

Holly Carr:

Hello. I'm Holly Carr with the US Department of Energy. I'd like to welcome you to the season opener for the 2015-2016 Better Buildings webinar series. In this series we profile the best practices of Better Buildings challenge partners, Better Buildings alliance members, and aligned organizations who are working to improve building energy efficiency.

Today we'll be looking at energy models and how building owners, managers, and tenants can use them strategically to improve energy performance in buildings. Many building owners are familiar with energy models in the context of LEED certifications where models provide a basis for determining points awarded for energy performance.

But, that's really just the tip of the iceberg, and our panelists today will provide you with information and examples that you can use right away to make use of energy models in new building construction retrofit inside out. So, let me go ahead and introduce our presenters for today. Next slide, please.

First up is Kristin Field. Kristin works as an engineer in the commercial buildings research group at the National Renewable Energy Lab, or NREL in Colorado. Her expertise is in collaborating with industry partners to identify feasible energy efficiency strategies and using EnergyPlus computer simulation to evaluate standard energy performance and improve design decisions concerning energy efficiency buildings.

Working with Amir Roth at DOE, who we'll also hear from today, Kristin has overseen work done with the Rocky Mountain Institute and with the International Building Performance Simulation association, USA Chapter, to create a building energy modeling library, or BEM library. The owner's guide that she will discuss today is an important part of the BEM library work.

Secondly, Mark Chambers, Mark is the sustainability and energy management director at DC Department of General Services. Mark Chambers is a licensed architect, DIY enthusiast, husband, and father of two, living in and working for the District of Columbia here in Washington.

He has focused the last 15 years locally on design performance excellence, construction management, and sustainability policy development focusing on creative strategic planning, energy resource conservation, green building process management and occupant education.

Chambers directs energy management sustainability, policy development and resource conservation implementation across the nearly 30 million square feet of real estate managed by the DC Department of General Services inclusive of the district's municipal offices, public schools, police, fire, and emergency service facilities and parks and recreation centers.

And last but not least, Amir Roth. Amir is the technology manager for our building technologies office here at DOE and the building energy modeling, or BEM sub-program where he manages the EnergyPlus or the OpenStudio projects. Before coming to DOE in 2010 he was an associate professor of computer science at the University of Pennsylvania.

He has a BS in physics from Yale University and a PhD in computer science from University of Wisconsin – Madison. He also has a wife, two children, a black lab, a minivan, and an ardent passion for the Philadelphia Eagles. So, thanks to all of you for being with us today, appreciate it. Next slide please.

Before we get started with our presentations, I do want to remind our audience that we will hold questions until near the end of the hour. Please send your questions in through the chat box on your webinar screen throughout the session today, and we'll try to get to as many of them as we possibly can during the Q&A period towards the end.

This session will be archived and posted to the Web for your reference. So, if you're looking for those slides or you'd like to access those slides later they will be available probably within about a week after the session. With that let me turn it over to Kristin to give us a primer on modeling; when to do it, how to find the right person to do it, and how to take advantage of the results you've paid for. Kristin.

Kristin Field:

Thank you, Holly. And I noticed that my family information was the only one missing from the bios, so I'm the mother of one and soon to be step-mother of two. So, can you advance to the next slide? Thank you.

So, this presentation is going to focus on a resource that we developed through the work with, as it was mentioned in my bio, Amir and DOE and also Rocky Mountain Institute, or RMI and it's a document called *The Owners' Guide to Building Energy Modeling*. Actually I believe it's Owners' and Managers' Guide. It

was sort of developed to fill a void.

There's some materials that are directed at teaching people how to do modeling, you know, be practitioners. They were less focused on teaching owners and managers who were not necessarily going to be doing the modeling themselves but that need to know what is this really about, what can I get out of it, and what do I need to know to be sure that I'm getting a good model, you know, good results. So, next slide. Thank you.

So, what is BEM? We abbreviate it frequently, Building Energy Modeling. And it's basically software calculation of, you know, physical equations that could be done by hand but would be very tedious and if they were done that way it would probably stay in the realm of graduate students and professors.

So, this is, you know, software calculation to kind of make it possible for this to go more mainstream, and the inputs that it takes are descriptions of the physical building, you know, what's its layout? How big is it? Occupancy, how many people are in it? What hours do they occupy the building?

Operations, which is anything from your equipment that you have in there to your lights to how frequently people go in and out and then the weather. You know, where is the building located? So, it takes all those kinds of inputs that usually the architecture, the whole design team is aware of and puts those into a – into some software, which then calculates consumption for the building.

This image that you see below is directly from the guide and gives you some more detailed information, but that's kind of the summary. So, next slide, please.

So, you may wonder, why do this at all? Why bother with this software? It has benefits. The main one is a better understanding of building stock, basically it – I guess if you're looking on a broader scale, what kind of energy and water consumption do you have, say from one building, or you can model different types of buildings and sort of project it out to a whole building stock.

This would be energy consumption, also water consumption. Several softwares are capable of having you input that as well, and then peak demand. Sometimes that's more of interest than the full consumption. Another benefit is that there's a greater ability to identify energy savings opportunities. So, there are – there are definitely rules of thumb out there in the industry, and there are

sort of known combinations of factors that would lead you to select, say, evaporative cooling or, you know, with this set of conditions of your building, you're likely going to want a lighting retrofit or lighting upgrade.

