

Implementing Building Energy Codes: Status of Building Energy Code Development and Implementation Globally and in China, France and the United States

—Transcript of a webinar offered by the Clean Energy Solutions Center on 20 October 2015—
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This Transcript

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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 Global Buildings Performance Network. Today's webinar will present the current status and key areas for international collaboration in building energy code implementation and compliance, and the experience of code implementation in China and the US.

And one important note of mention before we begin our presentation 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.

And I just want to go over some of the audio and webinar features for you. You do have two options for audio. You may either listen to your computer or over your telephone. If you choose to listen to your computer, please select the mike and speakers option in the audio pane. Doing that will just help eliminate echo and feedback. And if you choose to dial in by phone, please

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And we encourage anyone from the audience to ask questions at any point throughout the webinar. To ask a question, simply type it into the questions pane, and you can submit it there. If you're having difficulty viewing the material through the webinar portal, we will be posting the PDF copies of the presentations to cleanenergysolutions.org/training. And you may follow along as the speakers present.

Also, an audio recording of the presentation will be posted to the Solutions Center's training page within a few days of this broadcast. And we are also now adding the recordings to the Solutions Center's [YouTube channel](#). You'll find a nice list of other webinars you can listen to 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, Chen Peng, and David Cohan. And these panelists have been kind enough to join us to discuss the current status in key areas for international collaboration on building energy code implementation and compliance. Before our speakers begin their presentations, I'll provide a short, informative overview of the Clean Energy Solutions Center initiative. And then following the presentations we will have a question and answer session where the panelists will address questions submitted by the audience.

Mr. Peter Graham, executive director of the Global Buildings Performance Network, will also be joining us for the question and answer session. And then finally we will close with a brief audience survey.

This slide provides a bit of background in terms of how the solution center came to be formed. And the solution center is one of 13 initiatives of the Clean Energy Ministerial, which was launched in April of 2011. It's primarily led by Australia, the US, 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 assets, no cost extra policy assistance, and peer to peer learning and training tools, such as the webinar you're attending right now.

And there's four primary goals for the Solutions Center. The first goal is to serve as a clearing house of clean energy policy resources. Second is to share policy best practices, data and analysis tools specific to clean energy policies and programs. And third, the Solutions Center delivers dynamic services that enable expert assistance, learning, peer to peer sharing of experiences. And then lastly the Center fosters dialogue on emerging policy issues and innovation from around the globe.

And our primary audience for the Solutions Center are energy policymakers and analysts from governments and technical organizations in all countries,

but then we also strive to engage with the private sector and NGOs and also civil society. This slide provides a bit of information on one of the marquee features that the Solutions Center provides, which is its no cost expert policy assistance, known as 'ask an expert'. And 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 to you.

So for example, in the area of buildings, we're very pleased to have Cesar Trevino, leader of the Mexican 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. So if you have a question for our experts, please submit it through our simple online form at cleanenergysolutions.org/expert. Or, if you want to find out more information on how ask an expert can benefit your work, please feel free to contact me directly at Sean.Esterly@EnRail.gov, or give me a call at (303) 384-7436.

And we also encourage you to spread the word about this service to those in your network, in your organization. So now I'd like to provide brief introductions for today's panelists. Our first panelist is Jonah Steinbuck. And 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 the building energy efficiency task group of the International Partnership for Energy Efficiency Cooperation, and his work primarily focuses on advancing clean energy and energy efficient policy through international forum, such as the IPEEC, the Clean Energy Ministerial, and the G-20.

And 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. She's spent four years in Paris, seconded to the IEA, during which time she served as acting head of the non-member country division.

And our third speaker is Chen Peng, who will be joining us from the Center for the Science and Technology of Construction. And then our final presenter today will be David Cohan, the building energy codes program manager at the US Department of Energy. David has over 20 years of energy efficiency experience in a variety of capacities, including evaluation and program design. For the last decade he has worked on development and implementation of building energy codes to mandate minimum efficiency levels for all new buildings constructed in the US. He's especially focused on ways to increase compliance with code so that potential energy savings turn into real life savings.

And then finally Peter Graham will be joining us for the question and answer session. And Peter is currently the executive director of GPPN. And Dr. Graham has previously served as the technical advisor and coordinator of the

United Nation's environment program sustainable buildings and climate initiative. So with those introductions, I'd like to go ahead and now welcome Jonah to the webinar.

Jonah Steinbuck

Thanks very much, Sean. And good day to everyone. And thank you for joining this webinar on building energy codes. As Sean mentioned, 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. And this task group supported a project over the past year on an exchange of code practices and experiences that you'll hear about today.

As some of you are familiar, IPEEC, the International Partnership for Energy Efficiency and Cooperation, is an international forum comprised of 16 major economies, collectively responsible for about three fourths of global GDP and energy use. And it's dedicated to accelerating the adoption of energy efficiency policies and practices through dialogue and action, within a range of different energy efficiency initiatives.

One of those initiatives is the building energy efficiency task group, or BEET. And through BEET governments work collaboratively to research and support the development of effective building energy efficient policies. This task group 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 IPEEC and the G-20 economies shown on this slide.

Over the past few years, the BEET has conducted projects on building energy ratings systems. We've looked at opportunities for international collaboration across a range of building energy policy areas. We've looked at building energy performance metrics and the webinar topic today, building energy codes. Next slide, please.

So the codes project started in last fall, fall of 2014, as a collaborative effort of the national governments engaged in IPEEC/BEET, as well as the Global Buildings Performance Network and the Pacific Northwest National Laboratory. And this followed on an earlier project that showed building codes were a key area of interest for international collaboration among IPEEC government energy efficiency experts. The project focuses on identifying the key areas for international collaboration on building energy code implementation. So essentially we're trying to better understand how to realize greater energy savings from codes.

