John Agan: Hello, and welcome to the February fourth edition of the Better Buildings webinar series. In this series, we profile best practices of Better Buildings challenge and alliance partners and other organizations working to improve energy efficiency in building. I'm your moderator, John Agan. I'm a senior advisor in the US Department of Energy's Weatherization and Intergovernmental Programs Office. My work primarily focuses on the role of energy efficiency and other distributed energy resources in supporting the affordability, resilience, and sustainability of energy in the United States.

With that, I'd like to introduce our other two presenters. First will be Emma Elgqvist from the National Renewable Energy Lab in Golden, Colorado; and is an engineer and is part of the re-op team, and her work includes providing technical assistance and deployment guidance on distributed energy technologies, conducting renewable energy screenings, evaluating renewable energy and storage to point of potential, and resilience benefits of integrating renewables and microgrid designs. Emma holds degrees from Georgia Tech and the Colorado School of Mines.

Second will be Nicholas DeForest, who is a senior scientific engineering associate in the Grid Integration Group at Lawrence Berkeley National Laboratory. Nicholas is a developer on the distributed energy resources customer adoption model team, which we'll hear more about today. His work also focuses on the development of microgrid control algorithms and advanced microgrid deployment on demonstration projects. So anyone who has questions on those topics, I will be happy to direct them to Nicholas.

Thanks to you both for being with us today. Let's move onto the next slide, and before I dive in, we are hoping to get to know a little bit more about all of you. We have three polls lined up today, and I'll ask that we launch the first poll. Great. So question number one here. What value streams have you monetized or are you thinking about monetizing for potential customer-sided storage projects if you're considering them as part of your interest in the webinar today.

And I think we'll give folks about a minute to chime in here… Great. So we've got some results. Looks like there's a pretty even split between folks who have not or don't have any immediate plans on storage projects, and then also some who are thinking quite a bit about utility bill savings and also using projects and monetizing demand response programs. So that's great to see.

If we could bring up the second poll… Great. So we're here looking for what are your biggest barriers, thinking about PV and storage systems for backup power… Okay. So this is a helpful set of results here. It looks like our leader is not knowing how to pay for the system, and also not confident that PV+ storage will provide power when needed, and also a couple of respondents about figuring out what system size to install. We'll look forward to hearing from our panelists in the ways that their tools can help you answer and think about these questions. So that will be great.

And now if we could bring up the final question, we'll launch the last poll. This is more numeric question we're interested in seeing results on. How much more would you be willing to pay on your annual utilities bills at a site to have backup power available during an outage? Great. So we've got a distribution here at the low end of the willingness to pay curve. It looks like most people would like to see ten percent or less of an increase in their utility bills in exchange for having backup power available. So that's very helpful.

I also want to take a moment to acknowledge our webinar organizers for getting these results in so quickly, especially today. That's very much appreciated. Thanks again to everyone for participating. And I'd like to remind our audience in case you haven't been on a webinar before with us, that we'll hold questions until near the end of the hour. You can please send in questions 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 can.

Additionally, the session will be archived and posted to the Better Buildings Solutions Center for your reference. I will kick us off now with a few slides from some of DOE's work with each of the tools that our panelists will be talking about more today. So, if we could go to the next slide. Thanks.

So, to start off, I want to acknowledge that resilience is a very broad concept, and we only have one hour today. So, I would like to focus us on a nationwide trend that's been pronounced more so in certain regions of the country of longer and more frequent disruptions to the electric grid in recent years. The tools you'll hear about today can help you get site- or facility-specific insights into two key points.

First, distributed generation coupled with microgrid technology can help critical facilities continue operating during a grid outage.

And second – and this will be no surprise to our Better Buildings Challenge partners – energy efficiency is a critical first step that can often dramatically reduce the costs of microgrid investments for meeting energy needs when it matters most.

Let's go to the next slide. To illustrate these points, I want to share this graphic from a recent publication that represents electricity needs of a fictional single critical facility before and after investing in efficiency and other DERs for resilience. On the left side here, the gray box is meant to represent some average daily electricity demand during normal operations. The rectangle outline in the bottom half of the box here illustrates a subset of the normal energy demand that's been identified by the facility manager as critical load or the energy services that are most important to continue providing even when the grid is out.

On the right side, the scenario we're showing is where the facility owner has achieved a 20 percent reduction in the average daily electricity demand, signified by the green box at the top. And then it's also installed some capacity of onsite generation as providing a share of the site year-round electricity needs, represented by the blue stripes. During normal operation, the site is still buying some power from the grid, and so the gray color is still there.

But at this lower level of electricity demand, the share of load that's defined as critical will be smaller, meaning that less onsite generation capacity is needed to power the site during an outage. This, obviously, makes it less expensive for the facility to meet a defined resilience goal, and those are savings that would accrue on top of the utility bill savings from the energy efficiency and distributed generation during normal operations.

