Otto VanGeet: So, good afternoon, everyone. Welcome to the 2020 Better Buildings Better Plants Summit, Virtual Leadership Symposium. Thank you for being with us today and I look forward to your participation in today's session. Next slide, please.

So today's session is all about stumping the chumps. You'll get to meet the chumps here in a little bit. The conversation will be focused around how to optimize critical facilities. The session will be very interactive. We look forward to addressing all your questions around critical facilities.

Before we dive in, there are a few housekeeping items I'd like to cover. Yeah. Please note that today's session will be recorded and archived on the Better Buildings Solution Center. We'll be able to follow up when today's recordings and slides are made available. We'll follow up with you. Attendees are in listen-only mode, meaning your microphones are muted. If you experience any audio or visual issues any time throughout today's session, please send a message in your chat box in the window located below on your Zoom panel.

All right. So, my name's Otto VanGeet. I'll be the moderator for today's session. I'm a principal engineer at the National Renewable Energy Lab, or NREL. I'm a registered mechanical engineer, and I lead our work at NREL on critical facilities like you'll be hearing about today. My co-moderator is Rachel Shepherd from the US Department of Energy's Federal Energy Management Program, FEMP. And in today's session, she'll be behind the scenes fielding questions. Rachel leads FEMP's work on critical facilities. So next slide, please.

So, the agenda. We'll be going through introduction to critical facilities. Those facilities are data centers, labs, water, wastewater facilities, and the energy water nexus, hospitals, and then high security facilities and others. Then we'll be going through, having the speakers do a brief, five-minute introduction on each critical facility type.

After that, we'll be having the majority of the session be a panel discussion. The panel discussion will be broken into two rounds. Round one will have three each sessions at about ten minutes per topic. Those topics will be continuity of operations, project implementation, and then energy management best practices. Round two will be the remaining questions from Slido, which I'll explain soon.

So, you can also follow along on social media. Here's the social media on Twitter and LinkedIn and the address for that. So you can follow that. And then next slide, please.

So, Slido. Logistics-wise Slido will be used for the platform for our Q and A throughout the webinar. Please go to Slido.com right now and see if that works for you. It's highly interactive, so using your device, please go to Better Buildings, the site there, and then you should be able to see a list that's provided, scroll down the list and pick, select Stump the Chumps, this session. I'll give you a few seconds here to do that, and then we're going to go through and test our Slido.

I just wanted to remind you that Slido is where we need to send the questions. We will not be answering any questions through Zoom. All right. So I think everybody's had a moment to load Slido. And the first question that you should be seeing is "Where are you joining us from today?" So, please answer that question, and I'll get to see – we're starting to see all over the country. Wow. Maryland is the early winner. Wow. We got a lot of – oh, Chicago. Chicago is now the winner. Denver. Denver's good. That's where I'm based out of. We've got Philadelphia, Indiana – pretty much the whole country covered, which is great.

Looks like the overall winner was probably Chicago and Maryland. And Chicago is looking like it's going to be the overall winner. So thank you for joining us from all over the country. So, let's go – it's pretty good. We're also getting 147, 150 responses out of 350 or so participants. So pretty good responses. And again, good job in Chicago. You guys get the early win. Let's go ahead and we'll go to the next slide.

So, this is another Slido question. And this question is "What critical facilities do you work with the most?" And it looks like, reading the results that hopefully you guys are seeing right now, laboratories are the winner. Other, which could be all other categories. We've got kind of a third – laboratory is a third, a third other, a third data centers. And then some – oh, hospitals are doing good, also. Emergency management centers, public safety. So kind of a good representation.

And it looks like other, which could be anything, is kind of the overall winner with the labs as close second, data centers third, hospitals fourth, wastewater treatment plants in fifth. But a good representation. And a good number of participants, about half the

participants; 150. So that's great. That helps me as a moderator, also, to focus on different critical facilities types.

So, now we're going to go to introducing our panelists. And I'll provide more detailed introductions, and you'll get to hear from each of these panelists. But starting at the upper left-hand corner, my friend and colleague, Dale Sartor from Lawrence Berkeley National Labs. And my friend and colleague, Wendell Brase from University of California, Irvine. Jen Muir from JK Muir, Limited. Daniel from New York-Presbyterian Hospital – Daniel Mastin. And then Chris Halpin from Energy Services. So with that – from NV5 Energy Services. Sorry about that, Chris. So, thanks to all of our panelists for being with us today. And they'll share their thoughts soon about critical facilities that they specialize in.

But before turning it over to them, I'd like to first provide some brief information on critical facilities and why energy and resources are important to them.

So this is a slide on what are critical facilities. And according to FEMA, the first bullet, critical facilities provide services and functions essential to an organization or community. And then from the Patriot Act, "Critical facilities house critical infrastructure, which collectively refers to those assets, systems, and networks that, if incapacitated, would have a substantial negative impact on national or regional security, economic operations, or public health and safety."

And then there's some images along the bottom. The bottom left is a water or wastewater treatment, which we'll hear about. Image in the middle is a laboratory building. And the image on the right is a data center. So with that, let's go ahead and we'll go to the next slide.

And we're going to talk about resource use a lot in this webinar. And the resource use in critical facilities is significant. And because they're resource-intensive facilities – and again, our panelists will describe how – so we're going to hear about the importance of optimizing these facilities. And what I mean by optimizing is being efficient with the resources. Again, energy, water, et cetera, costs, and operations. So optimizing all three for these critical facilities.

And then due to increasing threats, such as natural disasters, we need to plan for continuity of operations for critical infrastructure. And the NOAA image on the bottom is a nice image where the

vertical bars and the left-hand vertical axis show number of events. And then the lines and the costs in billions of dollars on the right-hand axis shows an increasing trend as time has gone on. And we're all aware of this with different hurricanes, and storms, and et cetera. And this breaks those down by different colors, but all of these things affect our critical facilities. So let's go ahead and we'll go to the next slide, please.

So, some common threads that you're going to hear from today's panelists about critical facilities, again, that they're typically resource intensive; meaning, again, energy and water. They require a high reliability. Resiliency will be another word we use there. That it's very important to benchmark the resource performance, then optimize that performance. And then once you've optimized it, to monitor that performance real-time; meaning ongoing monitoring of energy and water use real time.

It'll be important to establish a strong project and/or program team for implementing the energy – or, I mean, water – projects and other optimization projects. And then it's going to be important for protecting and improving the resilience of critical facilities in the face of man-made and natural disasters will require ongoing effort that will require vigilance, contingency planning, and training. So, we'll go ahead and we'll go to the next slide, please.

So, there's another Slido poll here. And this is similar to a previous one, but related. So, what sector does your organization represent? So, we've got a lot of federal, state, and local representatives; higher education, research facilities, industrial and manufacturing, non-profits, utilities, and then some other. And we'll give it a few more seconds here for this to populate. And it looks like by far the winner is going to be state, local, and federal governments; which is great. Certainly, critical facilities fall under government interactions and responsibilities.