So, there's certain things like that in the industry that are known, but having a building model allows you to quantitatively predict the savings that could come from measures and then also optimize the savings, and then once you have that number, that quantitative estimation then you can do calculations like return on investment and net present value and things like that because you actually have an input for the savings dollar amount.

Also, a benefit of BEM is that you can demonstrate, you know, because of this quantification, compliance with building codes, performance level for green certification such as LEED, and you could demonstrate how much you qualify or whether you hit some threshold for incentives and rebates. And then overall sort of, you know, the reason why we would look into this in the first place is, this should lead you to a more energy efficient and cost-effective building. Next slide.

So, when do you do BEM? You know, different projects have different entry points, but the point of this slide is to remind you that basically the earlier you do it, the more effective it is because major design decisions are sort of made along the path of a project, and BEM – having a building model will help you avoid mistakes that are difficult to overcome later.

So, let's say sometimes you already have certain pieces of a design laid out, and in order to change one thing that you realize because of the building model is not a very good idea. You would have to change so many other portions of the design that it's just impractical and you have to go ahead with whatever you had originally decided without the information that could've been provided to you from the building model.

So, anyway, use it at least so you can make the decisions, and that will result in a better performing, more cost-effective project. This little graphic down below is in the guide, and it's also something from our RMI that shows sort of a lot of typical phases of a design project, and it shows that line that shows where a lot of people start, and what this tells us is that opportunities to reduce loads and identify some measures, probably not needs but measures, are usually sort of foregone because people have already started getting that stuff set in stone before they are informed by a

building model. Next slide. Can you go to the next slide, please?
Thank you.

So, let's say that I've convinced you and you think that building energy modeling is worthwhile endeavor, how do you get started? So, there are a few basic questions that you want to ask. What modeling services exist, and which ones of those should I want? How would I know if a modeler is good? There are a lot of them out there, how do I know they're going to give me results that are meaningful?

Should I ask for a potential software because they're, you know, some softwares are more appropriate than others, and some modelers have more experience than others. And then, what goes into the contract that I would have that modeler for their services? Next slide, please.

So, short answer, read this first. Read this guide first, that is what it was intended for. It was intended to answer those basic questions. It was developed a couple years ago jointly by RMI, NREL and DOE and then it has been distributed already to trade groups, owners, corporations, investors, you know, a large audience, but we're doing this webinar and hoping to sort of get it out into the modeling community and owner and manager community people that need to interpret these results more deeply.

So, anyway, we would encourage you to take a look at this. It's 30-something pages, and actually that's sort of small bi-fold pages, so it's not a big tome of 100 pages that you're never going to get through, and there will be a link to it later. All right. Next slide, please.

So, what's inside this? Just overall there's an overview of the building energy modeling for people that want just a basic idea of what is this stuff? The services typically offered, so what are the roles and scopes of the modeler, what kind of timelines can you expect for different types of services, and then what are all the softwares out there?

There's a useful table in there that shows, you know, here are things that you might want to use an energy model for, and then to the right here are the names of softwares that are typically used to perform that function. So, that can be a really good reference for, are you using this just to calculate the loads and the building, and you're not trying to design anything? Are you using it to try and simulate annual performance? Are you using this to calibrate?

So, it could be a pretty useful resource, and then also in this guide contracting modeling services. What are the types of contracts that you might consider? What are modeler credentials that are out there? And how would you solicit and contract these services? So, pretty useful stuff for someone who's especially at the beginning process of trying to enter into the contracting modeler world. Next slide.

So, I guess getting into that a little deeper, how do you choose a modeler? The affiliation can be an important factor. Are they affiliated with a specialized consulting firm, let's say one that does energy modeling all the time, that is maybe a sustainable design firm or something like that? Are they a project architect or a project mechanical engineer?

Some architecting engineer firms or individuals have actually a lot of experience with modeling that's, let's say, something that they've done on most of their projects. So, really either of those three options could result in really qualified individuals that have a lot of experience, and there may be others too.

So, who are they affiliated with, what firm – or maybe an individual with less experience or like, specific credentials, modeling credentials that we know of now that are included in the guide are ASHRAE, BEMP, which is Building Energy Modeling Professional, another one is AEE, Association of Energy Engineers. BESA, let's see if I can get this right. Building Energy Simulation Analysis I think. Anyway.

Amir Roth:

I think it's Analysts.

Kristin Field:

Analysts, sorry. Almost got it. Thank you, Amir. Another very important credential is experience. You know, it's just sort of like a lot of jobs, on-the-job training is very important and learning sort of typical, typical problems that you see in models and how to address them most reliably is extremely important.

So, like with someone – look for someone who's not just starting out if possible or at least someone if they're starting out they have very good mentors, and then overall it should be a firm that's dedicated to quality assurance because modeling is – it's kind of a tricky business and there are so many detailed inputs and so many ways of looking at the outputs and analyzing metrics that a firm who's sort of known for their quality assurance would be a better bet.

