setting these benchmarks?

**Meredydd Evans** I'm not entirely sure I understand the question. I would actually recommend if the person who posed it could explain what they man by benchmarks. That would be helpful and we can answer it.

**Sean Esterly** They do provide an example such as baseline U-values or daylit area thresholds, et cetera.

**Meredydd Evans** You know if you want to have an EPI-based code where you have a U-value per square meter and then you may or may not benchmark that against other buildings. And that's how your code is written. That can provide a lot of flexibility for designers which can allow you to have a more rigorous code in the end potentially. The challenge is how do you translate that into compliance if I understand the question correctly. Most people don't think in terms of kilowatt hours per square meter of energy use.

The approach at the end of the day I think would be quite similar. You make sure that your design is compliant using probably building energy simulation software. And then you would develop a checklist of the items that you want to check when you actually go in and inspect the building. You could have a more detailed protocol for figuring out what you need to check and how you need to document that as China has. And that probably would improve the rigor of implementation.

But you know you have to translate your design into what you're actually going to check at some stage.

**Sean Esterly** Thanks again Meredydd. Let's do one more question before we move on to the case study presentations. This one asks if you have any insight onto the cost associated with implementing building codes in emerging economies, specifically when there is little commitment from local governments.

**Meredydd Evans** Most of the cost studies that have been done look at the cost of additional energy efficiency measures in the buildings. And they pretty much universally show that the costs of compliance are overwhelmingly positive in that you invest a little bit. You might increase the cost of the building by—I've seen studies that show five percent, maybe eight percent, maybe even ten percent, depending on the country. But you save a lot more over the course of the next, say seven years in energy terms. And typically most codes set a pretty low bar for it.

They'll say okay you show what you're going to save in the next seven years or ten years and that's what we'll include in the code. And then buildings last a lot longer. So the savings are huge. On the side of how much it costs the local government sure there are costs. I would—I think using third parties is one way a lot of developing countries have started to consider putting those costs through to the developers. But typically the costs of those programs are even smaller than the additional costs of compliance in buildings.

But one other thing I'll say on cost is that in countries that don't yet have a vibrant market for energy efficiency. Codes will expand that market substantially which is a corollary benefit. But at the very beginning it means that you may have higher costs because maybe you have to import windows or whatnot. I think those countries do transition pretty quickly. But that is something to consider.

**Peter Graham** Can I weigh in too please. This is Peter Graham from the GBPN. We've looked at the macro scale and costs and benefits of different building energy policies including codes. And what we've found overwhelmingly is that building codes deliver economic savings over time. So while there might be some upfront costs associated with, as Meredydd mentioned, new technologies or capacity building, in general the building codes are paying off well. And the only risk in losing money implementing it or establishing a building code program is not implementing it effectively.

There were some studies done in the US for example showing that if you could achieve full compliance with the US building code nationally you would be saving between $63 million and $189 million a year in energy costs.

So for the lifetime of buildings in the US then you would be saving around $37 billion in the long term. Our studies—and there's a comprehensive cost study on the GBPN website you can look at—really demonstrates that you do need to take the view of building codes and support policy as a long term investment.

But that investment does pay off. And in fact the more ambitious you are with the performance requirements for the code over the long term the more it pays off. I hope that helps answer the question. I would also just mention that for developing countries, countries that have yet to begin with building codes, there are substantial financial support mechanisms through development banks or through the West recently the Green Climate Fund and also the NAMA Development facilities which can also support that sort of upfront cost.

**Meredydd Evans** And this is Meredydd. I wonder if this might also be a good topic for a future webinar: the costs and the benefits of codes and also how to consider cost optimal of _____ calculations for the measures to go into the codes.

**Peter Graham** I'd support that.

**Sean Esterly** Certainly. We can discuss that too after the webinar. But Peter I think that was a good introduction for you. We do have quite a few questions left but I think some of these might be addressed in the next round of presentations. So let's move on now to Peter Graham's presentation.

**Peter Graham** Can you hear me and see my slides?

**Sean Esterly** Yeah we can see the slides. You'll just want to throw them into the slideshow view.

**Peter Graham** Okay, how is that.

**Sean Esterly** We're actually seeing the full program. So it's showing two split screens. If you hit plot displays up at the top it should solve it.