We could go to the next slide. So, in order to explore how this would work with some real-world critical facilities, DOE was proud to partner with three of our Better Buildings Challenge partners to produce this now-available guide with the title and logo that you see on the left. Our aim with this was to introduce readers to the benefits of integrating efficiency with other DERs for resilience, and to describe two tools, which you'll hear about more today, that are freely available to analyze distributed energy resource options at your own facilities. This report also concludes with a step-by-step guide so readers can get an idea of how to conduct this analysis for themselves.

And here I want to acknowledge Brooke Holleman, who is one of our colleagues here at DOE who is a main driver of getting this guide completed and out, and also to both of our panelists, Emma and Nicholas, who were very helpful with getting us through producing this. Next slide.

Great. So, I want to just briefly acknowledge the three partners that we worked with on this guide: the state of North Carolina, the City of Hillsboro, Oregon, and Alachua County Public Schools in Florida. This table is meant to give you an idea of the types of resilience metrics and scenarios for which they were planning. In each case, the partners shared information from different types of critical facilities, facilities that they identified as important to their own resilience in providing power during outages, and what the resilience goals would be based on different circumstances that they had.

Because each partner had already reported to us energy usage data to track their goal, the additional information we needed was minimal, and you'll see a little bit more about those details from our other panelists. Just as one example, hurricane season poses a key threat to two of our Southeastern partners, and in one case historical use of schools as emergency shelters in Alachua County was the basis for considering a goal of being able to island those schools from the grid for up to five days. We can go to the next slide.

So, I'll throw down on just one example here quickly, which highlights the impact specifically that energy efficiency can have for resilience investments. This was our kind of specific site embodiment of the graph that I showed you earlier. So, North Carolina faces a dual task of meeting goals under their executive order number 80 for both reducing state energy building consumption and also addressing growing concerns and grid outages caused by hurricanes and recent flooding.

At one of their sites in particular, they were curious about the impact of potential deep energy efficiency savings, which led to the scenarios in this table alongside the resilience metrics that they were trying to meet. The leftmost column here shows the different demand scenarios for the site from historic annual electric usage down to a 40 percent reduction in electric use. And that's a level of savings that we've seen in other comparable sites that we thought was realistic.

So, ignoring for a moment the energy cost savings from reduced utility purchases and only looking at the cost of installing a resilient solar plus storage system and NREL's REopt Lite light tool estimated that the initial cost savings to the state would be nearly $200,000.00 for this one site alone. So this is really a clear example of how energy efficiency can significantly lower the cost of meeting energy resilience goals. We can go to the next slide.

So, folks will receive this presentation after, as I mentioned. So I wanted to include on the slide a couple of examples of titles for resources that are currently available from DOE that address resilience and specifically resilience and energy efficiency. And I believe onto the last slide, if we could.

So, just to conclude, if you're a state or local government, or if you work with K through 12 school districts – one or more – my office has tools and resources on a variety of energy efficiency and renewable energy strategies. We invite you to visit our state and local solutions center online, subscribe to our monthly spotlight newsletter, or send an e-mail either to our state and local inbox, which you see here, or directly through me at the e-mail address on the slide. And I can either help you directly or connect you with an expert on any questions that you may have. Next slide.

Great. So thank you all for listening. And with that, I'd like to pass it over to Emma to tell us more about REopt Lite.

Emma Elgqvist: Hey there. Thanks for having me. So, again, my name is Emma. I want to start with apologizing for a little bit of background noise that I have going on here. There's mainly birds, but also the occasional airplane. So I hope everybody can hear me okay despite that. You can go ahead and advance to the next slide, please.

So, today I'm going to be talking about a tool that was developed at the lab called REopt Lite. It's built on a more comprehensive model called REopt that's used for internal research and development purposes. But REopt Lite is the publicly available web version of that tool. I'll start here by just going through some of the general inputs and outputs of the tool, and then the majority of my presentation is going to focus on some recent updates that relate to resilience analysis.

So in general, the way the tool works is that the user enters an electric load profile, shown at the bottom of the graph here. And then that electric load has to be met in every time stop by some combination of technology options listed on the left hand side. So that includes renewable generation, such as solar PV, and wind; conventional generation, such as the electric grid and diesel generators; and then batteries for energy storage. We're also currently working on adding a CHP module to the suite of technology options.

The model then determines based on the drivers listed across the top of the slide here what sites and combination of technologies will help most cost effectively meet the goals. So, users have two options when it comes to defining the goals of the analysis: either to just minimize the total life cycle cost of energy at the site, or to do so while also meeting a resilience goal.