And then I think I'm running a little bit long on time, so I'll just say, do you prefer particular software, and if so, if you're going to this knowing want to use EnergyPlus, I want to use Trace or whatever, does your modeler know that? You should communicate that to them. Next slide.

So, Soliciting the Services, the type of contract you have may impact the ability to meet targets. What is their motivation? There are four different types we've listed here, and this is discussed more in the guide, so I won't go too long on this. This guide also provides some templates that will be useful in addition to the narrative explaining things, things that you list the things to communicate to the proposers, what to look for when you evaluate your bids. And there's also an example RFP, request for proposal, something to kind of help – a starting point to help design you own one. Next slide.

And, okay, so this is just a link of where to get this actual document. I believe it will also be provided later, so that is it for my presentation. Thank you very much. And I believe we're holding questions for the end, so I can just pass it over to Holly for Mark. Thank you.

Holly Carr:

Great. Thanks very much, Kristin. It's a great guide, and I certainly recommend that folks take a look at it, particularly if you are receiving the services of an energy modeler or you're ready to reach out and try to find a modeler for a project that you're working on, and we'll have additional links at the end of the program around this guide. So, now let's turn our attention to Mark Chambers at the District of Columbia Office of Sustainability.

D.C. is a better building challenge partner, which means they have committed to 20 percent energy reduction across their entire building portfolio over the next 10 years, and they're tracking those reductions with the Department of Energy and also sharing their best practices, and this is certainly one of the best practices that's helping the district achieve that 20 percent goal. So, Mark, you and your team are using information from models in a variety of different ways to reduce energy in the D.C. building portfolio. Can you give us some concrete examples of what you've done and of the benefits of what you're seeing?

Mark Chambers:

Absolutely. Thank you, Holly and Kendall Sanderson just for inviting us to talk and kind of share some of the things we're working on, and also I think that was a great intro from Kristin, so

thanks again for all the work that NREL's doing to really streamline a lot of the efforts and the communication that comes out so we can participate in a world where we can make more use of these energy models.

So, I'm going to actually try and be fairly brief with my comments. I want to make sure that, keeping in mind from the perspective of the building owner, portfolio manager there are a lot of times where this can become kind of highly technical, and I think hopefully what I can do is be able to create more of a launching pad for future conversations as well as provide somewhat of a window to the practical applications of these models so that we are kind of all speaking the same language. We can go to the next slide. It might be the intro slide. Sure.

So, I just quickly wanted to mention this model that we use, which is More Data. Less Carbon. Zero Excuses. It's something that helps us to frame all of the work that we're doing, and you'll see that on our Build Smart DC website, which is, again, where we display a lot of our building information data. So, quickly, just in terms of scale, we have a fairly large portfolio, and it's roughly 30 million square feet, as Holly mentioned.

We have about \$75 million in utility spends annually, and that is really not just electricity, but it's natural gas and other commodities. So, it's fairly significant, and it requires a very intentional approach to being able to reduce some of those expenditures. We also have other environmental and carbon-based goals.

In particular, we have a 50 percent reduction goal that we're working towards with carbon towards 2032 in addition to the Better Building goals that Holly mentioned before. So, there are a lot of aligned objectives that we're using to try to get where we're going. I think that what I wanted to talk about in particular was one of our case studies really, and actually you can go to the next slide.

This is – I'm going to kind of be on the framework of talking about schools. We've undergone a very large modernization program over the last eight years, which is looked to revamp the entire District of Columbia school system. So, in doing so in combination with our Green Building Act here in the city, we typically produce lead silver or gold buildings, all of which ultimately include an energy model to develop during the design phase of that project.

What we found though is that in practical application, a lot of the

buildings will get designed to a certain performance standard, and many of them will be built to that standard, and many of them will not. So, when you're managing so many buildings you really have to have systems in place to be able to go back and check, and to be honest, you can't do that without having a launching pad, an energy model is that launching pad.

In this particular project we were looking at a school that was called Stoddert Elementary School. It's a green ribbon school, LEED Gold building, about 65,000 square feet, and we really just found out that it was not performing nearly as well as it should be, so we ran what we call a retrocommissioning project, which in short is to basically find out if everything that's installed is actually functioning the way it's supposed to.

So, if you have a damper, it should be opening and closing. If you have your air intake, it should be actually turning on, and you'd be surprised at how many things actually don't do that. So, being able to begin the process of retrocommissioning, looking at the mechanical systems, the control systems, it opened up a gateway of conversation for us and it started to be able to find a way to match the actual targets of the energy model to the performance of the building and there's no way to really do that without being able to dive further into the energy model.

But, I think what we found is that a lot of portfolio managers are dealing with existing buildings, not so much just new construction. So, we use the energy model. We had a retrocommissioning agent go through the project, we found not only issues in terms of the outside air, but also in terms of the controls, and we started to then look at how can we increase the communication coming out of the building.

So, this was the first of dozens and dozens of projects where we started to unlock the communication from the building and started to look at the building management systems making sure that they were all speaking the same language, making sure that we had a way to receive the data that they were putting out, and sometimes that's as simple as connecting an Internet cord to it. In some ways it's more complicated, but this particular project you'll see the graph on the right.