**Peter Graham** Yeah how is that?

**Sean Esterly** There you go, very good. All yours Peter.

**Peter Graham** Excellent. Well thank you very much and thank you everybody for tuning into this webinar. I'm here to present a case study of the Australian experience with implementing the National Construction Code Energy Provisions and some lessons learned from the field in terms of compliance. And helping me with this presentation was Neil Savery from the Australian Building Codes Board. He would love to have presented this himself but the time zone does not make that possible it being 2:45 AM in Australia.

So he and I have collaborated on this presentation. I hope I do it justice. First of all just a quick overview of the way the building code works and the energy provisions in Australia. In Australia it's a federal system. The building code of Australia and the National Plumbing Code have been combined into

the National Construction Code and the energy provisions for buildings in Australia are covered by the Section J of the building code of Australia.

The code is a national code but it's adopted and adapted by states and territories to meet various contextual requirements including changes in climate zone. It's implemented and enforced by the municipality. This is I think quite a common structure around the world that the municipal governments, cities are at the front end of implementing and enforcing the code. At that level too municipalities can make local adjustments through planning laws. That's a little bit of leverage that the municipalities have on the code requirements and standard enforcement.

The energy provisions in the National Construction Code apply to all new residential and non-residential buildings. And the also apply to renovations, particularly the renovation for hot water services which is covered by the National Plumbing Code. The energy provisions in the National Construction Code were introduced in 2003 in the Section J of the Building Code of Australia. And they've been a number of revisions since then.

They have included extending the energy performance requirements to multi-residential buildings and then to non-residential buildings in 2006 increasing the stringency of the performance requirements for house in 2006, and then increasing the stringency for non-residential buildings in 2010, in fact four building types in 2010. You can see on this timeline that there is a fairly regular revision cycle which is an important aspect of good practice in implementing building energy codes.

And you can also see if you look at the timeline underneath the time scale there the announcement for changes bringing in the code or changes to the code were made in advance of the actual adoption of the changes. And that's another very important component of best practice—that is having a regular revision cycle but being able to communicate effectively to the industry in advance of that change so that there's a chance for stakeholder comment and also time for capacity building and time for also the government to establish supporting tools and resources.

Just quickly I want to look at the scope of provisions. The energy provisions for residential housing reference an energy performance standard called NatHERS, the Nationwide House Energy Rating Scheme. And the current performance requirement is receiving a 6 star writing under NatHERS. The actual energy performance required _____ hours per square meter varies across the country depending on the location and related to issues in the location such as climate and building type—heating and cooling zones, et cetera.

Just to give you a sense of what that means and how it differs if you're building a new single family home in Sydney the 6-star requirement is around 11 kilowatt-hours per square meter for thermal energy. And in Melbourne it's around about 32 kilowatt hours per square meter for thermal energy. So it's quite a high performance requirement. It also includes not just the thermal but also lighting and other building services.

There are two compliance pathways both for residential and non-residential. The performance pathway which requires third party assessment of design and there is no national required software. It's software that's used for energy simulations and need to be accredited through the NatHERS program. Also a prescriptive path or Deemed to Comply path which sets out performance provisions for different elements in the buildings including the building fabric and glazing, shading, ceiling of the buildings, et cetera.

Moving on to the multi-family residential and the non-residential building types again there is a fairly stringent performance requirement for multi-family residential buildings, in that case recognizing that not all of the building is habitable. The requirement there is that the overall average for energy performance of the building needs to be 6-star, a minimum of 5 stars for individual dwelling units or apartments. And again the compliance pathway can either be by performance or Deemed to Comply provisions.

In this case third party assessors, certified energy professionals are required to issue compliance certificates. They're also supporting tools I should say for getting through compliance pathway, setting up for a performance check or a Deemed to Comply. Different states have different tools which enable practitioners to check plans for compliance prior to submission and then also either issue provisional certificates using a Deemed to Comply path or a common platform for enabling certified assistance to submit compliance certificates with building permits applications.

One noteworthy tool like that has been established in New South Wales. It's BASIX. And this is a tool which helps practitioners to develop and check plans that would comply with energy provisions but also with greenhouse gas emissions to mitigation targets, and also water saving features as well. And the good thing about the BASIX platform is that all of the information for projects is submitted online. And so over the years the BASIX program has actually captured a lot of data about how building designers and the industry in general is adapting to comply with the building codes and also with the other environmental targets which are part of the approvals process in New South Wales.

And it is an interesting resource to look at. There have been some reviews of the information which is contained in the BASIX platform but unfortunately it doesn't collect actual performance data. There is a good basis for quite an extensive study of actual performance. There isn't any automatic collection of energy _____ after occupancy. That's the building code. The building code applies to new construction and renovation and is mandatory.