The technology choices are also driven by the cost of these technologies any incentives that may be available to lower those, and other financial parameters. And then finally, the third kind of main driver here is the current utility cost structure at a given site. Users can enter that manually, but we also leveraged a great resource called the Utility Rate Database that we REopt Lite programmatically interacts with. And so if you know the name of your utility and rate tariffs, you can simply select it from a drop-down menu and not have to answer the details around that.

And again, what comes out of the tool is to optimize minimum cost solution. So the mix and size of technologies, how those should be dispatched or operated, and each time step, and what the associated economics are. So, capital cost, LNM cost, and then the present value. You can go to the next slide, please.

So, here you'll see a screenshot of the inputs page of REopt Lite. So, again, it's a web tool that you can interact with through your browser, and it has a subset of the capabilities of the REopt model. And there's two main ways or objectives when interacting with a tool. The first one is the financial mode, where the tool looks at PV, wind, and battery storage to find the optimal sizes to minimize the cost of electricity at a site.

And then the second one is the resilience mode, where you can then layer on requirements for sustaining in an outage of a certain length. And in that scenario, the model can also consider either existing or additional generators that might be part of that. There's a link here at the bottom for access to the tools, but you can – there's additional links at the end of the slide deck. I think we have them all in one place. You can go to the next slide, please.

So, some of the key outputs of the tool are shown here in the three boxes. I'll start on the left. So the mean output is the combination and sizes of technologies, along with the net present value. And so one feature of the tool – because it's an optimization model – is that the user doesn't need to specify anything about the technologies to include or the system sizes to consider. The model will consider kind of all possible combinations of these technologies to determine which combination provides the lowest net – or, excuse me – highest net present value savings over the analysis period.

To do so, the tool also considers how the technology should be dispatched. So you can see in the upper right hand corner here, it's a screenshot of a week in June where the load, which is the thin black line here, is being met by a combination of solar PV, battery storage, and then electricity from the grid.

And then finally, the detailed financial outputs on the bottom right hand corner there is also a pro forma to go along with that, an Excel spreadsheet that you can download, that it'll give some high-level summaries and these table of just some sizes, costs, and then how the base case and savings break down on your utility bills by energy and demand charges. You can go to the next slide, please.

So, the tool was first launched in 2017, and we continued to update and add features to the tool. So you'll see a running list here of some of the updates and additions that have happened since then, such as kind of enhanced rate structures to model, updating solar resource data sets to be used, and adding a wind module. The update I'm going to focus on today is one that was released in October of last year. So that included a whole host of things, but one of those being kind of additional features for the resilience model. So you can go onto the next slide, please.

So, one of the key inputs when thinking about evaluating these technologies for resilience purposes is the load that needs to be met during an outage, as well as thinking about what length outage you may want to consider. And so, on the top here is a screen shot of the critical load inputs. You can specify your critical load or load to be met during an outage in three different ways. You can either specify it as a percentage of your typical load.

So in this case, the hourly load that you have entered or modeled will just be reduced by this percentage in each time step. You can also, if you have integral data of, say, you know, just one kind of critical facility on the campus, or you have very specific requirements for certain components upload, like a 15-minute or hourly load profile for the critical load itself.

And then finally, there's a critical load module that allows you to build up a critical load based on common end uses. So it has 8 track systems and other plug loads in there that you can use to then build up a critical load.

And then you also need to enter information around when the outage is expected to occur. So that includes the duration, and then time and date of when the outage occurs. We recognize this is something that's oftentimes not known. And so we have added some additional outputs that uses a simulation engine to look at how you're, kind of what changes you would see should that outage happen throughout the year. You can also go back and kind of iteratively evaluate a few different options here for outage duration and start date and time. You can go to the next slide, please.

So, one of the other capabilities we've added in the latest update is generator modeling. And so now when you are going through the resilience mode of evaluation here – so it's not available in the financial mode – you'll get an option to select whether or not you want to include generators in your optimization.

So, you can either specify existing generators that maybe available on site already along with fuel availability, or you can let the REopt Lite module size a generator for you. And in that case, it will consider the costs and benefits of a generator, in addition to other distributed energy resources. The generator that we've currently configured is for a diesel generator, so you can change some of the defaults to reflect the natural gas generator. It does still only dispatch or run while the outage is occurring. You can go to the next slide, please.

So, two of the key features when doing this resilience analysis – in addition to the net present value and system sizes were looking at earlier – is your potential resilience. The model will, by default, make sure that the critical load is met during the one outage that you specified throughout the year. But then it will also calculate how that specific system would perform throughout the year. So, you can see here that in your potential resilience at the top blue box here, you specified an outage from January 4 through January 11. So that outage will be met by the recommended system. But then, that same system has a 72 percent chance of sustaining and outage of a week, which is what we specified, should it occur at any time, a different time throughout the year.