The next two are sort of a tie. Higher education or research facilities, at 18 percent. And again, higher education often has a lot of these different critical facilities, such as laboratories. We'll be hearing about that. Same for research facilities and energy consultants and energy service companies are the ones who are often responsible for optimizing these critical facilities. Industrial manufacturing, obviously, has a lot of critical facilities. And then we have non-profit others, and then commercial real estate and for-profit in the mix, also. So with that, I'd like to go to the next slide.

All right. And on this slide, I wanted to introduce my friend and colleague, Dale Sartor from Lawrence Berkeley National Labs, who is an expert in data centers. And Dale's a staff scientist and engineer at LBNL, where he focuses on building efficient technology applications. Dale has an AB in architecture and a master's in business administration. He's a licensed mechanical engineer and a licensed general building contractor. And again, I want to remind you to submit questions for Dale on the Slido link shown at the bottom. And with that, I'm going to turn this over to Dale to start presenting on data centers. Thanks, Dale. Your turn.

Dale Sartor: All right. Thank you, Otto. You can hear me?

Otto VanGeet: Yes. Yes.

Dale Sartor: All right. Thanks a lot for joining us here. Next slide. Okay. Here we go. So, as Otto mentioned, most critical facilities are highly energy intensive, and data centers certainly fit that bill. They're about ten to 100 times more energy intensive than a typical office. The server racks now are being designed for up to or even in excess of 30 kilowatts, each. That's like a refrigerator size, almost. And there's a surging demand for data processing and storage so that the end isn't in sight. Combined data centers consume about 1.8 percent of the US's electrical consumption. That's more than most states. And many of us experience power and cooling constraints within our existing data centers.

The potential for energy efficiency is great. Typically, we see 20 to 40 percent savings opportunities with high return on investments available. But with aggressive strategies, we can yield 50 percent or more, especially when we combine both IT and infrastructure improvements. By implementing energy efficiency, we not only save money and energy, but we can extend the life and capacity of the infrastructure, and also increase the resiliency of the data center. Next.

So, the first step – and I think this is on Otto's list – is benchmarking, installing metering so that we can understand where the power is being used and track it over time. The two pie charts are illustrative of two typical data centers, and one could assume, assuming that everything else is equal, that the data center on the right where a greater percentage of the power actually makes it to the IT equipment, is more efficient than the data center on the left, where only about half of the power makes it to the IT equipment.

This basically describes a metric called PUE, power utilization effectiveness, which is the total power divided by the IT power. And by using such metrics, we can compare our performance to our peers. And there's a wide variation. You can see the graph at the bottom right, where the green or yellow is the one, or the IT load; and the blue is the ratio, or the amount of power that goes to the infrastructure.

By looking at the best-performing data centers, we can identify best practices, and we can identify opportunities for improvement, and we can track performance over time. Next.

So, the opportunities are varied. I'll start on the lower right, the supplying the power to the data center. Here we can use renewables, or on-site generation for resiliency. We want to deliver that power efficiently. And one example in data centers is high-efficiency UPSs. We've seen UPSs consume large percentages of the power, just because of their age and how well they're loaded.

And then in the IT equipment itself, there's a lot of opportunities. For example, with virtualization we can dramatically reduce the number of servers required, enhance their energy consumption. And then all the energy that goes into a data center eventually has to be removed with cooling. And there's a number of opportunities there, including better air management and the use of free cooling. Next.

So, DOE is ready to help. The Center of Expertise provides tools, resources, and training. And on the training front, we have a website or URL for coming up webinars. So I welcome you to join. Thank you. I think that's the last slide.

Otto VanGeet: Great. Thank you, Dale. So, what I'd like to do now is move onto Wendell Brase, who is the associate chancellor for sustainability at University of California, Irvine. And Wendell will be talking about laboratory buildings. Wendell is the first associate chancellor for sustainability. In this role, he leads UC Irvine's sustainability efforts, and he also assists other campuses throughout the University of California system to implement UC's carbon neutral initiative. Wendell also co-chairs the University of California's Global Climate Leadership Council.

And again, similar to with Dale, please submit questions through Slido for Wendell. And with that, Wendell, please take over.

Wendell Brase: Thank you, Otto. Can you hear me?

Otto VanGeet: Yep. I can hear you. Thanks.

Wendell Brase: Okay. I'm ready for the first slide. So, I'll focus most of my remarks here on smart labs. But let me first start out by talking a little bit about the basics in a smart building – any smart building. I think these four attributes here exist in any type of smart building. If you want to call it smart, it needs to have demand-controlled HVAC. Demand-controlled could just be occupancy-controlling HVAC, as well as lighting in a simple office building. But in a laboratory building, you'll see that we measure a lot of other things for demand control, like CO2 particulates, VOCs.

And this is all about precision control. So that means you need quite a few HVAC zones. You can't have one zone be half a floor. You have to have zones that are small enough that you actually get precision control using the kinds of sensors I just described. We've found that right-sizing air changes actually results in quite a few benefits, including minimizing reheat, especially in an air conditioning climate like we have. And it's not just about HVAC ventilation and exhaust. It also includes efficient lighting and more efficient plug-loads to really make it a holistic idea. Next slide.

So, smart lab. What I'm going to say now and in the next couple minutes will be very oversimplified. It actually takes a full day packed agenda workshop to cover what we call the smart labs program. We call it a program because it's a whole different way of looking at laboratory operations as well as design. And if anyone's interested, by the way, in our smart labs workshop, we tend to do one every July or February. And it's a no-cost event, actually. Or a very low-cost event. And if anyone's interested, contact us, and we'll put you on the list for the next one.

So, a smart lab, in terms of its outcomes, the three outcomes you see here are the kind of basic ones you'd find in every smart lab. And so reducing energy consumption by half. This isn't an aspirational goal. It's actually been measured. And we've done about 25 of these projects; about 15 in retrofitted existing buildings, and about 10 in new buildings. The average for new buildings is that we're beating California's Title 24, which is a tough energy code, by 50 to 55 percent on all those projects. And then for the retrofitted ones, there it's a before-versus-after measurement. And our results range from 41 percent to 80 percent.

We are also improving safety again. We have data on this. You'll see why as I describe a little bit more. And we have a data stream

in the background that actually enables sustained precision performance. In other words, we need a system to keep a smart building smarter, or a smart campus smarter. And that's what that last one's about. Next slide.

Here are the fundamental components of a smart lab. The first two bullets we've already touched upon. The next four bullets, about exhaust fan, discharge air speed, pressure-drop optimization, fume hood flow optimization, and so on; those four are really performance specifications. And these performance-based specs in our design build competition process for all of our new laboratories that we build – and actually most of the retrofits now – we're using design build competition.

So, we're a public research university. We share everything openly that we have tried and worked on in a way that we know will be worthy of sharing with others who are working on climate solutions. We think that's part of our mission. Anyone can have our performance specs that represent these bullet points here. Just ask and we'll give them to you.

Commissioning with automated – that's about the informatics system that's in the background. It's not just for laboratories, by the way. On our campus now, we have a lot of informatics behind all of our buildings of all types. We're measuring 465,000 data points every five seconds at the UC Irvine campus. Next slide, please.

This is a simplified cartoon of the demand-controlled ventilation concept here. If you can give it one click, it will animate this slide. Here we go. You see the vacuum pump down here in the corner near the sensor suite. It's creating a vacuum. It's drawing an air sample from the outdoors. That's a reference probe. Then, it's taking a sample from room one, lab room two, classroom 103.