And as a first step, the focus has been on sharing building energy code approaches and experiences. As part of this project, we developed a web portal to support more efficient international knowledge exchange on building energy code implementation. This provides information, experience, resources, and as well as a network of codes experts from around the world. And I encourage you to check it out. The web link is showed there. www.gppn.org/beet3. And we very much look forward to continued collaboration on codes. We expect this work to continue. And hope that you can continue to join us in this effort going forward.

There's going to be a webinar coming up on November 12th to further explore approaches to implementing building energy codes. And hope you can join us for that. And with that introduction, let me turn it over to Meredydd Evans of the Pacific Northwest National Lab for the next segment.

Meredydd Evans

Thank you, Jonah. And welcome, everyone, this morning, or this afternoon, depending on where you are. I will provide a brief overview of the information that we learned about building energy codes globally in developing the web portal and also just more broadly in implementing the BEET 3 project. I think it really is helpful to understand what is going on in other parts of the world. Because there are a lot of potential lessons that countries can learn from each other.

So the purpose of this webinar is to provide the groundwork and framework so as we move forward people have a better general understanding of what flavors of codes exist. So today I will provide a brief introduction and talk about the different types of codes that exist around the world. Talk about what codes typically cover. Also the implementation process and the different institutional roles that may exist in different parts of the world. Briefly, I'll talk about code revision schedules. And then provide some conclusions.

So what is a building energy code, or a building energy efficiency code? We feel they're mandatory requirements on building design and construction for improved energy performance. It's minimal requirements for the energy efficient design and construction or renovation of new and existing buildings. I think it's also important to think about the fact that these are actually requirements, and that distinguishes codes from building performance labels that explain how a building performs or may perform, but doesn't typically actually require certain features in the building.

What do codes cover? Codes typically one of the first things that will show up in codes are elements related to building envelopes. Things like thermal loss through the walls or the windows. Which is U-value. Solar heat gain through windows and window to wall ratio. Air tightness. Shading. Building orientation. The latter two are newer. Many countries don't have them in their codes. Lighting is often in building energy codes. A few countries have it in a separate document, but very common, because it's so cost effective. HVAC requirements are typically in codes, as well as requirements regarding service water heating.

This is not an exhaustive list, it's just to give you an idea of some of the major elements in terms of the technical measures that typically show up in codes. And some countries have much more limited codes than this, and they may only have a code that focuses on envelope, for example. Increasingly, countries are including post completion requirements in their code. So for example commissioning and blower door tests are two common examples.

There are differences across countries in the scope of the codes. So what kinds of buildings get covered? You can see it in terms of the size threshold of buildings. And some countries, any building, or any building that gets base conditioning, is required to comply with the code. In other countries, there

may be a threshold that's quite high, of, say, 1,000 square meters, particularly when countries are just beginning to implement the code. But actually not only. I mean there can be some surprising differences in this area.

And it ultimately has a large impact on just how much the new building stock is covered. Types of buildings. Some countries limit their code to certain types of buildings. A good example of that is India, which has a code that covers only large commercial buildings. Brazil actually doesn't technically have a code. They have a labeling program. Focused on government buildings.

So then one question people often wonder about with codes is—is a code mandatory or voluntary? And it's a very tricky question. So we were using a working definition that a mandatory code is an implemented code. And it's important to think through the range of factors that affects whether the code ultimately is implemented. First is whether the code has been adopted in all or most jurisdictions. That's particularly important in countries that have a federal form of government, where the national government can't just simply say we're adopting a code.

The next is the extent of compliance checks. So people tend to comply more if you're checking compliance. Also, the ease of compliance. If the code requires really complicated formulas and calculations, it might be difficult for people to comply with the code, or they may not have the skillset to date based on the type of code that a country has adopted. And it's also important to note some codes, in fact most codes, provide flexibility in their compliance approach, so that if somebody wants to have more windows, for example, they can, if they compensate for that in other parts of the building.

That fact alone doesn't make the code voluntary. It just provides a framework that allows people to ultimately achieve greater energy savings, because they do have that flexibility, I think. So in the end it's challenging to categorize countries definitively. And the most important thing at the end of the day is to work for broad implementation. Then, looking at the codes in terms of their different compliance approaches, there are also quite a few differences across countries. Typically the first thing that countries will start with is a prescriptive code, which has specific rules on an individual building component, like on the windows, or on the kinds of how much insulation may need to be in the building, and so on.

A next step would be to provide some simple tradeoffs between building elements. So for example between elements of the envelope. And many countries, although not all, do have some kind of simple tradeoff. Some will use a calculated formula. Some may use tables. Then, moving on from that, a lot of countries increasingly are encouraging or requiring simulated performance to understand how much energy the building would likely use. And there are different approaches here as well where it may be in comparison to a theoretical reference building that would apply with the prescriptive measures, or it might be compared to a specific set target.

And that could be expressed in energy used per square meter, for example, or maybe in carbon dioxide emissions per square meter. And that's one area where there's potentially some interesting collaboration between countries, because of the different approaches. Some countries have a totally different approach, and that is a point system. Quite common in some—will add up their points, and at the end of the day, they have to have a certain number of points to pass the code. And if they exceed that, they may be able to get some low interest loans or other incentives.

And then finally there's a new concept called an outcomes-based code that would require people to demonstrate that their actual building uses only a certain amount of energy, and doesn't exceed certain thresholds, either by posting bonds that, say, after a year out, they could get back if their building in fact only consumes that much energy. Or maybe something in an ongoing way.

This is I would say is mostly a theoretical idea at this point. There have been some attempts. I would argue that Tokyo is probably the most advanced, although theirs is through a cap and trade system. So there are no full scale examples yet, but it's a really intriguing concept that a lot of countries are interested in learning about.