You can also look at at the bottom chart. Again, this is using that recommended optimal configuration for the outage that was specified to see how long of an outage you could survive throughout different months of the year. So it's a little hard to see here because there's no legend. But each of the lines from the bottom chart is a different month, and January and February are the two months on the left hand side there. And then to the right are months where there's a higher kind of solar resource availability to load ratio. You can go to the next slide, please.

So, two additional features for the resilience is first comparing the system sizes and economics of a system that was sized for resilience to that which was optimized for the financial benefits only. So, you can look at comparison of both system sizes, what it would do to the overall net present value, and then how that system would perform on average in the event of an outage.

And then finally on the bottom, we provide some sliders that users can use to see how both the added cost to kind of island or microgrid the system would impact the overall net present value, as well as how avoided outage costs, or the value of lost load, would impact the overall economics of the system. Next slide, please.

So that summarizes the main content of my presentation. I have just a few more slides. Just wanted to highlight that in addition to the web interface, you can also interact with those tools through an API or application programming interface. That allows kind of a programmatic way of accessing REopt Lite. So, typically we've seen a lot of like university researchers, for example, as well as some of the research we do at the lab.

This is kind of how we interact with the tool. You would use something like Python to write a script that then kind of accesses REopt Lite in a programmatic fashion and can allow you to run kind of hundreds or hundreds of thousands of different scenarios to look at maybe not one specific site, but oftentimes we do this across a geographic area. So you can go to the next slide, please.

So, just highlighting here a couple of examples of projects that have used the API to answer questions, again, on that kind of national scale. You know, where does PV and storage make sense? The bottom right hand corner is actually from a study looking at how PV and stationary storage can be used to lower the cost of operating DC fast-charging stations for electric vehicles. Next slide, please.

So, finally, like I said, we're continuously updating and modifying this tool. So slide 12 here just shows a list of our FY20 development plan, so you can see kind of what's coming here soon. With that, I'll hand it back to you, John. Thank you.

John Agan: Great. Thanks very much, Emma. That's a great presentation, and I look forward to hearing questions at the end of the session. Just a quick reminder, folks can send any questions you have through the webinar chat box, and we'll be collecting those to get through once we're done with all of the presentations.

Now, we can go from Golden, Colorado, to Berkeley, California, and we'll tee up Nicholas DeForest for a presentation about the DER-CAM. Nicholas?

Nicholas DeForest: Thanks, John. You can go to the next slide. All right. Great. So thanks, everyone, for attending today. I wanted to give you just a quick introduction to Berkeley Labs microgrid tool DER-CAM. So, DER-CAM stands for the Distributed Energy Resources Customer Adoption Model. And it's a decision-support tool that uses optimization to help guide the process of planning, design, and analysis for de-centralized energy systems and microgrids.

So, my presentation today is a little more high-level. To help illustrate how DER-CAM works, I want to just frame the challenge of microgrid design. So if you go to the next slide…

As you might imagine, the motivations to deploy DERs and microgrids vary a lot by application. They might focus on installing local generation to reduce the money you're paying to a utility to import energy. They might focus on deploying renewable technologies to help you reduce your environmental impact, in particular your CO2 emissions. They might focus on deploying resources to keep your site resilient in the face of grid outages. Or they might be some combination of all of those potential benefits. And, as you might imagine, the design selected to do any of those things is going to vary a lot, in terms of supporting those objectives and responding to the site-specific characteristics.

So moving onto the next slide, it's really important to consider when designing a microgrid solution to include these site-specific characteristics, including the energy cost landscape, so the utility tariff structures and rates, the fuel prices, the way the energy's consumed on site. That's typically your load consumption profiles. Site-specific data related to weather that might influence the suitability of certain technologies to be deployed there. Information about the technologies themselves. So, you know, which ones are being considered for deployment, their technical performance characteristics, and things like capital and ONM costs.

And then for certain sites, large sites where you have sort of multiple buildings that are connected within an internal microgrid network, the details and topology of that network. Because that might influence where resources need to be placed and how they're going to interact with each other. Each of these factors have the potential to influence the best system configuration, and some of them quite significantly. So, when engaging in a design process, you really want to take into account each of these. Next slide, please.

So the actual process of deploying a distributed energy system on a microgrid is often really long and complex. But the first step is to develop a feasible actual design. So, it goes into a feasibility design. Well, you need specific information about the sort of basic cost and performance metrics; things like total capital costs or net changes to your operational costs, and payback periods for new investment.