It doesn't do it this fast in real time. It does it about every couple minutes. Because it's – for each one of those air packets that's coming down to the sensor suite, it's evaluating all those things: total VOCs, carbon dioxide, carbon monoxide, dew point, particulates, particulates down to a pretty low – or a very high level of resolution. All that data's ending up at a web-based user interface, which I just mentioned. Next slide, please.

This was a really great and welcome surprise to us. We had no idea that the co-benefits of this program would be as massive as they've turned out to be, or as valuable as they've turned out to be. Real-time commissioning and fault-detection, and making laboratories

safe. Those are two sides of the same coin. The reason laboratories are safer is because we discovered faults. They're detected within minutes or hours, at the most. Some of those faults, I think, probably could go on for decades in a university in the old paradigm where we didn't have this kind of informatics.

We consider a laboratory a safety machine. A good machine operates with precision, and it has precision fault detection. That's why our laboratories are safer. And we have the data to prove that. Indoor air quality and improved infection control, again, two sides of the same coin. The fact is most pathogens are hitchhikers. They travel on particulates. We've been able, because we've slowed down air changes and therefore the air speeds coming through fans and filtration medium about in half. And that means our standard filter is now a mere 14, which is one notch below a HEPA filter. That is a safer infection control environment.

Next thing here is longer life for reduced-speed – everything that's turning, or heating, or cooling is basically running at half speed. And some of those devices follow the square rule, meaning they're going to last not twice as long at half speed; four times as long. Some actually follow the cube rule, like exhaust fans on lab buildings. They'll last eight times as long. We're a public research university. Tax payers pay for us and tuition payers. This is a big deal, actually, having this kind of savings. Avoiding carbon costs. Carbon costs in California are still pretty low. The cap-and-trade last option was only a little bit north of $15 per metric ton. We expect that number to get much higher. These benefits will improve for years and years and years.

Deferred maintenance. About ten percent of our retrofitted projects went into fixing deferred maintenance problems, including things that were unfunded and would have stayed that way if we didn't, had not had all the energy savings we yielded through this program, which have now fixed all these deferred maintenance problems in laboratories. And maintenance expense, same thing, same story.

Just scan this for a second, and you'll realize we could actually put dollar numbers on a lot of these estimates. These are tangible economic savings. We can add these up and we could – that makes a project which was already net positive in terms of the cost-to-benefit ratio, it makes it massively beneficial. This is like practically a no-brainer. Next slide.

So here's my final summary. We've already talked about the energy savings, safety, no deterioration due to this continuous commissioning, using the informatics layer that I've described. Lower maintenance costs. I guess I've talked about all these things now. But I did actually forget to mention one thing here, and that's just because we take it for granted. All of this adds up to a more reliable research environment. That is priceless to researchers. That's why I didn't list it. We just take for granted that that is probably the most important benefit for a research university. And so that's the end of my remarks. Thank you.

Otto VanGeet: So, thank you, Wendell. Those were great remarks. And again, reminder for everyone to go to Slido and submit questions for Wendell, or Dale, or our next speaker, Jen Muir, from JK Muir, LCC. Jen will be talking about wastewater facilities and the energy water nexus.

And a little bit of background on Jen. She's the president of JK Muir, LLC. Jen's experience includes conducting energy evaluations of pumping and process systems, design of improvements for those systems, and obtaining grant funding. Jen received her bachelor's and master's degrees from MIT in environmental engineering, and she's a registered professional engineer. With that, I'd like to turn it over to Jen, and let's learn about the wastewater facilities and energy water nexus. Go ahead, Jen.

Jen Muir: Thank you so much. Great. Well, let's get started. A pleasure to be here with all of you. And again, what we're going to talk about just in the next few minutes here is about the water energy nexus and how we service this with our critical facilities. So let's just get right to the next slide.

So why water? Why are we spending so much time talking about water? Well, I wanted to just give you a quick overview. I think it's probably really clear to us why these are critical facilities. And first it has a lot to do with the fact that these are essential to public and environmental health. And we also need to do them on a local level. That's obviously how we handle both drinking water and wastewater treatment. But in terms of their energy usage and where we see this water energy nexus come together is that it's over 75 billion kilowatt hours per year in the water industry.

That's over three percent of the total US consumption; more than or equal to the entire residential demand of the state of California. And you might be surprised to know that it's actually more than the

pulp and paper and petroleum sectors combined. So a huge energy usage. It's something that we often don't think of, right? We all just walk over to the sink, we turn on the water, and the water arrives. When it goes down the drain, it just goes away. And it turns out that this is actually a huge energy sink in our world. So it's about $4 billion a year is spent on energy in this sector.

So when I talk about critical infrastructure, I'll just point to this picture that's in the lower right-hand corner of your screen, and you can see this wastewater facility, of course, looking very beautiful, sitting on the edge of the river here.

And what I want to point out, though, is that if you think about the most efficient way to transport wastewater, in particular, it's of course to let it run downhill through our collection system. So what ends up happening in addition to being very critical to public and environmental health is the fact that these facilities also sit in very low-lying areas and are going to be subject to the implications associated with sea level rise.

Again, why water? We see these facilities increasing their energy usage so that they can meet more stringent demands in terms of regulations. This is both on the drinking water side and the wastewater side. We've got leaks and losses in these systems. When we think about the status or the state of our infrastructure in this country, we know all of our public infrastructure is lacking in some ways, and in particular our water wastewater infrastructure is aging. So we've got leaks and losses, and we also have the large cost that's associated with upgrading these facilities. And we're going to talk about pumping in a minute. You can just go to the next slide.

So let's talk about pumping. One of my favorite quotes when I talk about energy efficiency in the water sector is to say that if we want to avoid extreme energy, we need extreme efficiency. And I really think the water sector – in particular drinking water and wastewater facilities – provide this opportunity to really mine past the low-hanging fruit, and get down to how do we get to some really substantial efficiency? And what it means is that we have to think about pumping.

When you consider your water sources and where your wastewater goes, think about how many times every individual drop of water is pumped. As it comes out of a reservoir or a well through a treatment facility, a booster pump out to you, and then again down through the sewer system pump stations and wastewater facility.

There's this much energy we're using for pumping. Electric motors in North America account for 66 percent of the industrial electrical usage, and of that 25 percent is from pumping systems. In a typical municipal water system, we're talking about energy usage associated with pumping systems of about 46 percent, or about half. And most importantly for the end user, the overall life cycle, the amount of money they're going to spend on that pump from the time they buy it through its entire life to replacement energy costs represent about 75 percent of that. So again, pumping being very critical, and an excellent opportunity for energy efficiency. Next slide.

So, I want to just talk about some of the unique, touch on some of these unique opportunities we also have for renewable energy in this sector, particularly at the wastewater facilities. This is the DC water, wastewater treatment facility. And many of you may be familiar with it because it is one of the largest ones in the country. But what's interesting about the water sector is that we didn't used to hang out with the solid waste folks. But now, because of our push towards sustainability, we see that many municipalities are trying to go with zero waste. What does that mean? We've got to get the waste out of the landfills.