We cumulatively have looked towards almost a 25 percent reduction in energy costs based on basically taking the energy model and actually checking to make sure everything's functioning the way it's supposed to. And what we found is that this doesn't

just allow for us to better manage the buildings that we do have but it also increases the potential for what we can do in other building projects.

On the bottom of this page it starts to reference the notion that we have been gaining a lot of public, private partnership agreements for new technologies. All new technologies that will tie into your building, whether it's district energy, or in this case we're piloting a sewage-based heat exchange system.

They all require some base level information as relates to what's going on in your building. Now, that's what the energy model provides. So, we look at it as the roadmap for us to be able to not just manage the buildings that we have, but figure out where we're going to go.

So, I think the perspective of building management and building owners when we have hundreds of buildings in particular you really do need to be able to chart not just your current needs but your future needs as well. So, that's something that we found – it is extremely valuable to not just push towards energy models, but to understand how to read them and putting them in front of all the people who are working on your projects. Next slide.

What I wanted to kind of continue talking about is related to how this let us open the doors for a lot of other communication. I mean, I didn't want to spend too much time on this, but we've been looking now into integrating a lot of much more advanced building automation technology. So, now we're partnering with BuildingIQ, and we're doing a predictive energy pilot, and this would not be possible without our energy model, and it's delivering a significant amount of potential savings that we're going to be tracking over time and doing that in concert with other entities that are pushing the efforts towards better building management. Next slide.

Another clear example is our work with Lawrence Berkeley National Labs, very similar to what I was referencing. There are a lot of cutting edge softwares and folks out there that are working on energy modeling that happens more in real-time so that you can make microadjustments to your building management in a way that can save energy usage and tie it with energy pricing and as well as ongoing weather data. Next slide.

I'm trying to wrap it up here 'cause I know we want to get to the place where folks can ask questions. Lastly, I kind of wanted to just use this graphic. This is something that's just also displayed on

our buildsmartdc.com website. It is important for us to not just look at ways to better manage our buildings. It's also important to figure out a way to allow the district's management of our buildings to display leadership, locally, regionally, nationally.

And we have done that by making a commitment to transparency. So, part of being a part of this webinar, being a part of this communication is that we realize it's important to get this information out there as much as possible. If you go to our Build Smart DC website, you will find all of the energy data that we have for all of our buildings, and you can track the building energy usage from yesterday, from last week, from last year.

And you really get a chance to understand the, the larger context in which we're working, and hopefully that sets the precedent for building owners to want to release that data as well. The more information that's out there, the more start-ups and other entities working on data can use these datasets to be able to come up with better ways for us to reduce our energy costs and also reduce the carbon associated with meeting the energy needs.

So, for us it's not just about the particular kind of dollars and sense in each building, but it's also about setting the framework for an environment in which the energy modeling matches the performance of the building, and it all moves towards a larger reduction in fossil fuel usage and energy consumption regionally and nationally. I think that's the end. Last slide. Yep, thanks. And definitely feel free to reach out to me, and I'll be around at the end for questions.

Holly Carr:

Great, thanks so much, Mark. And speaking of transparency and leadership and energy reduction DC is already collecting six percent portfolio-wide reductions through the Better Buildings Challenge and reporting on all of that annually. So, DC's definitely walking the talk here, and we're really glad to have you as a part of the Better Buildings Challenge.

A quick reminder to our audience members to feel free to send in any questions you might have through that webinar chat box. We've gotten a number of good questions from folks and we're collecting those, and we'll respond to those at the end. Our final speaker is Amir Roth from DOE, and I believe maybe one of our presenters is not on mute, so if you are not Amir Roth and if you're not presenting, please put your speaker on mute. Thanks.

Amir is going to provide us some details on one specific energy

modeling tool, and that is EnergyPlus, which is near and dear to Amir's heart, and Amir will be talking a little bit about that tool and about the benefits of using this tool for your next energy modeling project. Amir.

Amir Roth: Thanks, Holly. So, as Holly said, I'm Amir Roth, I'm a colleague of Holly's at DOE, and actually that just became official today, not on my part, today is Holly's first official day as a federal employee. So, all of you, please take the opportunity to congratulate Holly next time you see her, or maybe on Facebook if you do that.

I run the – sorry, Holly. I run the – you didn't think you were going to have me on here without me trying to embarrass you in some way, did you?

Holly Carr: No, no, no. I knew it was [*crosstalk*].

Amir Roth: That'll teach you for next time, for next time.

Holly Carr: Thanks.

Amir Roth: As Holly said, I manage the building energy modeling portfolio DOE that's kind of a cost-cutting portfolio in our building's group. You can read about all of our programs and our projects at the web URL at the top there, and that's kind of my – that dreamcatcher there is kind of my spirit animal. I mean, I'll talk about it a little bit later on. Click forward, please.

So, as Kristin mentioned and Mark kind of iterated in the talk afterwards, energy modeling is really sort of an exercise where you gather some information about your building, whether that be sort of your building assets, like the geometry or systems construction, information about operations, the weather, consumption data if you have it in whatever level of detail you can muster, and then you feed that to a software tool.