Okay. So. Moving on to the implementation process and the different options. I think first it's important to say not all countries have a robust implementation process, and many countries recognize in fact all the countries we spoke with felt that they had a lot of room for improvement in their implementation process. Some of the elements that will typically show up, although they may not show up in all three of these may not show up in each country—includes plan review. So that means reviewing the design of the building to see if it complies with the code.

That's the most common. If countries are going to have any kind of implementation process, most likely that's what they'll do. The next is on-site inspections, and that could actually involve multiple inspections throughout the construction process. It might involve extensive documentation to demonstrate compliance during the construction process. Or it may not. And finally, it may involve some type of post-completion efforts like commissioning or blower-door tests. Those are increasingly common, but the majority of countries do not have anything in that space.

Also important to note—local governments everywhere typically play the key role in enforcing building energy codes. Compliance software can be a really important tool to help mainstream compliance. And also one thing we found in the implementation process is that building material testing rating and labeling while it may sound like a fairly technical topic, it's actually really important to make sure you're achieving the results you want. Because if you think you're going to put in a window that has certain characteristics, and in fact the testing process is not as robust as you think, your window may not perform as you want it to in the end. So that's an important piece not to forget about.

Sorry. So next. Moving onto the government roles in the codes process. At the national level, many governments will develop the codes, or provide training and resources. Australia is a good example of that. Canada, India, Mexico. In the United States, there's a model code that's adopted sort of not at the national level but at the national scale. And or I'm sorry. It's developed at the national scale. And at the state, regional, or province level, in many countries, that's the level at which the code might be adopted. Particularly for countries with a federal form of government, or that have devolved some of the regulatory responsibilities to the state or regional government.

So that's certainly true in the United States. Australia is in that situation. China as well. And then the local jurisdictions, as I mentioned, are typically responsible for enforcing the code. That's true in almost all countries. So then who is responsible for checking compliance? That varies a lot as well. At the design phase, many countries do involve local government, but I don't think that' actually the majority of the cases.

Local government there's the idea this could be more robust, because they may be more objective. There are also just limits on how many resources local governments might have. They may not be quite as expert in all the technical skills necessary to check a complicated building for compliance. Many countries have relied on third parties as well. Sometimes they may involve some review by the local government. Like in the case of China, there's fairly extensive review. Or it may be occasional spot reviews of, say, one or two percent of the buildings by the government in addition to the third party reviews.

South Korea, we found there's a national government institute that is involved in the design phase reviews. At the construction phase, and, again, a lot of countries do not do construction phase reviews, or, if they do, it's only sporadic, it's only a small percent of the buildings may see construction phase reviews, including the countries, some of the countries mentioned here. And it may also depend on the jurisdiction, where some jurisdictions do it most of the time, and others don't, within a given country.

So, here, again, it's a similar story. The local government may be involved in inspections at the construction stage in some countries. Australia, Canada, United States. India has talked about that, but today there really isn't significant construction phase inspection. Third parties may be involved in a lot of other countries. So China has a well-developed system of third party reviews. France and so on. And then again many countries don't do third party reviews or any kind of construction reviews.

So the code revision schedule I think is also something interesting. How— what's the process to improve the code over time? We also looked at the extent of stakeholder involvement. And I won't speak in great detail about that today, but if you go on the BEET website, you can see more information about the stakeholder process in different countries. So we looked at 22 countries, and of those only four have regular schedules for code updates. Clear revision schedule in theory can help industry plan and adopt. It can also facilitate more stakeholder involvement.

Then, of course, most importantly, frequent updates allow for faster code improvements. So ensuring that some way or another there's a process to have frequent updates, I think, is quite important. And you see the countries that have some of the most stringent measures will have more frequent updates to their code every several years at least.

In conclusion, codes are becoming more common and rigorous throughout the world. It's true not just in the developed world, but also in the developing world. And because they are being revised more frequently, they are getting more rigorous. Implementation is challenging everywhere. There are interesting examples in different countries of potential solutions.

So collaboration is I think would benefit all of us. Because it is a complicated subject. But I do feel it's one where we can see important gains, particularly through learning from each other and working hard at this. Thank you.

Sean Esterly Great. Thank you very much, Meredydd, for the presentation. And we will be turning now to Chen for his presentation.

Chen Peng Morning. Can you see my screen now?

Sean Esterly Yes, we can, Chen.

Chen Peng Can you see my screen now?

Sean Esterly Yes, we can see your screen, you'll just want to go to the slideshow view.

Chen Peng Okay. I'll begin. And _____ introduce _____ the building efficiency codes in China. And it will include five parts. And from 1980s, China began to develop building energy efficiency codes. And we start to name from foreign countries, like US and like European countries. That is before the 1986. And after, we began to do some light demonstration in the pollution standards in the codes. And in the _____ stage, we think it's from 2001 and to 2005. The ground units man-du-lar code systems in different type of building, in different climate zones. And after 2006, and the _____ has _____ codes all around. And we can see this mike, this is climate zone, in China.

Conversely, there cervical in cervical account a zone, there building energy efficiency code was mandated to improve the building _____ solution, and they aft-slides, in _____ some, and called the winter zone, new standard, new codes was _____ for improves the building energy efficiency. Aft-slides is move front to the south part of China. In _____-some and warm winter-zone.

And the building type for the code, for the code for the building types, well, firstly, just a focus on the urban _____ _____. And after that commission the public buildings was big focus on their building energy efficiency. And just about two or three years ago, the codes and for rules resignation of buildings was _____. And firstly was a newly built buildings was more to be pained more at-Haitians than existing buildings.

And the post process was mainder will include the laws and regulations, aiming for newer built buildings, where we should be energy saving buildings

in China, in most urban area. And _____ our existing building will be retrofit if no energy efficiency. And _____ for pollution, liable for energy efficiency, and a data-stay-status are also being done in China now. And standards, and codes, was gradually developed just during these years. Energy saving tagalong dues, that codes focus on energy saving tagalong dues, well, carver, the primer design construction operation, and then retrofit, period.