One of the most important components is organics. Well, it turns out we're already dealing with a lot of organics at wastewater facilities by combining both food waste and wastewater. So joining these two sectors, we have an opportunity to produce basically a renewable fuel or a renewable gas through our digestion process. So, just an example of a city that's considering this embarking on this – next slide.

Similarly an often-overlooked aspect of what we can regain or recapture from what we traditionally call a waste, wastewater, is the fact that it has this latent heat. The idea that it's actually warmer than the air, and that we can actually mine that heat from it. And just an example of Vancouver setting up an actual large-scale facility to do this in which they are actually taking out or utilizing the heat from the sewage, and it's supplying a substantial portion of the hot water needs in that area, heating and hot water needs. And, next one.

And again, just another example of major cities really looking at how they can minimize the energy impact, the energy footprint of their water and wastewater facilities is to really try to combine how do we mine out all of the potential energy potential of the wastewater itself? So again, through solar, thermal, and then what

we call co-generation. And in some cases, co-digestion with the food waste.

But in this case, I like to point out that not only has the Philadelphia wastewater facilities looked at solar, substantially looked at some of the energy efficiency opportunities, but they have also taken things like aircraft de-icer from the airport, and will actually be useful in producing additional bio gas at this facility, which further offsets their own energy footprint. So we see a strong move in the water wastewater industry to move towards what we call energy neutrality, or net zero. Happy to answer more questions about that. And again, pleasure to be with you. Thanks so much.

Otto VanGeet: All right. Thank you, Jen. That was a great presentation. And again, reminder for everybody to ask questions on Slido for all of our speakers, and our next speaker coming up, which is Dan Mastin from New York-Presbyterian Hospitals. Dan is the energy and commissioning program manager at Presbyterian, which encompasses nine hospital campuses covering 8.6 million square feet. Dan holds a certified energy manager and certified measurement in verification professional certification. And with that, I'd like to turn this over to Dan and have him tell us about hospitals. Please take over, Dan.

Daniel Mastin: Good afternoon. Thanks, Otto, and thanks Free Tech and the Department of Energy for inviting me to join the panel today. So this slide kind of shows a brief overview of New York-Presbyterian's infrastructure portfolio. Some background on NYP. We're proud to be named a top five hospital by *US News and World Report* in their most recent ranking. Kind of unique. We're the teaching hospital for two Ivy League institutions: Cornell University and Columbia University. Another unique thing about New York-Presbyterian is that our two largest campuses act as district utilities for some neighboring institutions, hospitals, residential and commercial buildings. Next slide, please.

In the commercial building sector, hospitals consume an outside proportion of energy compared to their footprint. According to the EPA, the EUI of a medium hospital is about two and a half times that of a medium commercial office building. There's a wide variety of hospital types. They're not all created equal. For instance, there's a difference between a specialty hospital like a bone and joint center, where you might go and get a hip replacement versus a large academic research institution like New York-Presbyterian.

Another example is New York-Presbyterian has about 400 intensive care beds. If Presbyterian itself were a state, we'd have as many ICU beds – about as many – as the entire state of New Mexico. There would be more ICU beds than 12 other states in the country. ICUs have strict conditioning and pressurization requirements. More ICUs typically leads to higher energy consumption. So you can see how different programming at different hospitals would affect energy consumption. Next slide, please.

There's a lot of challenges to energy efficiency in the health care sector. We have a wide variety of ages and of buildings. There's been huge changes of building codes over the last hundred years. Working in older buildings can increase a project's cost and scope, as we need to bring different systems up to current code. Hospitals are subject to numerous regulatory bodies beyond just the local code authorities. We have joint commission, which provides certification for an accreditation for Medicare and Medicaid funding, which makes up a lot of hospital's revenue. Regulations interpretations between all these different regulatory bodies can be contradictory. That increases the complexity of our projects. Next slide, please.

Within the last ten years, New York City has implemented and adopted a number of regulations dealing directly with energy efficiency. Many of these are being adopted by other jurisdictions throughout the country. Implementing each of these regulations poses unique challenges to hospitals. Most of them are sort of focused, I think, more towards the commercial sector. Hospitals need to still meet these regulations. But the application and the cost benefit analysis for hospitals is a whole different calculation than sometimes the savings and the paybacks aren't as great for hospitals as they are in the commercial sector. Next slide, please.

The most recent and challenging regulation that has been put forth by the city is Local Law 97. This sets carbon caps on buildings based on the occupancy type. A hospital is an I-2 occupancy. Here are the carbon caps for hospitals, and they get more stringent as the years go on. About every five to six years the carbon cap on a building is going to be reduced. Emissions for each building are going to be calculated based on your energy consumption, your electric, natural gas usage, district steam, fuel oil; and then applying those carbon coefficients that you see in the chart there on the slide.

If your emissions exceed the cap, you're going to be fined at a rate of $268 per ton. The fines, starting especially in 2030 are expected to be pretty significant. By 2030, hospitals in New York City will have to reduce their EUI by roughly two and a half times or face significant fines. A reduction of this magnitude would put hospitals – EUI of hospitals – on par with a median office building. So it's a really significant reduction.

The question I pose: Is CO2 per square foot a good measure of efficiency? Are there better metrics out there? New York City in general is, has a low carbon per capita carbon emissions compared to suburban areas, as you can see from the maps there. New York City, Philadelphia, Baltimore, Washington, DC, Richmond. They really stand out as being low carbon emitters per capita because of the high density. Next slide, please.

Some of the challenges of energy efficiency in hospitals completing projects, we're occupied 24 hours of the day, 7 days a week. Typically, we're operating at 90 percent-plus occupancy. Changing lights, for example, isn't as easy as it is in an office building. We can't just go in at 5:00, change a bunch of fixtures, and then nobody's there. We have people there all the time, and we have infection control protocols that we need to meet.

And that picture there, you can see on of our electricians is working in a HEPA cart. Any time we get up above the ceiling, pull a ceiling tile, we need to have one of those carts available. So it's negatively pressurized. It captures all the dust and prevents it from getting in the patients' faces. A lot of the patients are immunocompromised. So this is a method of protecting them. It increases the cost, time, and complexity of completing projects.

So doing something like a wetting project, this increases the payback of that project. We also have operational requirements, temperature and humidity requirements that might prevent us from being as aggressive with certain set points. You know, chilled water resets. We can't economize necessarily as aggressively as some other building types. So this is a challenge as far as getting more efficient. Next slide, please.

So here's another example. We're replacing air handlers in critical areas. When we're doing this, we need to find another way to supply air to the space. So this might mean providing, installing temporary ducting from another air handler to serve the space temporarily. We might also have to install a temporary air handler. We have a project right now where we have the crane lift at 25,000

CFM air handler through the roof temporarily while we replace two air handlers, serving NOLAR. This is going to serve as the swing air handler. At the end of the project, we'll remove the temporary air handler from the roof. Again, it requires to crane picks, significantly adds to the complexity of the project, and also the cost. Another way to do it, and what you see pictured here, is we can demolish and replace one section of an air handler at a time over the course of three weekends.