Then there are supporting policies and frameworks in Australia as well which are encouraging practitioners to go beyond minimum performance requirements and also energy rating and disclosure which are both voluntary and also mandatory. It's worth noting the commercial building disclosure program which establishes mandatory disclosure requirements for energy efficiency performance of commercial offices greater than 2,000 square meters at point of lease or sale.

This uses a program called NABERS which is a rating program which covers issues beyond energy. So it covers energy, water, waste, and indoor environment for some building types. You can see on this slide here the scope of the NABERS rating program. But the energy rating tool is used by the Commercial Building Disclosure program and is used as a basis for issuing a Building Energy Efficiency certificate which verifies a measured performance for the leased space or the building. And those data need to be displayed at sale or lease or sub-lease.

There are also voluntary rating programs such as Green Star which is sort of analogous with LEED or BREEAM or _____ and these sorts of green building rating schemes. But they're linked also to the NABERS program. So if you have a NABERS rating that NABERS rating can be used to get the energy points for Green Star for example. There is also a program called City Switch which is a program which uses the NABERS ratings for tenancies, and then the GRESB which is looking at portfolio wide energy performance. That also uses the NABERS tool. They're quite integrated.

That's the map but it is the territory. The key of course is how well are codes being complied with? And what we find in Australia there's been quite a good review of compliance in Australia which was published last year. And what we find from that review which was quite extensive is it involves a whole range of outreach to stakeholders and surveys. It's quite an extensive reach to find out what was going on in the field. And the overall conclusion from that survey is that full compliance with the energy performance requirements of the National Construction Code are rare.

And there are some reasons that the study found why the energy performance requirements are being fully complied with. And you can see on this slide here is the summary of issues which are at play in Australia at the moment which might be common in other countries. So for example there is little intention to orientation or master planning for energy efficiency. Perhaps in terms of actual energy performance the building design or the plan is compromised by the citing or other master planning issues.

Again the building designs themselves aren't being optimized for energy performance. But in some cases there is a design by numbers approach with the rating schemes. And sometimes the plans themselves aren't being submitted with sufficient data to be able to really tell whether or not a design will achieve the energy performance requirements of the code. Certification is an issue. There is an issue with lack of physical inspections which I'll get to later on.

And also there are poor practices in construction with limited inspections and also perhaps not sufficient training of practitioners. And construction quality also undermines the energy performance and compliance with provisions in the code. Commissioning is in some cases actually required in some states but not consistently enforced. And then actually in use and energy consumption isn't systematically checked. There isn't the data which enables good learning.

I'm going to go through some more detailed observations from Neil as well now which kind of reinforce the strategies for change and also the sort of recommendations that the report made. Looking at that review but then also looking at it from the regulator's perspective there really seems to be a lack of understanding and awareness about the importance of energy efficiencies and also how the energy efficiency requirements in code can be complied with particularly for complex buildings. There is also a lack of incentive from clients to insist that the evidence be shown that the energy provisions are being met.

There is a lack of capacity to order and enforce compliance with the code. The approach in Australia is to use third party auditors if municipalities don't have the staff. And energy performance isn't a high priority among all of the code requirements so that the auditors have to check. The other issue of course is that there is a decline in energy consumption in buildings which tends to suggest that even though compliance isn't 100 percent effective that having the code has actually positively influenced energy consumption overall. But it could be better.

Where do we go in Australia to improve the situation? There are some opportunities that could be leveraged to improve compliance. One of the key opportunities is that there is an emerging view that energy efficiency buildings—high performance buildings—do attract better tenants. And so raising awareness among building owners that energy efficiency does translate into better occupancy rates and higher rents is a message that could potentially help the clients demand that energy provisions be met.

The NABERS program and the mandatory disclosure laws are starting to have an effect in the commercial building market and together with the Green Star program are considered to be labels that demonstrate high quality. That helps again with the demand side and helping the clients ask the right questions of the contractors and the building designers about meeting energy provisions.

I mentioned BASIX before. There isn't data that will be able to pin the effectiveness of the BASIX tool with energy savings. It is a great resource for collecting data on what is happening in the building sector. And so addressing issues such as how designers can deal with complex buildings for example is really informed by the kind of information the BASIX tool collects.

What can be done to improve compliance? The Australia Building Code Board is following a number of activities at the moment. One of them is to try and simplify the language that the building code is using to describe energy performance and also trying to quantify energy performance more effectively in the code so it's easier to understand. They have really decided to focus on improving compliance as a priority rather than brining in the next level of stringency.