You need to know which new technologies you should invest and the capacities for each. You'd also typically like to know how they're operated on a day-to-day basis. That's going to influence a lot of things related to ONM costs. And then again, for these larger sites, where you need to put them. Because there's constraints that go beyond the pure techno-economic modeling about where resources can actually be placed. So, next slide, please.

So given all of these factors, it's pretty clear that the process for designing a microgrid system is actually very complex. Fortunately, this is precisely the problem that DER-CAM has been developed to answer. So DER-CAM, like I said, is an optimization tool that is designed to find the optimal DER solution to a specific site problem. It does this by simultaneously considering a range of value streams for each DER asset that it might deploy at the site. DER-CAM solves this problem holistically.

So it's looking at all of these design decisions simultaneously, assessing the potential of each technology to either compete with or complement one another across all the different value streams, and then selects a design that maximizes the total system value.

And again, that's going to be based on the user's defined objectives and constraints. Next slide, please.

So, getting into the details of what actually DER-CAM includes, there's a wide variety of DER technologies. Most technologies that are commercially available, including solar PV, combined heat and power, or other gen sets, as well as a number of other renewable sources; on the energy storage front, we consider both electrical storages – so batteries and flow batteries – but also thermal storage – so heat, and chilled water and ice storage, which is important for serving specific end uses.

We also consider sort of load-side control and management options, which can be a really significant factor to be used to support or strengthen the active energy technology investment. And then again on the load side, we're in the process of deploying energy efficiency investments, which can be considered in conjunction with the active energy, the DER energy investments, to allow you to further explore what sort of demand site options your design solution includes. Next slide, please.

In terms of value streams, DER-CAM allows you to explore what we call stacked value for the different assets by utilizing them across a number of different value streams simultaneously to look at using the technology to, for instance, reduce energy imports, or do load shifting to managed demand charges. You can export energy back to the grid for revenue, or provide demand response or ancillary services back to the grid. And then again on the demand side, you can use energy efficiency to reduce your total consumption, or just improve the overall efficiency of the system with something like CHP, which improves the efficiency of serving thermal loads. Next slide, please.

So, DER-CAM has a number of advanced features that helps set it apart from other design tools in this space. So in particular, DER-CAM focuses on – or has the ability to model multi-building networked microgrids. So you can look at these larger-scale applications where the constraints for heat or power flow between different buildings is going to be an important determination for the overall design of the system. It also has a strong emphasis on multi-energy microgrids. So serving both the electrical side and the thermal side of the buildings is an important component of DER-CAM.

And then finally some advanced features including what we call security constrain design, allow you to apply DER-CAM to, for instance, off-grid microgrid systems, or sites with sort of critical operational requirements. And what that means is that you can create a design in which if one of your DER assets goes down, your site will still have adequate capacity to keep operating. So it's really about emphasizing the resiliency of the system. Next slide, please.

So, generically DER-CAM refers to an optimization engine. It's a big mathematical problem that powers a number of Berkeley Lab research tools. But we make the tool available to the public in the form of DER-CAM Desktop. This is a user interface that provides just a structured environment for users to build, modify, and explore their microgrid models, as well as to navigate results, and things like that. Next slide, please.

DER-CAM also provides a number of data libraries to help you get started in building your projects. So these include building loads for typical building types, solar insulation for hundreds of US locations, a number of electricity tariffs – although those change quickly – and then technology libraries for a broad array of DER technologies. So, like I said, these allow you to quickly construct new models if you don't necessarily have data readily available. But, you also have the option to, if you'd like, to customize any of these data fields to fit your specific needs. Next slide, please.

So, given a little information about DER-CAM, what can you actually do with it? So, you can do, like I said, quick feasibility studies. You know, put together a model really quickly. And then if you go to the next slide, this is an example of what you get if you do that. So, basically a report page showing you basic results metrics for things like the recommended capacities of DER to invest in, the capital costs of those new investments, and the changes to things like annual energy costs, energy consumption and production on site, and CO2 emissions. Next slide, please.

So, it gets more interesting when you think about how you can develop more complex multi-run scenario analysis so explore the impacts of important site characteristics on the design outcomes. So those include things like the DER technologies and costs, which are changing rapidly; tariffs and energy rates; basically the price of energy you're paying; load consumption characteristics, as well as other energy policy impacts or other model parameters that might be important.

And if you go to the next slide, you can see how this can be particularly useful when you need to develop a single design solution that's capable of delivering strong economic performance across a number of different possible scenarios for your real-world system. This is an example of work we did with John for one of the sites where we looked at how changing the level of critical load that's being served during outage impacts both the DER investments that are being made, and then the total annual energy costs that are being spent to operate the site. Next slide, please.

And again, embracing the more advanced capabilities of DER-CAM. This is an example of a case study that we did in conjunction with the University of Alaska, where we're looking at an entire off-grid city. So we're basically able to capture this large microgrid and construct a really complex representation where within this system where resources are placed is a really critical component of the design solution. Next slide, please.