So Friday, the space gets shut down. We demolish one section of the air handler, replace it. We start it up as a Frankenstein unit, operate it for the week, the next weekend. Next week, we might demolish the coils, replace that section, start it back up. Operate again a mix of the old and new unit for the next week. Third weekend, we'd replace the mixed air section, demolish it, and then we have a brand-new unit. But we're running around the clock with demolition and construction from Friday evening until Monday morning to get it back in operation for the Monday through Friday work week. And paying premium time, it's costly to do a project like that. Next slide, please.

So, all these challenges increase the cost and complexity of completing these projects. It doesn't necessarily increase – the energy savings don't increase. So what it does is just push the payback on the project out further. State and utility incentives, at least in New York, seem to be more set up for typical commercial office building. We don't really offset enough of the project costs to move the needle to make the projects that much more attractive. So we need to look to other areas to show value with the project. This could include reductions in operations and maintenance costs, and increased resiliency, reducing liability, increase in the lifespan of assets. And we can stack those values. It makes this easier to push these projects forward, and get them funded, and implement them. Next slide, please.

One of these projects that we were able to stack multiple values is we're looking to – we're currently in the process of winterizing a couple of our cooling towers. Right now, any time the temperatures drop below freezing outdoors, we have to drain the cooling towers below the roof line and shut down the central chiller plant. This requires that we have multiple process chillers for imaging equipment, and pharmacies, and other critical areas throughout the campus. So we have tons of process cooling all over the place that's not on the central plant.

Once we winterize our cooling towers, we'll be able to operate the central plant year-round, we can eliminate some of these process chillers. We don't need to drain and refill our cooling towers multiple times every winter, which is going to save on overtime. It's going to save on our water consumption, our chemical consumption and water treatment. It reduces the number of times you need to sterilize the tower. If we have to sterilize the tower, we kind of open ourselves up to potential fines from the city if we do it incorrectly.

Installing a water site economizer is going to allow us to reduce our air site economizing, which is going to reduce our humidification loads. So there's a lot of different values beyond energy savings that we're able to stack into this project, and it makes for a great, a good project for us financially. And I think that's it. Thank you.

Otto VanGeet: All right. Well, thank you, Dan. That was a great presentation on hospitals, and a very challenging sector, and look forward to lots of questions that hopefully the audience is submitting through Slido. In the meantime, I'd like to move onto our next speaker, Chris Halpin, of NV5 Energy Efficiency Services. Since 2003, Chris has been a FEMP-approved project facilitator, where he has managed over $2 billion in projects for federal agencies. Impressive number.

He's currently working on public-private partnership energy projects and resilience/microgrid projects for several clients. In 2018, his firm, Celtic Energy, was acquired by NV5 Global, a large multi-disciplinary engineering and technical services firm. And with that, Chris, please take over and tell us about high security facilities and some other things.

Chris Halpin: Right, Otto. Thank you so much. Appreciate it. And everyone, thank you for your time, and everyone in the audience, we really appreciate it, taking time out of your day to listen to this webinar, and hopefully you get something out of it. So, I wanted to talk a little bit about high-security facilities. And we've heard so many wonderful and interesting things so far from the other panelists; really some amazing statistics. I was sort of counting up on the back of the envelope the energy use from all these different facility sectors that you heard already. And that's between five and ten percent of the whole American energy use, just in those sectors. And so that's a really big deal.

So these are some examples – you can see on the slides that are up right now – of facilities that we've actually worked in, and helped

them with efficiency projects, and/or resilience projects. And they're all critical in one way or another. We did a comprehensive energy audit of the whole FBI academy lab complex in Quantico, VA. That's the lab that everybody sees in the CSI shows all the time. It's very famous, very interesting. So, and they pursued some pretty aggressive energy efficiency upgrades. As a result of our study, they did a complete retro commissioning of that laboratory, and saving a ton of money. And it's a big deal. It's a very big deal for their facility.

And then Jen talked a lot about sanitation and water and how much energy they use, and how critical they are. And we're working on a project now for LA county sanitation district where they had some 30-plus-year-old equipment that they needed to have replaced. They didn't have the bandwidth to do it, so they looked outside to bring in a third party solutions provider that used energy savings as a way to retrofit a lot of critical blowers, compressors, and so on.

Same thing with University Medical Center, and Dan did a great job talking about Presbyterian in New York. They're involved in similar projects here in Las Vegas at University Medical Center, where we used a turnkey retrofit energy provider to do a bunch of lighting retrofits and other things, but most importantly, replaced air handling units in ORs, and ERs without shutting them down, which is no small feat. All paid for out of savings.

And then lastly, an example in the commercial sector, we've been working with Pratt & Whitney for about 10, 12 years. They produce all kinds of jet engines, but are the sole producer for the new joint strike fighter military jet engine. And they did the same thing: comprehensive energy audit on the whole 2 million square foot campus in Middletown, Connecticut; one of the most secure facilities I've ever been in, and were I able to identify tons of energy savings that they could fund internally, and also go outside, if they wanted to.

What all of these facilities have in common are high security, and the absolute need for continuity of operations. In general, a lack of funding for operations and maintenance, which is surprising for some of the premier level things that you see here. But I've seen this in Fortune 50 companies. And deferred maintenance; big, big issue. It's becoming crisis level now in many sectors.

And a reduced availability with capital, especially today; whether you're a federal, state, local government agency, hospital, private company; just because of COVID-19 alone, there's serious, serious

issues with trying to get capital. So opportunities that presents, exploring alternative approaches to funding solutions to common challenges. And you've heard this all already. There's tons of challenges, lots of opportunity. Next slide.

So, sort of a tagline here is critical facilities: so much to do, so little funding. And it's very true. So how do you get past this? Well, if you're in the federal government, one of the things you can do is try to get whatever budgeted funding you can find. Sometimes some of our clients go after end-of-year money. If things haven't been spent in the budget by July or August, they can sometimes get money towards the end of the fiscal year, which is September 30, and at least use that as a seed fund to attract more capital to your project.

You can also look at alternative findings projects, and you'll see that all of these are live links, which we don't have time to get into now, but we can take a look at yourself afterwards. Some of these projects include energy savings, performance contracting, which the federal government has done over $8 billion worth and over 750 projects around the country.

And overseas utility energy services contracts, we do similar turnkey retrofit project. We source it through your local utility, through an area-wide agreement so you don't need to go through the whole elaborate federal design and build procurement process. You can do an enhanced use lease, which is less commonplace, but it's commonly used for sort of military bases will basically hand over a chunk of land that they're not using to a solar developer, will put a large solar array and give the government right of first refusal on use of that electricity. So the government gets a benefit.

And one of the more interesting things that have come up here in the past few years is energy as a service and resilience as a service. And this is something that's becoming really critical, as we know. You've heard it all already. How important keeping these facilities operating, and not always having the funding to do it. And that's owing to NRAL study that describes in fantastic detail how can really take a look at resilience as a service for your facility.

And I want to close this slide with a great quote from Mark Corell, who is the colonel in charge of the US Air Force's Office of Energy Assurance and everything in the federal government today – and I'm seeing it bleed into other levels of the government – is "Mission Assurance through Energy Assurance." Next slide.