I think this is a really good move because we find in our research across the world that when we're discussing implementation of new building codes in countries or increasing the stringency of building codes in countries there is

definitely a political barrier where politicians or bureaucrats who are against more regulation for the building sector can say with some authority that unless you can demonstrate you can comply with the laws we already have don't come and ask me for more stringent rules or more laws.

I think it's a very important priority there. That's one of their objectives. It's also important that we increase the level of importance placed on energy performance. Moves to be able to increase understanding amongst the building sector and also building owners, operators, and clients is going to be a good long term strategy before level of stringency can be increased. Education training and continued professional development is really important.

There seems to be a lack of that when it comes to the energy provisions in the code. But also overall the ability for practitioners to deal with complex buildings needs to be addressed. There are a range of support programs for practitioners in terms of finding out about the building energy codes and how to comply with them including practice notes, handbooks, YouTube clips, and so on. A piece of research done by GBPN looking at best practices in renovation policies around the world showed that—

We looked at jurisdictions which had been able to demonstrate a reduction in energy demand over a decade. And one of the common elements in all jurisdictions that were able to achieve an energy demand reduction in residential buildings over a decade was having a very strong support program—one stop shops for energy efficiency we call them. Doubling up efforts to buy that kind of knowledge is very, very important.

I mentioned before trying to provide quantified performance measures to make it clearer in the code what's required. Trying to increase the use of the performance path rather than the need to satisfy a pathway is something that they're trying to do because we found also that when you're trying to get to very high levels of performance and trying to mandate very high levels of performance a performance solution is really necessary because it enables the industry to innovate and the need to satisfy pathways which generally require sort of the selection of high performance building components doesn't necessarily get to the full savings potential.

The last set of actions which I really think _____ are to try and ensure that auditing is more effective. There needs to be more capacity building especially within the municipalities and the states for working out ways of being able to improve activities such as onsite construction inspections and being able to understand or help the code officials or the third party auditors really understand what they should be looking for. Increasing the number of inspectors in the field and improving generally the methodology for inspections is very important.

At the end of the day what they're aiming for is to really make sure that full compliance with the building code equals full compliance with the energy performance provisions, not just the structural provisions. And so there needs to be some work done on ensuring that energy provisions are met when

certificates of occupancy are issued. And there is a building energy passport being considered for that purpose.

And also they're looking at how information technology and digital means are being used by building designers such as building information modeling can be used to make compliance easy to achieve and also beyond the compliance performance easier to achieve at the design phase and track through construction and then into operation.

That's a brief walk through Australia. I'll leave it there and then I'll hand it over to Sha for a look at China and the US.

**Sean Esterly** Great, thank you Peter. Sha we are running a little low on time now. So you have about ten minutes for your presentation just so you know. I apologize about that.

**Sha Yu** I will try to [inaudible]. Are you able to see my screen right now?

**Sean Esterly** Yeah we can see your screen. It sounds like you might be a little bit far from your microphone if you could just speak up a little bit.

**Sha Yu** Is this any better?

**Sean Esterly** Much, thank you.

**Sha Yu** Okay thank you everyone. Hello to everyone. And I think today I just would like to share the experiences in US and China due to the energy code implementation. Starting with the China system if we're going into the system it will be helpful to give you a little bit of a background on the key stakeholders in China involved in the building code implementation There are building developers who initiate the building project by providing financing, applying for land use construction, and occupancy permits.

And they're also forming a project team. The project team consists of building design companies, the design inspection company, the construction company, and the construction inspection company. And at a government level there are local construction departments that are in charge of local compliance and enforcement activities. And they're issuing occupancy and construction permits. And also they're doing the local capacity building. And also at the local level there are something called local policies to provisions _____ in China.

There are semi-government agencies and they're working for local construction departments. So the local quality supervision station supervise the work of third parties especially during the construction phase. They're also doing the site inspection during the construction, also collecting information relevant to the code compliance. And working with them are the local _____ centers the _____. They're doing reading materials and components I think as required by the _____ code.

And also as discussed earlier by Meredydd the China relies heavily on third party inspectors. So there are third party design inspection companies and

also third party construction inspection companies involved in the whole process to make sure the code compliance throughout the process. The site here actually shows the procedure or process for new construction in China as well as the code enforcement staff in China. And in the beginning the developer must go through several steps.