And it improves enveloping solution, nature-when-the-nation, shading etch-VNC in the 1960s. There are be several laws and regulations in China like energy conservation law, like the renewable engine-law, like building energy conservation ordinance, and the public sector energy efficiency recognize. Different laws or regulations have different content, just to show you a table for example, energy conservation laws, when could engraved in the energy management, energy savings technologies, and so on.

And the standards or codes will improve to basically standards, design standards, acceptance standards, testing standards, evaluation standards, and the transformation standards. These standards or codes remainder from 1986. And some of them was—has been reviewed for two or three times. And it covers different kind of buildings, and different types of existence.

For example, the residential buildings, it has—the standards or codes for residential buildings were firstly mainly in 1986. And the targets was save about 30 percent energy. And in 1995, it has been reviewed, and the target—at what rise to 50 percent. And in 2001, the standard was mainder in hot summer and cold winter zone, not just in north space, and it will be—it was be made—it would be developing cold summer and the warm winter climate zone in 2003.

And in 2008, the cone-country has been mainder served residential building codes. The targets was rise to 65 percent percentage in several cities, like Beijing, Shanghai, and so on. From 2011 to 2020, the whole country will mainder serve package to improve energy efficiency of the buildings to save energy about 65 percentage. Several countries, like Beijing, Chai-jing, Shanghai, will improve their energy efficiency to save about 75 percentage. And from 2021 to 2030, the whole country's standards or codes for residential buildings will include passive house green buildings, virtual no energy buildings near zero energy buildings, and sell.

And for three NP buildings, in 2005, the whole country's remain a standards for target is save about 50 percent energy. And in 2015, just this year, the new standard was be reviewed for the whole country, and has made more details about assistance and about their different systems being different climate zones.

And what China to _____ make codes and recommends is stage by stage, and the way established different systems for new build the buildings, or existing buildings, and then for local government. And it will be updated for up to their improvement of technologies that someone new products, or some like building enveloping solutions. And EEB—energy efficient building—public training in to exchanger and draw local corporation will get

down in some university like a _____, or like an in-savior, some research institute.

So maybe that's just a brief discussion about Chinese codes and standards to have. Thank you.

Sean Esterly Great. Thank you very much, Chen. We will move ahead now to our next presenter, Mr. David Cohan.

David Cohan Okay. Hello, everybody. This is David Cohan. I'm speaking from the US Department of Energy in Washington DC. And hopefully you can all see my screen now.

Sean Esterly Yes, we can.

David Cohan Can you verify that, Sean? Okay. I'm going to give a very brief overview of the various code phase in the United States. The basis of the energy codes that's used in almost all the states are developed by two non-profit private organizations. So one is ASHRAE, which is a very large volunteer engineering society. And they develop something called Standard 90.1. And that's for commercial buildings only. And then a totally different group, the International Code Council, develops what's called the International Energy Conservation Code, which includes both residential and commercial buildings.

And these groups run public processes. Anyone can participate. So in general they're on a three year cycle. Meredydd mentioned earlier the frequency that countries change codes. So in the United States, historically, it's been every three years a new code has developed. And anyone can participate. You don't need to be an expert. You don't need to be nominated. You submit code change proposals. And then those are reviewed by a committee. And the process varies, depending on whether it's ASHRAE or the International Code Council.

But ultimately a vote is _____, and whatever's decided to change from the last code becomes the new code. The US government participates in these processes, but we do not have any special status. As I mentioned, these are private, non-profit organizations. So we are one of many stakeholders. Many people from industry participate. Energy efficiency advocates. Government representatives from state and local governments. Lots of people participate.

One of the really important things to understand is that ASHRAE 90.1 and the IECC are model codes. So there is no national code in the United States. And a model code, the best way to think about it is it's just a resource that's available for a government to adopt. Nobody is forcing it to adopt that. And in fact if a state wants to adopt a model code, they can also change it however they wish. States and in some cases local governments can even develop their own codes.

California, which is the largest state in the United States, has its own code. And they do not use these model codes at all. In most instances in the United States, codes are adopted by state governments. In about 10 states, the

individual cities adopt codes rather than the states. And when the states or the cities adopt a code, they run a public adoption process very similar to the ones that develop the national model code. They send out an announcement that says, "We are thinking of adopting this new code," and they invite people to participate and to submit code change proposals.

And then there are committees that vote on them. And when the voting is all done, they have a new state or local government code. And usually after they adopt it, they give people about six months before it's required to follow it, so that people who design and build buildings have a chance to understand the new code requirements and make the changes necessary.

So the US codes cover the building envelopes. The walls, floors, ceilings, and windows. _____ on both the inside and the outside of the building. Day lighting. And mechanical systems for heat recovery and control. Things that are not regulated are process loads. So things like factories, industrial facilities in general, are not covered by the building codes. Also, plug codes. So appliances and electronics are not covered. And most important, the efficiency of equipment is not covered in the building code. The national minimum equipment efficiency standards are created by a completely separate process by the US Department of Energy.

And there's actually a law that says a state or local government adopting a code cannot increase the minimum equipment efficiency. So it gets a little interesting that obviously the codes affect the energy use, but a very key component, the equipment itself, is determined by a different process. However, the code can control the systems—for example, the controls. If you want, for example, the code would say you have to insulate hot water pipes, even though you can't determine the efficiency of the water heater, anything that's not the equipment can be regulated by the code.

I'm going to show you two charts now. The first one, for residential, and the second one for commercial. And this shows how much energy savings have increased over time. So the bottom of the chart is time starting in 1970, about. And the left hand vertical axis is the easiest EUI, which is Energy Use Intensity, but it's easiest to think the amount of energy that these buildings can use. And what you'll see is that from about 1975 to 1985 almost nothing happened.