So, same thing in federal government. You can talk to your federal project executive, find out what resources are available. Talk to them and your contracting officer. You need to get contracting officers involved from the very beginning of any kind of project you want to do. Start that acquisition process. Develop and implement the program. Again, I do a full-day class on all this. It's hard to do it in a few minutes. Enjoy benefits of avoiding the business interruption. This has been a big deal for a lot of clients. And repay the financing for the term of that contract. So you don't have to wait for capital appropriations. You can use third party financing for this. Next.

For state and local governments, it's very, very similar. Face a lot of similar challenges. You can use an organization called the American Society of Hospital Engineers if you're in hospitals like Dan and others are, any kind of health care facility, for their best practices and business planning for energy resilience. Contact your state energy office or the National Association of State Energy Officials about their programs. They've all got assistance in this realm for you.

Also, what most people don't know – everyone knows FEMA. After a hurricane after or a tornado, they come in and help people rebuild homes, and so on. But they also have a pre-disaster mitigation grant program. So you can basically help things like this firehouse be more resilient so in case of a disaster, they're prepared. They have solar with battery storage, say. We've seen a lot out here in the West to help keep these programs running.

And the USDA also has a rural development energy program, a fantastic ran program if you're out on the country. It can also consider performance contracting with your state and local government agency, the energy services coalition has tons of resources for you. And always contact your local utilities about incentives and grants. You can get 30 to 50 percent of your project paid for through these incentives and grants. Next.

So for private entities – again, have a lot of the same challenges. But they've got to turn a profit on top of providing a service. So it's a similar process, except you don't really have the opportunity to do these long, 20-year performance contracts and UESCs. But what you do have in many states are Commercial Property Assessed Clean Energy programs. And again, that's a live link to PACE nation, which allows any commercial entity that pays taxes to the local government to basically fund these projects through their property taxes, pay for it over 20 years.

And you can take a seven or eight-year simple payback project, pay for it over 20 years, and it becomes a huge cash outlay for the site. Actually, anyway, cash producer for the site. And the investment stays with the property, not the owner. So the owner can sell the building two or three years later, and the new owner takes over that assessment, becomes a special assessment, like a sidewalk or a sewer assessment. And also conduct research about investments or grants and on-bill financing is a big opportunity for many, many businesses. Next.

That's all I have. Thank you again so much. Appreciate it.

Otto VanGeet: Well, thanks, Chris for that great presentation. And now we're going to move onto the fun part, the main part of today's session. And that's the panel discussions. So as a reminder, do go to Slido and submit questions. And with that, we're going to go ahead and move to the next slide. And again, our panel will be broken into two rounds: round one will be themed Q and A. we'll start with continuity of the operations on that one, then we'll have project implementation and energy management best practices. And then in round two, we'll have the remaining questions from Slido. So next slide.

And just for practice on Slido, for continuity of operations, on a scale of one to five, rate your building's ability to continue essential operations during disruption. Meaning like a grid outage, severe weather event, cybersecurity attack, those sorts of things. And from this, it looks like the majority – this is a pretty nice distribution, actually. The majority is moderately prepared, three out of five. And then about a quarter. So that's about 40 percent. And then about a quarter is two out of five, and a quarter is four out of five. And then there's some outliers. There's some outliers who are five out of five, about ten percent who are ready for anything.

And that's awesome. Like to hear how you're doing that. And then there's another, say, four percent, who are in trouble. They are going to have some challenges here. And having some good responses. I'll give it a few more seconds here. Not quite as high of response as we had before. Something like 77 people out of our remaining 400 on the webinar. And it looks like that distribution is going to be the final answer.

So, with that, let's go ahead and we're going to move to the panel view. And from this view, which you'll see for the remainder of the

presentation, I'm going to ask questions that I've received from Slido, and I'll direct them to certain people on the panel. Make sure all the panel members are unmuted here.

And I'm going to go ahead and start with a question for Wendell. And then I'd like to have Dan and then Dale comment on this one. But starting with Wendell, how do you balance the need for reliable power with, for mission critical facilities – like labs in your case, or hospitals for Dan, or data centers for Dale – with the desire for efficiency and sustainability? So, Wendell, if you could start us. And again, then Dan, and then Dale on that question.

Wendell Brase: A research university has a lot of facilities which need continuity of power. It's not just that we – many of us have hospitals, but we have a lot of outpatient facilities which are not on uninterruptible power. We have animal colonies at every research university. I can tell you right now there are animal colonies for researchers who are working on, if not vaccines, therapeutics around the COVID pandemic.

There are advanced microscopy centers, which actually a lot of people don't know this, but they don't take a quick photograph of a specimen. They run sometimes for days, actually. Growth chambers, all these ultra low freezers you see on research universities. Those are full of research specimens that will be lost, and their value, in fact, will be lost. The value is not just economic value. It's all the high-priced labor that went into those experiments that are represented.

So this is a really big deal for universities. And having a university which has the kind of informatics that I talked about a few minutes ago really makes it possible to do a holistic solution. This is just the opposite of having battery backups in stairwells and corridors, you know, space by space. This is looking at it at an enterprise level. And I think universities and medical centers are pretty good at this, actually.

Co-generation is a big asset for those institutions that have it. I was the administrative vice chancellor at UC Santa Cruz in 1989 when the Loma Prieta earthquake interrupted power for the campus. Well, the campus has a co-gen. And it went uninterrupted during that major outage. That's a pretty good model of how co-generation can really make a big impact on resiliency.

Now, it's also a very efficient form of energy for a campus. But the Achilles' heel, though, is that it's carbon-based. It's using natural

gas. Fortunately, in Southern California, So Cal Gas has made a commitment to decarbonize their entire system by 2045. They have an aspiration to be the greenest gas utility in the world. And they're taking action and scaling up demonstration projects. In fact, some of their work is being done, actually, in your shop, Otto. They have some contracts with NREL that we know about to scale up the technologies that we'll need to comprise decarbonized system.

So, that would be the best of all worlds for us, if we can transition to decarbonized gas. They think will be done through a combination of not just one thing, four things: hydrogen injection, hydrogen direct service to some things like the ports, where you could use hydrogen directly for fuel cells for transport and heavy machinery; landfill gas, which is just being flared now, harvesting that; egg-based projects in California, quite a few of them, where using anaerobic digestion for animal waste is in the cards; and then bio digestion for just the waste stream that's coming through normal refuse disposal. So we're hopeful that they will make progress.

We know that some of the demonstration projects will be at the University of California, including this campus. And by, again, summing it up in a university that takes a holistic view of resiliency, and efficiency, and decarbonization, that's where you get the kind of scale of the solutions that we need to really combat this climate crisis that is probably just around the corner.

Otto VanGeet: Great. That's an excellent answer, Wendell. Very detailed. And then Dan, your turn to answer that same question. So balancing resilience or reliability with efficiency and sustainability for hospitals.

Daniel Mastin: Sure. Yeah. Resilient power is critical to – very critical to – hospitals. You know, the joint commission, which is an accreditation agency for the hospitals, requires that we maintain a 96-hour emergency plan with contingencies for things like blackouts. We have currently 25.8 megawatts of emergency power generators that sustain us if we lose grid power. We have a 7.5 meg co-gen system on our Cornell campus. I don't think resiliency and sustainability are necessarily mutually exclusive.