At the start they have to apply for the land use permit from the local construction department. The land use permit, once it's issued, employees start the construction and the code enforcement process. Then the developer will form a project team with third parties which means the design company, design inspection company, construction company, and construction inspection company. And the local policies and provision station during this procedure will do the tax to make sure all the participating individuals and companies are certified and licensed.

And after design is completed the design inspection company checks the design detail to ensure it complies with the building code while that includes the energy code as well. Then it sends a compliance report to the developer, the local quality supervision station, as well as the local construction department. At this point in the process the designer and the design inspection company also use software to check is the building complies with the energy code or not.

And in China they have software called PKPM which actually links your design software like AutoCAD with your compliance software to give you the compliance report automatically generated by the software. Then or the local construction department after they receive assurance of code compliance from the local quality supervision station they will issue the construction permit. At this stage the developer also needs to work with the local quality supervision station to develop a very detailed, implementable construction compliance plan.

Here is the compliance procedure or enforcement procedure during the construction stage. And there are several systems in place to ensure the compliance with Building Energy Codes and also the quality of construction. The construction company itself must have a quality assurance program or system in place. And the local quality supervision actually reviews the quality_____ protocols and also systems during the permitting procedure. The construction supervision company has staff onsite 24/7 throughout the whole construction process to oversee the work of the builders and also to ensure that the construction matches the design and also complies with the code including the energy code.

If the construction supervision company finds there is a problem or flaw it can and often will alter changes. And the change can range from completing redoing a portion of the construction to some less severe penalties. The quality supervision station and testing centers do both scheduled and random inspections during the construction stage. At a minimum level they will be onsite for the pouring of the foundation and the completion of the main structure as well as before the final leasing of the building.

The local quality supervision station can usually stop work _____ and require revisions if the work is not properly done or if the building is not code compliant. Once the construction is completed and all the necessary tasks and documentations are done the local quality supervision station will prepare a completion report which kind of signals that they approve that the building is code compliant. Then they will give the report to the developer together with other compliance reports they got through the whole procedure.

The developer can submit the paperwork to the local construction department to apply for the occupancy permit. Once the occupancy permit is issued they can either rent or sell the building if the building actually goes to market. And one critical piece of the Chinese code enforcement system is something called acceptance code. Or it's called the Code for Acceptance of Energy Efficient Building Construction. It was issued in 2007 by the Chinese Administrative Health and Urban Growth Development.

It covers construction quality, testing, and documentation for the building _____, heating, ventilation, air conditioning system and the lighting system and the controls. It's about 70 pages long and it has several details to ensure the building is constructed with the Building Energy Codes. So the acceptance code provides details on issues like how to check if the exterior installation materials have bonded to the wall correctly. Or the parts of the HVAC system that need to be inspected and how to do the inspection. And also what onsite tasks need to be done and what can be done?

For each item in the code there is a description and a list of specifications that items must meet. And also a brief description of the inspection master and also how items must be inspected. The items that need to be inspected depends on the system. It ranges from 5 percent to 100 percent. I think as discussed earlier as a result of the acceptance code the Chinese code enforcement rate improved significantly from 2003 to 2004 or 2007 or even for now—I'm sorry from 2007 to now. And also as a result of this China's code requirements not only require the inspection for the design construction stage. It also requires for the building commissioning.

Now switching gears a little bit to the US code enforcement system. Enforcement in the US or most at the state and local level and different—It's also different by jurisdictions based on local resources and also regulatory authority. But overall local governments play a major role and third party was not often used throughout all states. During the plan review stage the state or local government normally reviews the building plans and specifications.

They will evaluate the products, materials, and equipment specifications. They will also review task certification reports and product listing. The compliance software REScheck for the national building contract for a commercial building will often be used to help mainstream compliance. And during the construction inspection stage there are often two or more site inspections during construction. And the inspectors will evaluate the materials if there is any substitution in the field. And they also will do inspection prior to occupancy.

However, because there are limited time and resources available the attention to the energy issues may be limited during this stage. And also some larger jurisdictions now often work with specialized staff or third parties to check the specific system or the whole building. For residential buildings some jurisdictions use the HERS raters to check the code compliance. And increasingly there are a large number of the end of pipe test requirements such as blower door tests and also commissioning requirements for certain systems.

One highlight of the US system is the US Compliance Assessment Program. It's a recent effort by the US Department of Energy Building Energy Codes Programs to do the compliance assessment of residential buildings. And the purpose of this is to determine whether an investment in building energy codes can produce notable changes in residential building energy savings. And this only covers new site built single family homes. And also it's a compliance assessment conducted at the requirement level, not at the unit or house level.