And then there was a big jump down in 1986. And then things sort of went slowly downwards over the next 20 years. And then in about ten years ago, we had two codes in a row, and these are the model codes, two model codes in a row that had major energy savings associated with them. And we're still now sort of getting those adopted and implemented in the states. I didn't mention it earlier, but the model codes are adopted by about 40 of the 50 states in the United States. So while they are not a requirement, they are very important in determining the codes in the country.

Okay. The next slide is commercial building. The same kind of slide. And you'll see that again there was a long plateau in the beginning where very

little energy was saved, but, in the last ten years, the codes have improved dramatically.

Okay. After a government has adopted a code, you need to implement it. And the first thing that usually happens is that my program at the department of energy creates educational materials that explain the difference between the old and the new model codes, and we also provide software that make it easy to show compliance. And then most states will use these materials, and they will provide classes to both building officials, and design and construction professionals, so they can learn what's changed in the code, and change their own practices so that they comply with it.

There's also states that do field research to discover if buildings are complying with the code. And that's different. In almost every state that has adopted a code, the people building the building have to pay a fee, and that fee covers a review of the plans, and then usually multiple inspections on site at different times. So they will go very early in the construction process to see whether the foundations have been insulated. And they'll go later to see if the walls have been insulated, and the windows meet the code. And then they'll go at the end and do a blower-door test and a duct-leakage test to make sure those meet the code requirements.

So in almost all cases, there is on-site inspections. But then above and beyond that, some of the states afterwards go out and do research to find out if everything is really working. And that's all I had to say. Free to answer questions afterwards, but thank you very much.

Sean Esterly Great. Thank you, David. And we have had a number of questions come in. Before we get to those, I would like to turn things over to Peter Graham, who is joining us. And he will address some things before we address the attendee questions.

Peter Graham Okay, thanks very much. Can you hear me okay?

Sean Esterly Yes, we can.

Peter Graham Okay, perfect. First of all, thanks to Meredydd, and Chen, and David, for really interesting presentations. And also to Jonah for setting the theme. It strikes me that one of the key issues really coming through is really about getting the actual energy saving out of real buildings once the codes have been set in place. And with the wealth of experience on the panel, I'm just wondering, whether you're seeing any common approaches which really work. Then clearly there are different contexts in each of the places that we've heard from today.

But getting down to this question of implementation, and achieving the energy saving which are pretty much on the table with regulations that are in place, I think is a key issue. We've found _____ as we work to try and help governments adopt best practices that often the failure to be able to realize energy savings that are currently mandated in existing codes, in terms of political _____. So I think this is a really key issue, and it'd be interesting to hear more from the panel about that.

And the other issue which has come up which might be related to _____ called barriers to achieving proper full implementation. I think that complicates the implementation _____ such as this question of the integration between different levels of government, and also, as we've heard from David, the integration between different forms of codes and standards _____ building codes and applied standards for materials, performance standards, and zones.

So I guess those to me seem to be issues which are common which are perhaps even embedded somewhat in the codes process of _____ building _____. It would be interesting hear more from the panel about how you can address implementation and integration in such a complicated market. Thank you very much.

Sean Esterly Great. Thank you, Peter. Did anyone want to address some of the points that Peter raised before we move to the attendee questions?

Meredydd Evans This is Meredydd, and maybe I'll make a brief comment. I think it is consistent hard work in having a system to check buildings, to check the plans. It doesn't have to be local government. It can be coordinated with third parties. But carefully thinking through the model to make sure that it's robust and objective. And then also evaluating the process. Having some way to check—are you actually getting the results you want? And to feed that back into your implementation program, and also ultimately into your code revision program. Because if there's certain things that are really challenging for people to implement, maybe there's a different way to phrase it. Maybe there's a different requirement that one could have. Thanks.

David Cohan And this is David. Peter mentioned politics. And I guess I would also say attitudes are important. So building codes are much broader than energy. There's electrical codes and structural codes and fire codes. And one of the problems we have in the United States is that the building officials, who are in charge of inspecting the buildings and reviewing the plans, often think that the energy code is not as important as those other codes. So they give it less resources and less time. And that makes it difficult to make sure everyone is meeting the requirements.

That's a much harder problem to solve, but we just know at some point, culturally, we need to get people to believe that the energy codes are just as important as all the rest of the codes if we want to see these implemented properly.

Sean Esterly Great. Thank you both for the additions. And it looks like we can move on now to some of the questions from the attendees. I'd like to start with a broader, more high level question. We've had a number of people ask how codes can be developed from scratch. Obviously that's a pretty detailed question. But maybe we could give just a broad overview of that. Again, a number of people have asked that. What is the first step in developing a building energy efficiency code? And what are the first steps for implementing them when there's none to begin with?

Meredydd Evans This is Meredydd again. Go ahead.