New York state's got one of the cleanest grids in the country. But I think our co-gen system, last time I looked into it, is still more efficient than the marginal peak producers at this point. And in the wintertime, a lot of the power plants are on interruptible gas. So they go to start burning fuel oil during the coldest days of winter.

They're doing that. Our co-gen is certainly more or less carbon intensive than those oil generators.

Some of the things that I worry about is New York state has some really aggressive goals for renewable energy; 70 percent by 2050 going to renewables. Currently, I think with nukes and wind, we're about 60 percent carbon neutral. You know, you look at a state like Texas, where they went to, I think they're about 20 percent wind generation. You know, last year in August, temperatures spiked to about 100 degrees. Spot electric prices went to $9,000.00 a megawatt. You know, if you're not hedged against that, your budget went up in smoke. But, they were also about three percent of excess capacity on the grid. So they were pushing pretty close to blacking out.

You know, as New York boasts of more and more renewables, our peak demand is probably going to shift from the summer to the winter. You know, you're probably going to be looking at the grid peaking sometime 7:00 AM on the coldest days of winter as New York City especially is pushing to electrify and decarbonize all heating fuels in buildings. So when you do that, the hospital is probably going to need about 40 megs of additional electric supply. So, there's concerns there.

And then we have to figure out how do we back that up? We're looking into some microgrid solutions with fuel cells, and hopefully decarbonizing the gas supply, as Wendell said, fuel cells can operate on hydrogen. So maybe you can build out your renewables so that you can over-generate and create crack water and create hydrogen, and use that to power fuel cells when your solar and wind and other renewables aren't produced.

Otto VanGeet: Cool. Yeah. That's a great answer. I'm going to actually move to the next question, so Dale you don't get to answer that first one, but you'll have plenty of opportunities for other questions, since Wendell and Dan did such a great job. So this next question I'm going to direct to Jen, and then have other panelists comment afterwards. But has the current pandemic made you think differently about continuity of operation plans? And then this will be the last question of this session. But again, Jen, if you could start that, and then other panelists chime in.

Jen Muir: Yeah. What's, I think, most interesting about that question is just thinking back about the fact that if we think about drinking water and wastewater facilitates that they are, in fact, critical facilities

related to public health. And so we do need to keep them operational.

And one of the largest concerns that happened with the pandemic or with COVID was actually the risk to the staff, and that the operation of the facility would be compromised by the fact that we would not have adequate staffing at the facilities. And that was one of the largest concerns for our industry was how do we protect not just folks on the facilities, but these critical folks who are operating the facilities who have that knowledge of how to operate and run these facilities.

Otto VanGeet: Cool. Let's see. Others? Has COVID affected your view of continuity of operations? Anybody else want to take that one? Dan, yeah, the New York-Presbyterian. *[Laughter]* You were at the epicenter of a lot of this. I'll bet you have a lot of great answers to this. *[Laughter]*

Daniel Mastin: *[Laughter]* Yeah. So, it was a struggle for all New York City hospitals. We were challenged by the governor to double our capacity. We had to double the number of beds we had. But we went from about 400 ICU beds to over 800. It put us on par with the state of Oregon for the number of ICU beds within our institution. Around the city, field hospitals were popping up. We had – we were putting hospital occupancies in areas that weren't designed to be hospitals: cafeterias, conference room, offices, lobbies.

You know, our friends at Mount Sinai up the street, they put a field hospital up in Central Park, a couple of tents there. The Javits Center, the state set up a temporary field hospital there. So, it's definitely a challenge when you have that huge surge, and talking to utilities, for instance, you know, Power Authority, Con Edison, the Gens Point. They had people actually moving into the plants and staying there for months at a time, living on cots. And it was to keep them isolated and prevent them from getting sick so that the electric grid can stay up and running. Interesting time.

Otto VanGeet: Boy, I guess. Challenging time. *[Laughter]*

Daniel Mastin: Yes. Yeah.

Otto VanGeet: Great job. So with that, I'd actually like to move to our round, our next questions in round one. And that's on project implementation. I guess actually maybe we're going to have a poll question. We already did that. So let's go to project implementation. In one or

two words, state your organization's main barriers for implementing projects. So this is a Slido question. And please go there and submit your answers to that – funding. Funding's the most common one. So how about some answers besides funding? Everybody has the funding challenge.

So, let's see. Management buy-in looks like it's there. Red tape. Staffing. Split incentives between management and C-suite. That's a really common one. That might be a good future question. Downtime. We heard several panelists talk about downtime. Yeah. Looks like the main themes are funding. No surprise there. That's the normal main theme. Then management buy-in, and then staffing/leadership, and then maybe staffing constraints. But with a lot of other great challenges there, also.

I'll give everybody a few more seconds to address this one. Yeah. Again, manpower, staffing seem to come up a lot. *[Laughter]* My favorite one here is "need Otto on our staff." *[Laughter]* I'm not so sure about that. *[Laughter]* But, thank you.

So, with that, I think we're going to go ahead and go back to our panel discussion. Welcome back, panel. And in this section, we're going to talk about project implementation. And now Dale is going to have his chance to talk since I cut him off last time. And then the question for Dale is given data centers are so energy-intensive, are there any requirements being put out there, being put out on computer vendors, et cetera, to use less energy? So what are vendors doing – and you can expand that as much as you want – to use less energy, Dale?

Dale Sartor: Sure. In the PUE calculation I mentioned, I mean, the IT equipment is the one, and that's often the dominant load. The first step, of course is to buy ENERGY STAR products, ENERGY STAR label servers, UPSs, and network equipment. Fortunately, partially because of Moore's Law, the efficiency of IT equipment doubles about every two years. So, we're doing the same amount of computations now for about the same amount of energy. I'm sorry. We're doing an order of magnitude more computations now with the same amount of energy that we did just a few years ago.

But I think the key on the IT side is utilization and virtualization. And that's more in the wheelhouse of the users to take advantage. I mean, buying a brand-new super powerful but very efficient server and running it – I mean, maybe you unload a server that was ten percent or 20 percent utilized and now you put that same load on a brand new server. Now it's only going to be like two percent

utilized. And it's using the same amount of power. So what we want to do is we want to increase that utilization rate, generally with virtualization. And if we can raise that up, we can get a lot more output for the same amount of input.

Otto VanGeet: Excellent. Thanks. That's impressive results and good opportunities. So, the next question – this is going to be directed to Wendell to start, and then other panelists to chime in. but what are your recommendations, Wendell, for pitching a program like smart labs – or other optimizing research at other facilities for other panelists – to organizational leadership? And can you address justifications providing up front capital for projects, maybe even how you funded some of your projects? So, Wendell to start, and then other panelists.

Wendell Brase: When we funded the smart labs improvements in buildings on two ways, depending on whether it was a retrofitted building or a new one. So for retrofits, what we did was the University of California for all of its campuses issued revenue bonds – 15-year revenue bonds. And there was some logic to the 15 years. The logic is this all started when the University of California in late 2007 made the commitment to become carbon neutral – the entire University of California; ten campuses and five medical centers.