What you get out of that really is a nice sort of analytical platform for viewing and understanding your building whether you've actually built that building yet or not. In fact, it's a very good idea in many cases to get a good analytical understanding of your building before you build so you end up building the building that you want.

But this analytical platform allows you to get some insight into what is either already happening or will happen in your building, where, from an energy standpoint, where does the money, where

do the kilowatt hours and the therms go? Where are the potential savings opportunities? Are your occupants comfortable and whether you have the opportunity to make them more comfortable?

Where you are relative to code or to certificates or incentive programs that you might be able to use. Basically, any sort of an energy question you can get a rough answer to once you have a model to your building. That graphic on the right is something that many of you have probably seen before. That's your monthly end-use breakdown for electricity and gas in your building, so you can see that you're – the bottom is the gas, you can see you're spending a lot of gas sort of in the winter months, presumably for heating.

And maybe you have some – that's the red part, maybe you have some gas process loads. Your electricity is on top, your HVAC, you're spending – that's the blue at the bottom there, you have lighting and some other loads as well. So, just looking at things this way can sort of help you see where your building is actually spending money.

Now, for those of you who are not already involved with energy modeling, I think it suffices to say that we would like you to get involved, hug an energy modeler, go and find an energy modeler out there and make use of them and their services. Your buildings will be better, and your lives will be better as a result.

It doesn't really matter so much which energy modeling tool you use, as long as you do something. Doing something is much, much better than doing nothing. But, if you're going to go to the effort of engaging with BEM, then you may as well engage with good BEM, and that's what I'm going to be pitching here in the next five minutes or so. Click forward, please.

So, DOE is not only, for those of you who may not know, DOE is not only sort of an aggregator of the market in the sense of the Better Buildings Challenge and the alliances, but we also develop or help develop some technologies, and one of those technologies is actually energy modeling software where DOE and the labs actually develop software that goes into tools that people actually use.

The energy modeling software, the engine that we developed is called EnergyPlus, which you may have heard of. It's a successor to an engine that we developed a long time ago called DOE 2, which we no longer develop and in fact no longer own. If you are

going to engage with a modeler, you should ask for not just an energy model, but an energy model that's an EnergyPlus, and transitively you should ask for an EnergyPlus modeler.

As the little graphic there shows below, EnergyPlus modelers are simply a more evolved species of modeler. Why are you so interested in EnergyPlus? Well, it has the most advanced capabilities out there that any engine has. It's capable of modeling low-energy designs and low-energy systems that you will need to create low-energy buildings, things like radiant systems, variable refrigerant flow systems. It's capable of evaluating thermal and visual comfort and indoor air quality. It's very capable in HVAC arena and the controls arena.

And first and foremost it has the DOE sort of strong backing, which means it gets continuously funded and it's continuously improved and maintained. So, if you engage with EnergyPlus today you will be engaging with something that's sort of living and continuously improving.

EnergyPlus is also a transparent tool. It's an open source tool, you know what you're getting when you're working with it, you know what the assumptions are, you know what the calculations are, and because it's open source you're avoiding sort of getting locked in with a proprietary vendor, and it's an increasingly popular tool.

It had, about five years ago when I came to DOE, it had just short of 5,000 users worldwide. It has over 27,000 now, and so it's not like you are going to be looking under rocks for EnergyPlus modelers, there are many people out there who know how to use this tool.

If you want to learn more about EnergyPlus, we have a website with a lot more information about it, it's called, energyplus.net. Next slide, please.

But, even more so than EnergyPlus, what I would encourage you to get involved with is the entire DOE's energy modeling ecosystem. This slide sort of is a little more intuitive, it was animated, but essentially the buildup is the following. We don't only produce EnergyPlus, we also produce this cube on top of it, which is called OpenStudio.

What OpenStudio is is basically a middleware or software development kit or platform that provides common core functions in which application vendors, either private or public, can build

sort of end-user apps on very easily. So, it's really one of these, you know, the analog – or the analogy we like to give for OpenStudio is it's like IOS or Android. So, once those mobile operating systems came about there was a proliferation of apps for mobile devices, and this is really what we're seeing happening with OpenStudio.

OpenStudio makes it very easy for people to develop applications that use EnergyPlus, whether these be for a design retrofit, code compliance, project management, and so on and so forth. And these are not just sort of abstract examples that I'm giving. Each one of these actually has at least one application already in place. Because they're all on the same platform they all sort of work together.

Some of these applications are free and open source, some of them are commercial, and this really – this network is really growing very quickly. We get a new sort of application to add to our stable every couple of months. I'm going to very briefly touch on three applications, EDAPT, COFFEE, and PAT, which are in that square box on the top right there. So, let's click forward please.

So, PAT, PAT is short for Parametric Analysis Tool, and one of the key features or key concepts in OpenStudio is this notion of measures. A measure is basically the small program that once you have a model, the program can do surgery and operate on your model and transform it in a way.

A measure can be something that's very simple, like, a search and replace, but it can be something very surgical and sophisticated. So, the surgical and sophisticated example that I like to show is the one that's shown on the right there where you have one building on top of the other, and the difference between the two, the building on top is the before building, and the building on the bottom is the after building.