- David Cohan This is David Cohan. I think the easiest answer to that is you should never start from scratch. Because there's been lots of good work that's been done all over the world. And what you want to do is take a look at other countries' codes—and it'll take a long time, but you need to set up a group of people whose job is to review those codes and determine what parts are relevant to your country, and what parts are not relevant to your country. And then both add things where necessary, and remove things that are not necessary. But it just would be way too much work to start from actual zero. And there's no reason to.
- Peter Graham Yeah, _____, too, David, and we've done a lot of work, looking at best practices around the world, and there are a lot of resources from a range of organizations that can be tapped into to avoid starting from scratch. I think that's a really good point. That also goes for the kind of data required to begin developing your codes program as well. It's quite a lot of data on building energy intensities, etcetera, which could be used as a basis as well. So just endorsing that. You don't need to start from scratch. Please don't. There's also _____ I guess.
- Meredydd Evans Yeah, and this is Meredydd. I agree, there are a lot of great resources. I think some key steps are bringing together the stakeholders and coming up with a plan. How do you want to go about this? What are the codes you might refer to? But then also thinking you don't have to start by requiring strict energy efficiency measures in every single building. You can start with a piece where you can test out your implementation in a way that builds your confidence, builds the market's confidence. Maybe you're starting with larger buildings.
- But then if you do it that way, make sure you have a clear roadmap for how quickly you're going to expand, so it doesn't become difficult later on. I think baking that in is important.
- Sean Esterly Great, thank you, everyone. Moving on now to the next question, it states that typically the penalty for non-compliance is non-issuance of construction permits. So for outcome based codes, and codes with post-completion requirements, such as commissioning, typically, what is the penalty for non-compliance?
- Meredydd Evans So I think that's the crux of the issue, really. I would also add that it's not universally true that non-occupancy is the typical stick. Different countries have very different approaches. Sometimes they have fines. It is not universally true that countries won't let people occupy buildings that don't meet the energy code. In terms of outcomes based codes—so I go back to the example of Tokyo, which is not technically speaking an outcomes based code, but it has many of the same features in that they're monitoring energy use in all the large commercial buildings over time, and the buildings have to stay within certain caps that are declining over time.
- And basically what happens there is the carbon cap and trade system—if you do not meet the requirements, you have to either buy credits from someone else, using money, or you have to find ways to invest in energy efficiency

measures, or some combination. David may want to speak about some of the models that have been discussed in the United States.

David Cohan Yeah. It's a little awkward in the United States, because there has been a great deal of discussion about it. But there are very few actual examples where it's been implemented. The main one was Seattle. And it did not really do very well. But I think part of the answer to the question is that the outcome based codes are on top of the design and construction code there. They do not replace them. So what you want is a good design and construction code. And you can just leave your current system in place.

But then the outcome based—maybe even different government agencies who monitor it and enforce it. but you really don't want to—what you don't want is to let buildings be designed and built any way they want, the people want to, and then hope that afterwards they'll perform properly. So exactly how you do outcome based codes, and how you motivate people to do them, it's a separate process, to me, is the most important thing to keep in mind.

Sean Esterly Thank you, Meredydd and David, for the response. And now we have a question that came in, this one specifically for Chen, on his presentation. And, Chen, it asks, in your presentation, in terms of improvement, you mentioned that for example the residential buildings, the target for 2021 to 2030, will be 75 percent. Does it mean 75 percent of buildings will be energy saving buildings, or 75 percent energy savings overall?

Chen Peng Thank you for question. And this target is for newer buildings. And compared to 1980s _____ were, newer buildings were safe about 15 five percentage energy, so is determined for the newly built buildings' energy efficiency. It's not for the how much for area of the energy efficiency building take part. It means another energy efficiency target for newly built buildings.

Sean Esterly Great. Thank you, Chen. And another question for you was—are there any plans to line up greenhouse gas reductions and savings being caused by the construction industry? Is there any plans to match that with the energy efficiency code?

Chen Peng Beg your pardon? You mention green building codes?

Sean Esterly Yeah, just the attendee is wondering if there is any plans to line up greenhouse gas reduction savings as a result of the energy efficiency codes. Are they tracking greenhouse gas reductions from the codes?

Chen Peng Yes. You mean for the green buildings, what's the target for the energy savings for green buildings, right?

Sean Esterly Yes, yes, so they—emission reductions.

Chen Peng Okay. Green buildings in China may—sorry? Green buildings in China will have their lapse for one star, two star, and three stars. And the target for different labels of green buildings, well, it's not just include save energy, but also save the land ward, and save the materials for the buildings. And it's target for promote their if tactical promotes the nature protector, so the energy

efficiency is just part of it. The target for the green buildings. Maybe is compared to the energy savings codes. Just mentioned that in—for example, in 2008, their target for the energy saving, for residential, is about save 50 percent.

So the green buildings in that time is targeted for, say, for 50 percentage, for green buildings. Is the same with their energy savings buildings code. Is not just _____ include any more song-more contents.

Sean Esterly Okay, thank you.

Chen Peng Is that agreed?

Sean Esterly Yes, yes, thank you. And Meredydd, I think this was directed towards you, but I think it's something everyone could address as well, so it's really for the whole panel—what are the major incentives for local governments to enforce code, assuming most local governments have to find a balance between social benefits and building developments, and owners?

Meredydd Evans Great question. I think that they're similar to those at the national level. So it's reduced strain on energy systems. It's homeowners and businesses that can have lower costs. And, in _____ they're more productive. It's the fact that there'll be lower emissions. Which in some cities is a very important issue. So I think it's at a smaller scale, but they're the same reasons that governments care about building energy codes overall. I think as David has mentioned the key is getting the individual code officials to understand that these issues are equally important to whether a building is likely to burn in a fire, or likely to stay standing because it's structurally sound. These are not peripheral issues, if we can come together in finding ways to implement the code robustly.

Peter Graham Yeah, and I'd like to add something, too. I think when you look at some of the experiences from jurisdictions in European countries, particularly with implementing energy efficiency codes for retrofitting, you see that there's quite a good link between energy efficiency codes and creation of local jobs in the construction sector. And so there's a co-benefit in terms of job creation. And another important issue which is coming up is the issue of urban air quality. And often in some countries at least anyway, reducing energy demand for buildings can help reduce air pollution.

So there are a range of other multiple benefits as well, which really do occur at the local level, and not so much at the state or the national level. Thanks.

Sean Esterly Thank you, Peter and Meredydd. This question is for David. David, do you know what the current code adopted in California is?