So, I won't go into details here, but this shows somewhat chaotically the construction of that large microgrid model within DER-CAM. And then you can see in each node there's recommendations being made about which resources should be placed there in order to satisfy the power flow constraints, and whatnot, of the system itself. Next slide, please.

So, like Emma, we're also constantly in the process of improving the model. I think some of the important new features that are coming out that I'd like to highlight are first the simple DER-CAM APIs. Again, that's a way for you to make use of the tool without having to use the interface directly by sending and receiving data files directly to our servers. We're finalizing our energy efficiency support, so providing an interface and data resources to help people build representative energy efficiency models and scenarios to do that analysis.

We'd also like to strengthen what we're able to do in terms of resiliency modeling. So that's something that's obviously very scenario-based, depending on unknowns like the critical load being served. And so we're building the capabilities to allow you to automate that, basically reduce the burden on you as the user in order to generate a wide array of results to explore resiliency.

And then finally expanding what we're doing in terms of grid services. I think that's increasingly an important aspect of the DER-CAM, or of the microgrid value stream, providing services back to the grid. And so we're expanding what we're able to capture there in order to get a better picture of what the forward-looking value proposition of a microgrid ends up being.

So, last slide. Wrapping up, I want to re-emphasize that, so DER-CAM is free to use. You can register for access to the desktop interface on our website, which is dercam.lbl.gov. We also provide sort of in beta a web, a browser-based version of that interface. So, if you'd like access to that, you can always contact us at dercam.lbl.gov, or @lbl.gov, excuse me. And that's it for me. So, thanks, everyone, for listening.

John Agan: Great. Thank you very much, Nicholas. Great presentation. As a reminder to listeners, we're going to have a Q and A in just a moment, so please go ahead and enter your questions into the Q and A box on the side of your screen. Before we dive into these questions, I'd like to highlight how to find additional resources relevant to this presentation after we're done.

If we could go to the next slide, this is the Better Building Solutions Center, where you can find one of our 2,500 publicly-available solutions. As you can see in the animation here, you can explore by topic, solution type, or go to one of our program and partner pages directly. Here is where you can find our resilience tab, also, filled with various resources focused on helping sectors and partners build resilience and minimize vulnerability. Again, you can go to energy.gov/bbsc, Better Building Solution Center, to explore all the resources that we have to offer. We could go to the next slide.

Great. So thanks, everyone, who is submitting questions to this point, particularly for those who have questions for Nicholas, we'll give you a few minutes here to get some questions in. But I want to kick off, maybe, with a question for Emma on the REopt Lite tool. I think this was one that came in pretty early about the generator capability. And if, Emma, you can say a little bit more about natural gas capabilities and the use of CHP.

Emma Elgqvist: Sure. And I'm actually just going to say a little bit, which is that we're in year two of a three-year effort to add CHP capabilities to the REopt Lite web tool. And so we're hoping to deploy the kind of beta version of that by the end of this year. And so, in adding CHP, it's not just a new technology. It's thinking about how to model the thermal side of things, as well.

In addition to that, there's lots of different options for CHP, and always not clear what's kind of the defaults or most optical technology. And so, right now what you can model in the tool is a back-up generator, both diesel, or you can change the inputs to reflect natural gas. But once we launch the CHP module, again, by the end of this year – you'll be able to fully explore kind of grid-connected benefits of CHP.

John Agan: Terrific. Thanks, Emma. If we can stay with you for one moment while it looks like questions for Nicholas on DER-CAM are still coming, I want to get to get to a question that looked like it was a version of something multiple people asked, which is about different building types. And folks are wondering if the tool accounts for daily load shapes, or different building types, and particularly here, the question is about multi-family.

Emma Elgqvist: Sure. Yeah. So, a couple of this here. One is we just published a set of really short YouTube video tutorials that walk through the various inputs and outputs of the tool in a little bit more detail. So, I sent a link for that YouTube channel in the chat box, so maybe that's something we could share after the webinar. So, I'd encourage you to go and check those out, just to get a little bit more in-depth information, especially about some of the topics I didn't cover today.

But to answer your question, yes. So the resolution of the tool is hourly. So, it does capture how your electricity use changes hour by hour over a full year. There are two different ways of entering that data into the tool. The first one is if you have actual interval data from your utilities for a particular building or site, you can upload that and the tool will take that load shape into consideration, again, a full year on an hour-by-hour basis.

If you don't have access to that kind of data, you can select from one of the commercial reference buildings, and so you're able to select a building type that has the 15 most common building commercial – excuse me 16 most common commercial buildings in the US. I think it covers like 75 percent of all commercial buildings. So that does include things like small, large, medium offices, hotels, as well as multi-family housing.