And the difference between those two is the application of the daylighting measure. If you actually see what happened to the model between the top and the bottom, it's actually a relatively serious set of transformations that prepare the building for daylighting, so you see that there's no more windows on the east face because you don't want those. Those just add load without – they add, and they add glare too without really improving the daylighting situation.

You can see that there is, on the south face, the windows have been

reconfigured to maximize daylighting while minimizing window to wall ratio. You see the addition of shading. You see that in a deep space where there isn't good daylighting penetration, skylights were added. This is the kind of transformation that can be automated, and these measures, daylighting package is a measure that simulates an energy conservation measure, which is where the name measure actually comes from.

But, these programs can also do QA or reporting on the model. And really we use them basically to automate and lubricate and streamline simulation processes. And so, modelers that use OpenStudio because they have access to these measures can be very, very productive.

And what this PAT tool does is, there's basically sort of two pieces to it. You take a basic model, you seat it into PAT, you select which energy conservation measures you want to apply to that model, and that's the screen on the left. You put \$10.00 on your Amazon EC2 account, you press Go, and then ten minutes later you have the packages of those measures sort of sorted by whatever it is you want them sorted by.

Whether that be simple payback, NPV, savings or whatnot. There's a nice little tutorial of this flow and what you can get out of it. That's the link below, which should be active. Next slide.

The last two tools I'm going to talk about are tools that actually were not developed by DOE, PAT was developed by DOE, by National Renewable Energy Lab. It was actually developed – it's a very sort of quick tool, and it was developed in about a quarter, which is pretty impressive and sort of lends credence to the fact that our platform makes it easy to write apps.

These two other apps were not developed by DOE, they were developed by utilities, and they should appeal to large building owners because they both have – they both deal with large building portfolios. So, let's start with the one on top. The one on top, which shows, which the graphic that's corresponding is the one that has a little map on it along with the sort of tornado plot at the top it's sort of the one screen.

That application is called EDAPT, it's Energy Design Assistance Project Tracker. It was developed by Xcel Energy in Colorado. What it is is a measure-driven sort of project tracking workflow that does sort of model checking, model quality assurance, reporting and rollups for both new construction and retrofit

projects.

This is an app that Xcel Energy developed, DOE bought it from Xcel Energy and opened it up, and now other utilities are using it as well, although if you are an organization that has lots of efficiency projects you may be interested in this application as well.

Another application along the same lines also developed by a utility, but not public yet because it's not competed yet, is an application called COFFEE, which is short for Customer Optimization for Energy Efficiency developed by National Grid in New York.

And what it is is it's actually an enterprise data system that's connected to PAT on the backend, so it creates – given the data that you have about your building, it creates consumption data, creates calibrated models for those buildings, and then basically tells you which buildings you need to sort of invest in first if you have a large portfolio creating sort of custom optimized packages for each of your buildings. That's what that flow is designed to demonstrate. Last slide, please.

So, again, that's just a little bit to whet your appetite. There's a lot more going on. If you want to follow up, here are two good places to, my e-mail address, and the Web address of the program sites, and that's it. Thank you.

Holly Carr:

Great. Thanks so much, Amir. And we've got a number of questions coming in from folks about EnergyPlus and how to use models in your city and so forth, and we're going to get to those in just a moment. If we can move onto the next slide, Kendall, and the next one.

As I mentioned, this slide deck will be posted along with these links to various resources. Just wanted to give you one slide where you can kind of come back and click on a lot of different resources that we've talked about here. First off is the Building Energy Modeling for Owners and Managers Guide that Kristin introduced, and which came out of NREL and Rocky Mountain Institute.

Secondly, some information on the District of Columbia's work with the Better Buildings Challenge and some of the successes that they've had in some of the district buildings, and the second – let's see, the third bullet there for the District of Columbia is their implementation model on community engagement and as well as a

link to Build Smart DC, which Mark mentioned.

And then, if you'd like to play around a little bit with EnergyPlus, you can sign up for an account right there in that fourth larger bullet, and check out all of our resources at DOE on Building Energy Modeling on that last link. Next slide, please. So, with that I'd like to move onto a few questions that we've gotten from our audience, and I will sort of dole these out.

Some of them could go to multiple folks but let's start with a basic question for Amir, just about the extent to which EnergyPlus can be used, so we have a question here about whether or not EnergyPlus can be used to model tenant spaces or if it just models whole buildings, and if it can't be used to model tenant spaces, are there other tools that are – that could be used for tenant spaces?

Amir Roth:

Yes. Yes and no. So, EnergyPlus is an engine, and it can model anything, and to model a tenant space, what you really need is EnergyPlus plus some skin on top of it that sort of hides all the non-tenant space stuff and just sort of gives you the tenant space stuff to play around with. Hopefully, as I try to imply, given the OpenStudio SDK that we have on top of EnergyPlus, it's very easy to create sort of new skins for EnergyPlus.

And we've actually had some discussion with folks here and there about creating a tenant space skin for EnergyPlus using OpenStudio, but I'm not sure that that has materialized yet or when that will actually happen. So, to answer the question sort of truthfully, for right now you're probably given the existing EnergyPlus skins or apps. You're probably not going to have a great time doing a tenant space, and I don't know what tool is really out there for that market.