David Cohan Well, its name is Title 24, which just refers to the name of the law. And I can only say that it's better than the current model code. The most recent version of the model code. But beyond that, I can't tell you any details of it. It's available online if you just google Title 24 California, you can review the whole code.

Sean Esterly Great. Thank you, David. I'll send that title to the attendee. And moving on to the net question, one of our attendees just wants to thank you for the overview and the background, and asks—what are the next—if you could outline the next key steps to improving implementation overall. Obviously this one is for everyone.

David Cohan This is David. I think I have to go back to what I said about the trying to get people to care more about the energy code. Because that's really the key to the whole thing. In the United States right now, the current version of the model codes are pretty good from an energy efficiency point of view. So if we could get everybody to adopt them, and everybody to enforce them seriously, we would save a lot of energy. So it's really just getting what we already have that exists already into place and enforced on a regular basis. And that we do some of that through education and training, but there also needs to be a call from policymakers to make people aware that this is important, and that the government people in charge of it need to pay attention and take it seriously.

Meredydd Evans This is Meredydd. I completely agree with David. I would also add that evaluation can sometimes help in this process. I've seen some jurisdictions that feel like they have a pretty robust process, but they have no information on whether people are actually adopting the code or not. And if you start to understand what is working, it can help you improve that process. It may also help in engaging the local officials who need more handholding or more information to be able to understand why there are benefits here.

Peter Graham Sorry for jumping in. Another thing, too, that we found is helpful is our US partner, IMT, has been running an awards program for local code officials. So if a code official has done very well in implementing the energy performance _____ then there is an award for them. So I think part of it is education and awareness raising, but I think also anything that can be done to demonstrate to the code officials that this is really important, such as an awards program, something like that. It seems to be working. It's not every day that a codes official gets an award for implementing the law.

This seems to be something which we're seeing as welcome in the US, at least. So that's something to consider. And I think also just to back up Meredydd—the point of evaluation and looking to collect data on the existing energy performance of buildings, to do either _____ to help with the political argument, demonstrating the need for a code, it's very important. And also of course how important it is to implement it properly. But then also going back to check to see that buildings are performing according to code improves the code, but I also think it provides a key element of motivation for officials, and also for governments to continue to push forward.

Finally, I think just looking at the example of China, and, again, the _____ in some reviews of its practice jurisdictions around the world, with respect to building code, the new building, and also for existing buildings, but particular for new buildings, the idea—the key—one of the common elements to success, I should say, is setting targets. Setting long term, medium term, and short term targets for improving the performance of building stock, and reflecting that in codes, and making sure that the changes to the codes are

communicated in advance to the industry, so that the capacity building _____ can happen to enable implementation when the new performance standards come into force, etcetera, is really important.

So getting back to what Meredydd said about having a plan is really key. But also having that plan with quantitative targets, and sort of projection of increasing stringency over time, I think are elements which we've seen be components of success for jurisdictions.

Sean Esterly Thank you, everyone. We'll move onto the next question. We do have quite a few questions left. So we'll try to get to as many as we can. Next question builds on what was stated before, looking at what other countries have done as a first step for implementing energy codes. It asks what are some reliable resources that the panel would recommend to review what other countries have done?

Meredydd Evans I would strongly recommend going to the BEET 3 portion of the GBPN website. Because there's quite a bit of information there on the 22 countries that we looked at. And so that I think is a really helpful resource. Also, in that web portal, there are links to other documents, other reports that have looked at early stage code adoption in different countries, and so on, and so forth.

Jonah Steinbuck This is Jonah as well. Just wanted to add to that. There's also in addition to the resources page and the summaries of code implementation practices across the countries, there's also lists of code experts from around 20 different countries, who have made themselves available to be sort of resources and help answer questions, point people towards more detailed resources within their country. So use that as another resource as well.

Sean Esterly Jonah that's—Sorry, just follow up, is that also on the GBPN website?

Jonah Steinbuck It is. It is. There's a directory of experts tab on the GBPN BEET 3 portal site.

Sean Esterly Great. I will send that out to the attendees.

Peter Graham Yeah, and just a couple of other things on the GBPN side. So there are two tools. One on best practices for building codes for new construction, and another for best practices for residential renovation energy policies. And this gives these two tools just give you a way of being able to compare different jurisdictions approaches to building energy codes, and across a range of best practice criteria, so that they _____ and other things.

But I'd also—and then the resources there are also available in Mandarin as well. So if you are looking at the site from China, then the resource is available in that language. But also I mean there are a whole range of other really interesting resources out there on the internet. Just off the top of my head, I'd refer also to the European commission, and the buildup web resource, which is actually quite good for renovation policy. And it also gives a range of resources for the energy performance and buildings directive, which is very interesting.

There's the BCAP for the US—the Building Code Assistance Project—which I think is also a great resource for the US codes. But I'm sure once you get into those resources, you'll find links to many others.

Sean Esterly

Great, thank you, everyone. And I did send out a couple of those links as well. Moving on to the next topic. Could you please share any encounter challenges and successful implementation tips of compliance software for energy efficiency codes?

David Cohan

Okay—there's two pieces of software. One for commercial building, and one for residential buildings. And if you'll remember, I said that states and local governments do not have to adopt the model codes as they are. They can amend them if they want. Then of course every three years there's a new model code. So there are some difficulties in having all the versions you need for to accommodate the states, and what code they've actually adopted.

And we get a lot of request from a state who has changed the code in some way, and they say, "Can you make us a custom version of the software?" And sometimes we can, but there's a resource issue. So to me it's just you will have to deal with many different versions of the code, at least if you have a system like the United States, and that's probably one of the hardest things we have to deal with.

Meredydd Evans

And this is Meredydd, adding on. From some of the things we've seen internationally. First, it's really important to have compliance software. If you have a code that has—in particular if you have trade off requirements. So think about that as you're designing your code. I've seen many countries that don't have robust software. And it really does stand in the way of implementation.