It includes some key items for check or for requirement. These items will all have the largest impact on building energy used based on _____ of simulation results. These are the envelope _____, window for heating coefficient, window u-factor, exterior wall insulation, ceiling insulation, and the fraction of high efficiency lighting, foundation insulation and also duct leakage. The US Building Energy Codes Program and the US DOE have a very detailed guidelines—like eight step guideline—to work to guide states or a project team on how do you collect data and how do you do the compliance assessment.

And following on that there is also a very detailed sampling plan for individual states and it starts with a very initial sampling plan based on the _____ of your permit data from the last three years. And after that there will be another final sampling developed by the project team and the stakeholder meetings in case there are any changes or additions to the original sampling plan. And in each phase there are 63 observations required based on statistical measures which means you actually may need to visit more than 63 homes because there are limitations and not all requirements could be observed in a single home.

And all the samples are randomly _____ to make sure the robustness of the _____. And also moving beyond that there is also a detailed data collect tool through a form. The form is kind of a combination of the checklist from REScheck, the compliance software, and also any items added or subtracted based on those state's _____ and also any additional items that may need to be used for any simulation later. At the data collection stage the project team will perform a blower door test and also duct leakage test as well as observation of frame cavity installation and installation grade.

And in the end all the teams need to enter the data online and form an online database. And also the information is confidential. No personal identifiable information will be reported in the online database to make sure the whole overall sum on the database. With that I think I conclude my presentation.

There are a few discussion classes. I know we're running out of time but it would be nice to still get your feedback on those things now or later. Thank you.

**Sean Esterly** Thank you Sha. And unfortunately we are very low on time. I think we have time to address one more question from the audience. But I will be e-mailing out the rest of the unanswered questions to the presenters today and they can respond to everyone through e-mail. Apologies to all the attendees if we didn't get to your question, but if you're just a little patient with us we will get to those and provide some responses through e-mail.

**Interviewee** We have a good question I think that may apply to a lot of attendees that we'll just try to provide a brief answer to if we can. And it asks: do you have any advice on how to keep a capacity building strategy that works with local governments that change every four years? How do you build on what has been one without starting from scratch every time the government changes? And this is for anyone.

**Meredydd Evans** This is Meredydd. I'll take a first stab at it. I think it's important in your training plan to consider different stakeholder groups so that you're not relying exclusively on local government. And you have simplified training for local government and then a more detailed training that you can go into. And most likely the code officials may change jobs. But hopefully they're not political employees. If there there's an election hopefully they're not actually being removed from office.

If you can get deep enough into the local governments hopefully you have some ability. But I think also stepping back and coming up with a training plan overall that figures out who your stakeholders are and what each one of them needs is an important piece.

**Peter Graham** And I would just add that this is a long term engagement that's required and that long term engagements and the stakeholder engagements should also include engagement with the public and with those that vote so that the importance of energy performance and also co-benefits and climate benefits of better performing buildings are really well known and hopefully become an important political issue that ensures that whichever administration is in is going to take it seriously.

**Sean Esterly** Great, thank you guys. We will have to go ahead and wrap up now. Before we do end the webinar I just kindly ask our attendees to participate in a very quick survey that we have for them. If you look at your screen I'll display the first question and you can respond directly on the screen: the webinar content provided me with useful information and insight. And the next question: the webinar's presenters were effective. And the final question is: overall the webinar met my expectations.

Great thank you everyone for answering the survey. On behalf of the Clean Energy Solutions Center I would just like to thank the expert panelists once again and also our attendees for participating in today's webinar. We very much appreciate everyone's time. And just a reminder I will be forwarding

any unanswered questions to the panelists so that they can respond. Again, apologies if we didn't get to your question today.

I do invite our attendees to check the Solutions Center website if you'd like to view the slides and listen to a recording of today's presentation as well as any previously held webinars. Additionally you can find information on other upcoming webinars that the Solutions Center is hosting as well as other training events. And additionally we are not posting the webinar recording to the Clean Energy Solutions Center YouTube channel. Please allow a few days for those recordings to be posted but they'll be available soon.

We also invite you to inform your colleagues and those in your networks about Solutions Center resources and services, including the no cost policy expert support known as Ask-an-Expert. With that I hope everyone has a great rest of your day and we hope to see you again at future Clean Energy Solutions Center events. This concludes our webinar.