However, given that there's already buzz about doing a tool like this, I would expect something to appear in the not too distant future, maybe 12 to 18 months.

Holly Carr:

Great. So, if you're a tenant occupying a whole building you're in luck, if you're not, hopefully you'll be in luck soon I think. And we also have another question, Amir, about eQUEST. You mentioned DOE2, but we've had a couple of questions about eQUEST and the difference between eQUEST and EnergyPlus?

Amir Roth:

Yeah. So, eQUEST is an interface for DOE2, so it's the counterpart to – so, DOE2 is the counterpart to EnergyPlus, you can think of EnergyPlus as sort of DOE2 plus, plus, plus, plus, plus, plus, plus.

It's sort of a much newer, more modern program that's based on sort of algorithms and capabilities that have been continuously developed over the last 20 years.

DOE2 is based on sort of much older technologies and assumptions and isn't really updated anymore. As far as eQUEST, eQUEST is kind of – is sort of the most popular interface for DOE2. There are a few others, but eQUEST is by far the dominant. There is nothing for EnergyPlus that is as popular, as currently popular as eQUEST is for DOE2, and that's really why sort of DOE2 is prevalent is because of the presence of eQUEST.

eQUEST I think is also – it's very sort of wizard-like and hand-holdy and people really like that. My dream is at some point for somebody to write an eQUEST, to write an eQUEST skin for OpenStudio. That may happen someday. There's some barriers for DOE doing such a thing itself, but yes. I don't know. I didn't actually hear a specific question about eQUEST, just could I talk about eQUEST. Is there a specific question about eQUEST?

Holly Carr: Yeah. The question was the difference between the two, and you got to that that it is basically DOE2, so yeah.

Amir Roth: Yeah. It's DOE2, yeah.

Holly Carr: Okay. Great. And then I'm not sure, Kristin, and/or Amir, you might both want to chime in on this one, but I have a question, what are the best practices to address changes in building and MEP aspects in the building over the continuum of the concept to build that significantly complicate the energy modeling process?

Kristin Field: This is Kristin. I can take a first shot at that. There was actually a different question that came in that reminded me of this a little bit, so I thought I might answer to that other question. I guess, so the question mentioned the continuum of the design process, and this other one that I was looking at was asking about at what points in that design process do you need – does a modeler need to step in and look at –

Holly Carr: [Crosstalk]

Kristin Field: Yeah. And look at the phases of the model or actually and then when do the owners and managers need to step in and ask the energy modelers for updates or have them rerun models, and very traditionally, there were very set times, which is at the end of design development, which is at the end of construction documents

that this is for a new design building.

But, and that should still happen, but I kind of see that as the minimum because if you wait until the end of design documents it's, you know, if you're going to suggest completely overhauling the HVAC system that's probably not going to go over well, and you're really going to have to work hard to convince someone to do that.

Whereas, if you adjusted it right when people were first trying to decide that that's a lot easier of a sell. So, I think my recommendation would be that if you're already sort of integrated into the project team schedule, if the modeling team is sort of kept on the team and they – of course they don't need to be at every project meeting where people are trying to decide sort of the nitty-gritty or I don't know, pick out building finishes towards the end or anything like that.

But, if they're in on some of the beginning design develop – or early design, developing the design team would be – massing things like that, maybe have them at periodic project meetings or every few, every few weeks, something then I think that's really the best time for owners and managers to solicit input from the energy modelers to say, okay, well, at first we thought we were going to lay out the building this way and have the people distributed this way, but now we're reconsidering. What would be the energy impact of that, and then they could run a model.

Here we have it laid out, but we don't know if we really want to go down the daylighting route because if we did that would impact our shading and things like that. Run the model then instead of you have the entire design decided upon, and then after the fact what if take our shades off, does it really matter?

Those are two ways that BEM can help you, but kind of like in the slide that I showed, people who are proponents of energy efficiency prefer the former to that latter, we prefer early engagement to later engagement. So, kind of a long answer, but that's what I say.

Holly Carr:

Great. Thank you. And I've got a few money-related questions here, probably directed at you, Kristin. Feel free others to chime in as well. But, I have a questions saying, "Straight up how does Building Energy Management – sorry, Building Energy Modeling typically cost?" How much does it cost? And sort of a follow-on question, "Our city is trying to encourage developers to use energy

modeling to improve the design of their projects. We often hear complaints about the cost. I think there's a miscommunication about the type of modeling that is needed for design purposes. Can you talk about how best to describe the type of modeling owners and designers should use for design purposes as opposed to code compliance and then give some general parameters about the cost involved in modeling."

Kristin Field:

So, I guess I can start off by saying, as far as what is the cost; I would have a little bit of a hard time quoting that right now. I don't know if Amir or Mark maybe have any numbers. I've seen it range across the board, and I think as the, I guess architecture, mechanical construction industry gets more familiar with energy modeling then the costs are starting to – the range is narrowing a little bit.