Next is some countries want to build in whole building simulation into their software from the get go, and it's really difficult to do it well, and in a robust, replicable way, where you get the results you want consistently. And I would argue don't worry so much about that. Worry about the other elements of the code, assuming that your code has prescriptive trade off and whole building paths.

And you can use other commercially available software to do your whole building simulations, as long as you have clear simulation rules in your code. So that would be the thing to focus on there. And then finally a robust library of building materials. That is a challenge in a lot of countries that are fairly new to this. And you can look at other countries' libraries as a starting point, but putting some effort into learning about the properties of typical materials that go into building so that your software can run on those is really helpful.

Most building designers really have no idea what the average you-value of a wall assembly is. So don't make them do that guesswork. Thanks.

Sean Esterly

Thank you both. We have a couple related questions. I'll try to word this to capture both of them. They're basically asking—what is the relationship between outcome based codes and benchmarking and disclosure? And also

along with that benchmarking and disclosure, what kind of monitoring usually needs to be put in place to make sure codes are being met?

Meredydd Evans So _____ the basic concept, and, again, it has not been implemented at scale anywhere that we're aware of. So it's a concept. But the idea is that it would incorporate benchmarking, because you have to have some way to tell if a building is meeting the outcomes that it would like. But it goes beyond that. Because it has specific targets. And presumably some carrots or sticks associated with matching your desired target.

Disclosure—you know an outcome based code does not have to have disclosure. And could or it couldn't. And different models for outcomes based code people have talked about would involve most in North America have talked about a fixed period of time where you sort of check the building for a year or so after you've built it to make sure that the consumption is as you expect it to be, but is not an ongoing basis.

I mentioned the example of Tokyo where it is ongoing. But it's not technically an outcome based code either, exactly.

Sean Esterly Thank you, Meredydd. And we have time for a couple more questions. Do you have any cost benefit estimates of implementing building energy codes? Just in general, not any specific numbers.

David Cohan We have, on EnergyCodes.gov, which is the Department of Energy's website, you can find a report called the National Benefits Assessment. And it does cost effectiveness—it's a 20 year—I think from 1992, or maybe a 30 year, 1992 to 2020, I think, we will be redoing that next year. And then various states have done their own cost effectiveness, and we have provided those analyses actually to every state. It's safe to say that in general energy codes are extremely cost effective, because it's much cheaper to change a building during the design phase than it is to change it after it's been built.

So there are resources out there, there are methodologies out there that people could look at. And you would just have to find something that makes sense for your situation.

Meredydd Evans This is an area where we've heard a lot of interest in collaboration between countries. One of the methodologies you use to assess costs and benefits. Because it's required in an increasing number of countries, particularly in the EU.

Sean Esterly Thank you, Meredydd. And, actually, building off that, we did have one person ask if you could give a very brief status on the codes in the EU.

Meredydd Evans I can try. I don't know, Peter, if you want to jump in on it?

Peter Graham Yeah, well, I'll give you what I've seen. I refer you to the Building Performance Institute of Europe, BPIE.eu, for a whole range of detailed analysis of the implementation of the European building codes, under the EPBD framework and also the _____, www.BPIE.eu. And I can tell you from reading some of their analysis that there is still a ways to go where

for many member states in achieving the EPBD nearly zero energy targets. And also the—probably a lot further to go for many member states in developing energy efficiency renovation roadmaps that are required by the energy efficiency directive.

Meredydd Evans

And if I could add onto that, briefly. So I think generally speaking, in Europe, the codes in most countries are integrally related with building energy performance certificates under the Building Performance Directive. So some codes have had more requirements historically linked to having a certificate that shows what the performance theoretically might be than requiring specific efficiency measures. That is changing.

Broadly speaking, there are stronger codes as you move north. Not universally true. Some Scandinavian countries have very weak codes. Some have excellent codes. Southern Europe, typically, has not had very strong codes. And Eastern Europe as well, Eastern or Central, tend to be less strong than looking farther west. There's been a lot of change in this space in the last even three years. France has adopted new code, and worked much harder on implementation, etcetera.

Sean Esterly

Great. Thank you, Peter. And thank you, Meredydd. We do have a number of questions left. But unfortunately, we are running low on time. So we're going to move ahead now to the next section. But I do want to just reassure everyone I have all the questions here, and I will email those out to our speakers. So give them some time to respond, but we will be able to address those in the near future. With that, I would now like to move ahead to a quick survey that we have for our attendees, just to help us evaluate how we did on the webinar, and improve for future webinars.

So I will go ahead and display the first statement. If you could please respond directly in the screen. The statement is—the webinar content provided me with useful information and insight. Great. Thank you. The second statement—the webinar's presenters were effective. And then the final statement is—overall, the webinar met my expectations. Great. Thank you, everyone, for responding to our survey. And again just a reminder—if we didn't get to your questions, my apologies, but I will be emailing those out as well.

So, with that, we'd like to go ahead and wrap up. On behalf of the Clean Energy Solutions Center I would just like to once again thank our panelists for joining us today. Great presentations. And, also, I'd like to thank our attendees for participating. We do appreciate your time and are happy you were able to join us today. And I invite the attendees to check the Solutions Center website if you'd like to view the slides which are now posted, and also listen to a recording of today's webinar, as well as any previously held webinars.

Additionally, you will find information on upcoming webinars and other training events. Also, just a reminder, we're posting all webinar recordings to the Clean Energy Solutions Center YouTube channel. So please go ahead and check that out as well. It will take a few days for today's recording to be

posted, so check back either tomorrow or the next day. We also invite you to inform your colleagues and those in your networks about Solutions Center resources and services, including the no-cost policy ask an expert policy support.

So 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 and webinars. And this concludes our broadcast.