And we didn't know how we were going to do it, frankly. We knew that the first big bite out of the carbon footprint would be deep energy efficiency, going deeper than we ever had, questioning all premises about things that were called best practices and standard practices, challenging those things; and wow did that work. I mean, smart labs is a prime example of how deep that went. So those project – the first smart lab projects are paid for with 15-year debt. And see what happens with that debt is it's paid off in 2024. The first debt issues in 2009. It was 15-year debt.

2025 is the day that the University of California has made the commitment to become carbon neutral. We expect to pay more for decarbonized energy. We think it's a big fallacy to just look at the cost of solar panels going down and say, "Oh, renewable energy is going to cost less than carbon-based energy." That is just oversimplified answer. It's ridiculous because it takes not into account at all the huge investments that are going to have to be made in storage, including seasonal storage, the grid improvements, all the resiliency stuff that is in the background at the infrastructure capital level.

So, we think we're going to have to pay more for decarbonized energy, and deep energy efficiency improvements will be paid off at just the right time to do that. So that is the logic behind that. I think I've drifted a little bit from the intent of your question, though.

Otto VanGeet: Yeah. And maybe the second half is management buy-in.

[Crosstalk]

Wendell Brase: These projects actually paid off. And that was before we knew what the co-benefits would be worth. So if you take that list of co-benefits that I had on that slide and put actual economic estimates on things like longer life of equipment, and less capital having to be spent in the central plant. And then it's really hard to put a dollar number on safer laboratories. They are safer. We have fewer airborne exposures. And that's what ventilation and air changes in laboratories are all about is preventing airborne exposure illnesses and injuries. Way less. It's hard to put a value on that because that's human suffering. And it's not just lost time. It's human suffering.

And so what you get is just an overwhelming ratio between the benefits and the costs. And management bought that. And actually, my boss at the time when we started that program, Michael Drake, he's a physician. He's now the president of the Ohio State University. And as soon as he saw that the people, students in laboratories and researchers in laboratories were going to be safer, that really sold it.

Otto VanGeet: All right. So, we're going to make that the last question for that subsection and move onto the energy management best practices session, because we're going to run out of time. And the first question we'll go to – let's go with Jen on this one, and then Chris. The first one is, Jen, how do you see the future of anaerobic digestion playing a key role in renewable energy investments as electrification becomes more appealing? So real specific anaerobic digestion question.

Jen Muir: Yeah. Great question. So it is a really important technology, particularly in the wastewater industry. And it does provide some ancillary benefits because at the same time we're doing anaerobic digestion to produce bio gas from the sewage sludge, we are also reducing the volume of waste product that eventually has to be disposed of, or hopefully beneficially reused, which is what we optimally like to do with the sludge and the bio solids.

But, as I noted in the slides earlier was that in addition to that, we have some of this drive for zero waste or organics or separation. And so our need to find a way to utilize that waste product, as well, really encourages the use of anaerobic digestion. But, to answer the portion of the question about electrification, we really have two choices in terms of what we do with the bio gas as produced. We can do co-generation on site, where we're actually producing power onsite, as well as heat.

And that can be, that's usually the first choice of a facility that has anaerobic digestion. And I think it will continue to be that way for a long time because they have such a large power demand onsite that they need to offset. The ability to make their own power onsite provides both resiliency, reliability, in addition to the obvious cost savings associated with energy reduction.

But, we do have another choice where we can convert, clean up the gas to the level so that it can be used in a CNG fueling station, or we can direct inject into the natural gas pipelines. And of course, there's some incentive programs and credits that can really make that a very viable and cost-effective option. And so my recent discussion with folks is that may be a way to go in the short term, a bridge type of technology. But I do feel like that anaerobic digestion is going to be with us for a long time, because of its usefulness in breaking down organics.

Otto VanGeet: Great. Well, thanks for that great answer, Jen. And the last question will be for Chris. And are there differences in ONM strategies for high-security facilities compared to normal facilities – say, an office building? So how do you do ONM for high-security facilities?

Chris Halpin: Sure. Thanks. Great question. So, there's certainly a big difference, and depending on the level of security you're talking about, the difference between going into, say, a city hall, versus a maximum security prison, or an FBI facility, there's a big difference in level of ONM that's required. What often happens is the background check process and vetting process of the employees of the companies, or the agencies that are running those facilities, as well as all of the contractors that they bring in are probably the first line of defense. That ends up cutting down the pool of applicants you can have either working for you directly as an employee or as a contractor.

So, it requires a lot more time and effort, honestly to get either just normal daily work done if you're an employee, to just operate air

conditioning equipment, heating equipment, process equipment, all that. On top of if you have to bring people in to do this work on a major retrofit project – like say you're going to do an anaerobic digestor at a wastewater treatment plant, you're going to be replacing a bunch of air conditioning units like Dan was talking about at New York-Presbyterian, it takes a long time to get set up, to do the work, to clean up, and leave and get off the premises, right?

And it ends up taking more calendar time, as well as more costs. And this is everything from just regular operations and maintenance, even when we're just changing filters in an operating hospital. I've been involved in hospitals for 35 years, and it's incredible what these folks are able to do to get that done. You have to run 24/7 requires a very strategic level of planning to be able to do that.

One of the things we're starting to see is a sort of combination of HVAC technologies and IT technologies – the whole Internet of things – offering that's going on, and using just sort of the power of data to optimize when you really need to get into those pieces of equipment and change filters, and lube motors, reshift fans, and all that. Because before, it would be like every six months, or every 4,000 hours you're going to do this. Now we're finding using real-time data acquisition you only need to do it when absolutely necessary.

So you may change one of ten filters that you would normally have changed. So that saves time, saves money, saves expense, and ultimately helps the bottom line, whether you're a public agency or a private company. It is important to everybody, too. And then you can gauge the energy efficiency of these things using building analytics in combination with computerized maintenance management systems. So there's a lot of powerful tools out there you can use.

Otto VanGeet: Great. Great. Yeah. And that's a great tie-in to some of the things Wendell had talked about, about building analytics and the information layer.

Chris Halpin: Mm-hmm.

Otto VanGeet: So, we are almost out of time, and I'm going to first thank all of our panelists for this great discussion. We have a lot more questions that we're going to have time to get to. But offline, we'll

try to answer some of those. And with that, Izzy, do you want to switch to some wrap-ups?

And some additional resources, hopefully you guys, everybody listening in, was inspired by what you heard from our panelists. Here's a list of additional resources. When you get the presentation this will all be live links. So I won't read through all of these for you. But so maybe if you could go to the next slide, Izzy…

And the Building Solution Center. And again, this is a comprehensive suite of available resources; over 2800 solutions to help you find proven and cost-effective energy and water solutions. Then there is also a video which we're not going to play right now talking about the Solution Center. And then the next slide.

There's also a Better Buildings Summer Webinar Series. Again, you can click on the register now to attend these great webinars. I encourage you to attend all of these. And let's go ahead and we'll go to the final slide.

And for additional questions, you can contact any of us. All of our presenters are listed on the right-hand side, and through Twitter, or the Better Buildings Solution Center. You can contact us at those locations. I'd like to thank everyone for submitting all your questions. Sorry we couldn't get to all of them. And I hope this was a valuable session. And I hope it was, more importantly, valuable for you, and you'll go out and implement some of these solutions for your critical facilities. With that, I'd like to go ahead and end this webinar.