But I think in the beginning when modeling was first becoming included that there were a lot of sort of mismatches of expectations and what fees should be and should you model once and just for LEED quantify how much you're projecting to save, or do you have this iterative process because we're saying the iterative process is great.

But sometimes somebody would think that they were paying for just kind of a LEED number at the very end, but what they really wanted was iterative models throughout the entire design process, and obviously that takes a lot more labor hours than just one model at the very end with no variations. So, that being said, I don't really have a great number for anyone. I can only say that I've seen a very wide range. Amir or Mark, do you have anything more quantitative to contribute?

Amir Roth:

No. Mark probably does since he's contracted modelers.

Mark Chambers:

Not really, to be honest. I mean, I think that it just varies on the climate. It's also what exactly working with, in DC we've had a very strong market for construction over the last few years. We had a few more options at our disposal, but I wouldn't say that that is consistent across the full landscape no matter where you're doing projects.

Kristin Field:

Yeah, sorry to the person that wanted a more specific answer, but it is pretty hard to quantify, and then there's also of course regional differences of what – are you talking about money on the east coast or middle, but yeah. The range that I've seen is so large that it's almost not even meaningful to say it.

The thing that I will say though about that longer question that talks about the complaints about the cost and there's a miscommunication about what type of modeling is needed. I do think that that was a good observation on the part of the person that wrote that, but I think that it would be important to engage frequently with the modelers to be sure those expectations are met on both sides, modeler and contractor of modeler.

Because if you want to do more of the sort of informing the design, let's say, informing the orientation of the building and informing of the shape of it and things like that, you can do that with a lot less attention to detail on HVAC or sometimes having no HVAC, just having sort of simple loads and saying, okay, forgetting about how efficient this system is that removes the heat from the building or puts it back in, just how much load are you actually adding to the space based on shaping the building this way or orienting it that way, putting shades on it, not putting shades on it.

So, there's a lot of that stuff that if you're very clear about this is exactly what I want to know, don't get off into the nitty-gritty of, how often are my dampers open or whatever, then you could probably make the process a lot more efficient. So, I think just really frequent communication would help because in some cases you do want to get into the nitty-gritty of HVAC.

Like, this HVAC option versus that one. Well, you want to be sure you're characterizing both of them very well and not sort of modeling one with sub-optimum operation and the other one with optimal. That's not apples to apples. So, anyway, I guess knowing when you need to really dive in deep because with energy modeling you can dive in very, very deep, and sometimes you want to, but I guess communicating so that you're sure that when you do that, you know you're going to need to pay for it, and you know you're going to get the value out of it.

Amir Roth:

Yeah. This is Amir, and I would like to just second that. I think Kristin said it very articulately already, but just to emphasize. Where energy modeling really provides value is in iterative design modeling. When you're doing modeling just for LEED, you're not really getting a lot of value. I mean, you are getting value in the sense that, obviously you want that LEED plaque and you know that gives you something.

But, the modeling is not giving you a better building than you otherwise would've had just from a raw energy build or

performance or occupant comfort standpoint and same for code compliance. Those are kind of compulsory activities and actually fairly mechanical and fairly rote. It's really in design where you can really sort of – where modeling really sort of flexes muscle and sort of shows really kind of a pulls good weight.

So, yes, that part is more expensive and requires more effort, but really is where you sort of get – you can really get some great benefits and if you invest in that part, the other part you can often – I won't say you get the other part for free, but you probably get it for very low premiums over what you had.

Like, if you pay a design, you buy a design model or you buy a design modeling process, you probably get your code compliance forms and your LEED forms with it for much additional effort at all. So, that's all that I will say.

Holly Carr:

Great. Thanks everybody for – okay. All right. Thanks everyone for those insights. And we have received a number of additional questions from folks, some of them more technical in nature about the specifics of OpenStudio and EnergyPlus, and I really encourage you to reach out to Amir and/or Kristin or Mark with those additional questions. If we can move to the next slide or soon thereafter I think the next slide will have contact information for all of our panelists who are happy to entertain your additional questions after the webinar.

I do want to make a quick plug here for our next webinar, always, or almost always the first Tuesday of the month from 3:00 to 4:00 PM, which will be the case in October. Our session is titled, Seize the Day – Using Building Milestones as Energy Efficiency Opportunities, and we're really going to be talking about how can you, as an energy person in your organization, take those building milestones that might be dictated by completely different interests in your organization, but really take those and use those to your advantage to improve the energy efficiency of your portfolio.

We'll have participants from the City of Hillsboro, Oregon, Arby's Restaurant Group, and University of Virginia all giving us kind of their perspective on best practices here. Next slide, please. There we go. So, there are your e-mails and contact information for our three panelists today, also e-mail for myself, and if you're interested in participating in the Better Buildings Program, the alliance, the challenge or any of the activities we have going on through Better Buildings, please feel free to reach out to me.

And with that I want to thank, very sincerely, our three panelists for joining us today and participating on our webinar. I encourage you to follow Better Buildings Initiative on Twitter for all of the latest information and also sign up for our newsletters that are publicly available.

You will all receive a notice by e-mail when an archive of this session is available online. Again, I suspect that in the next week or so, and thanks to everyone for joining us today. Take care.

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