John Agan: Great. Yeah. And thanks for that clarification about the commercial building types also do include multi-family residential. All right. I've got, it looks like, a couple of questions here for Nicholas. And this is special for me, because these are questions that I've asked him before. So I'm looking forward to having him share this with all of you.

First, is there a way to quantify carbon reduction from the implementation of a microgrid, particularly for fossil fuel distributed energy resources, displacing grid generation? So that's for the tool DER-CAM.

And then, Nicholas, I'll give you this one. You can answer them both. Is there a way for the DER-CAM tool to assess the impact of EV infrastructure on the microgrid system?

Nicholas DeForest: Yeah. Thanks. So, on the first question, yeah. We do quantify carbon reductions from different technologies deployed on site. In the results panel, we give some information about the source of emissions. So if it's coming from grid electricity versus fuel that you've consumed on site. And because DER-CAM gives you the option to optimize for CO2 reductions, you can actually use that to kind of drive the design outcome.

But, yeah, we do take into account given that we use CHP, there's instances where that can reduce your CO2 emissions due to increased efficiency of serving thermal loads. But, versus an all-PV battery solution, it might not be as strong of CO2 reduction. So it really depends on how you construct your model. But we do give you information for that.

On the EV side, that's an area where we're also doing some development to improve what we're able to offer. In terms of the model that's available right now, there isn't a lot of features to assess in detail the EV infrastructure. I think one thing you could do is have your electricity loads reflect EV consumption.

But, if you want the – if you have, for instance, controllable charging on site and you want that charging to support the microgrid objective, then the EV becomes essentially another energy resource. And that's what we're trying to build out now, is basically allow you to modulate EV charging to support the broader objective of the system. So that's something that we should have out sometime in the future.

John Agan: Terrific. Thanks, Nicholas. There's a question here that I think was about the REopt Lite tool, but I want to give Emma a chance to answer it first, and then Nicholas, as well. Because I think it's useful. These tools look great, so thanks for that feedback note, the person who submitted this question. But they say rather than require the end user to enter an assumed outage, both frequency and duration, it would seem that there's enough regional-specific data to establish some centrally accessible basic resilience metrics within a reasonable confidence interval.

Are there efforts underway to centralize and vet these regional metrics? And if so, does anyone know where it's located? I think that what I'm hoping to hear from Emma and then Nicholas is if you – either of you – in developing new features have thought about basing, having some baseline expectation or frequency or duration of outages, based on location in the country or if you, yeah, basically if you'd thought about that as an ability to have on these tools?

Emma Elgqvist: Sure. Yeah. I'll maybe start, and then hand it off to Nicholas to add some to this, too. So, a few things. I think there was kind of question on a centralized place where this is published. So, EIA publishes an annual report by utility on SAIDI and SAIFI metrics. So, that is kind of a resource, or a place to start. We don't have immediate plans to integrate that into the REopt Lite tool, but it is something we've talked about.

I did want to note, though, that while SAIDI and SAIFI metrics are good for kind of thinking of the historic events that have happened in the past, or how the utility has performed in the past, they are not really great for predicting kind of really rare but really major events. And so oftentimes we find that our users are not necessarily looking to plan for these couple of hour-long outages, but more thinking about how do I sustain like a week or a two-week-long outage? And so the SAIDI and SAIFI metrics are somewhat limited in their ability to predict those kind of long duration but really rare and impactful events.

Nicholas DeForest: Yeah. That's my thought exactly. We've done a little work on exploring the sort of reliability aspect of it, these short outages, on design. And we didn't really find that it was a huge driver. If you're only experiencing an hour or two of potential outage a year, you're not going to drive a significant investment in technologies. And so the work that we've done is really about folks who are looking to build a strong resilient system in the face of like a rare outage event.

John Agan: Great. An additional question here, I think, for both of you, that gets at the databases that are used for electric rates. So how are the rate schedules incorporated? And do they account for complex time of use rates, or different demand charges in calculating some of these financial factors that we're talking about? Nicholas, do you want to start, and then we'll go to Emma on this one?

Nicholas DeForest: I'm sorry. Could you repeat the last aspect of the question?

John Agan: Sure. And do the rate schedules or ability to represent rate include complex time of use rates, or different levels of demand charges?

Nicholas DeForest: Oh, okay. Yeah. So, in DER-CAM we try to capture the wide variety of potential tariffs that are out there. So we have the ability for users to sort of select different aspects of that. So that does include things like time of use tariffs, and demand charges across a number of different time periods, as well as like less common, but increasingly sort of emerging tariff configurations like real-time rates, and things like that. So, yeah, we try to – I don't know that we have everything, ever possible tariff out there. But we really try to capture the wide array of what's possible.

John Agan: Great, and anything to add on the REopt Lite side?

Emma Elgqvist: Not much to add, other than the rate structure is oftentimes really important and complex piece of these analyses. And so, yeah, same, we try to capture as broad of a set of rates as we can, and I think leveraging the URDB has been really helpful in getting to that 90-95 percent accuracy of the rates. But then, still kind of recognizing that there's always new and emerging rates. And I know the URDB folks are working on constantly updating that database, as well.

John Agan: Great. And that's the utility rate database. Just want to make sure that the acronym was caught for everyone. So, just an attempt to have existing and actual tariff information on rates that customers are on from around the country, so you can kind of automatically and save a step by just selecting the rate that you're on, rather than putting in all the details in the tool. Great.

Another question I want to pose to each of you, this comment here asks about while we have a lot of information here on government buildings and schools, is anyone focusing on hospitals? These tools look like they would be helpful in building resilience in the health care system. Maybe we'll start with Emma this time, and then let Nicholas say anything he wants about hospitals and the ability of each tool to address them.

Emma Elgqvist: Yeah. I think we don't have anything specifically for hospital, other than I think that the tool, as you say, is really applicable for hospitals, in thinking about these resilience requirements. I do believe that a hospital is one of the 16 default commercial reference building loads. And so from that perspective, you can model kind of what a typical hospital would look like. Though, I would encourage folks to if do have access to your hourly or 15-

minute interval data, to try to use that. You can see it does impact the sizing and the economics of results.

John Agan: Great. Nicholas, anything to add on that?

Nicholas DeForest: Yeah. I think DER-CAM is similar. One thing I would say, we've done a couple of analyses that involve hospitals. And one thing that's jumped out as somewhat different than other applications is the thermal load, because the occupancy tends to be high around the day and night, hospitals tend to have higher thermal loads sometimes than office buildings, and things like that. And so we've found in some cases CHP is a really promising solution for hospitals that are looking to build out resiliency.

John Agan: Yeah. I'll put another plug in on the Better Building Solutions Center site. There are a number of resources that I think would be directly relevant to hospitals and energy efficiency, particularly related to CHP, in the cases where it has proven an effective resilience option. So, that's helpful.

Great. Well, I think we're getting close to time here. We didn't – we weren't able to get to every question. But I'm hopeful that folks will be able to contact our panelists and follow up as interested for some of the other questions that came up. And I want to thank you both again for your presentations and thoughtful answers to each of these questions.

As we're moving on here, just to wrap up, in 2019 to 2020, the Better Buildings Webinar series will be taking on the most pressing topics facing energy professionals with new experts leading the conversations on proven best practices, cost-effective strategies, and innovative new ways to approach sustainability and energy performance. We do have a wonderful series going through the spring of 2020, and you'll see some of the topics listed here, including our topic for today. If we could go to the next slide.

We hope that you'll plan to attend our next Better Buildings Webinar on Tuesday, March 3, from 3:00 to 4:00 PM Eastern, titled "Building Value: How Energy Efficiency Impacts Mortgages and More." This webinar will address the financial impact of energy performance and provide attendees with the information needed to assess energy and climate risk in their portfolios. Expert panelists from academia, commercial real estate, and the insurance industry will discuss recent research results, new tools, and strategies that can help building owners analyze and quantify these risks, and inform resilience planning at the asset level. Next slide, please.

We're also pleased to announce registration for the 2020 Better Buildings Summit is now open. The summit is being held in Arlington, Virginia, from June 8 to June 10. In addition to engaging in interactive sessions, attendees can look forward to the return of Ask an Expert, building tours, and opportunities to network with their peers. Explore the session tracks and book your accommodations on the Better Buildings Solutions Center. Next slide, please.

We'd also like to highlight some additional resources available on the Better Buildings Solutions Center. When the slides are made available, please click each resource to learn more. Next slide.

Finally, if you have questions, comments, or feedback, please use any of the resources listed here, in addition to some of the other ones we've mentioned that will be made available after the webinar. You can also reach directly out to the e-mails listed, or visit the web pages to learn more. Next slide.

With that, I'd like to thank, again, our panelists very much for taking the time to be with us today. Feel free to contact our presenters directly with additional questions or if we couldn't get to your questions during the Q and A period. If you'd like to learn more about the resources discusses, please check our our website, or feel free to contact me at the e-mail shown. For any general inquiries or program support questions, click on the green icons, and they will direct you to the appropriate contact.

I encourage you also to follow the Better Buildings Initiative on Twitter for all the latest news. You'll receive an e-mail notice when the archive of this session is available on the Better Buildings Solutions Center. Thanks again, everyone. Have a great day.

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